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Effect of Varying Levels of Poultry Offal Meal Supplementation at Two Concentrate to Roughage Ratios on the Performance of Growing Lambs

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Abstract. Sixty Najdi lambs, weighing 23.5 kg were randomly placed in a 2 × 3 factorial arrangement of two levels of dietary energy (70:30 and 25:75 concentrate: roughage ratio) and three levels of poultry offal meal supplementation (0, 50 and 100 g POM/kg DM). Lambs were individually fed *ad libitum* and slaughtered after a 120-days feeding period; thereafter, slaughter weight, hot carcass weight, daily dry matter intake, feed to gain ratio and carcass composition including lean, bone and separable fat for each lamb were determined. The results showed that all studied traits were significantly influenced by the concentrate to roughage ratio; being superior ($P < 0.01$) for the lambs fed on high concentrate diets than for the high roughage fed lambs. Lambs fed on high concentrate diet supplemented with 10% POM produced 9.17, 4.39 and 0.45 kg more ($P < 0.01$) body, carcass and wool weight, respectively, over the 120 days feeding than for comparable POM-free diet group. Consequently, the former lambs consumed 1.5 kg or 21.1 MJ less dry matter intake or metabolizable energy intake respectively, per kg of body gain than those lambs fed on POM-free diet. On the other hand, threre was no significant effect due to POM supplementation on all carcass and performance data of the lambs fed on high roughage diets.

Introduction

Performance of lambs given grain-based diets are superior to those fed conventional roughage-based diets [1-2]. The future of availability of feed grains for sheep production is uncertain because of the high costs of production and the increased demand for cereals for human consumption. Therefore, reduced feed grains in lamb's diet would necessitate the identification of other unconventional resources that would produce acceptable performance and carcass characteristics. One of these resources is the poultry offal meal (POM) which considered unfit for human consumption and has a considerable potential as a source of both protein and dietary energy and may, therefore, be very useful as a nutritive supplement for ruminants [3]. However, accurate information on the nutritive value of POM needs to be available before it can be included effectively in compound diets. An experiment has therefore been carried out to examine the effects of varying levels of POM supplementation at two concentrate to roughage ratios on the performance and carcass traits of growing Najdi ram lambs.

Materials and Methods

Sixty Najdi ram lambs, weighing 23.5 kg and circa 3.5 months old, were randomly allotted to one of six dietary treatment groups in a 2 × 3 factorial arrangement of two concentrate to roughage ratios (70:30 and 25:75 concentrate: roughage ratio) and three levels of poultry offal meal supplementation (0,50 and 100 g POM/kg DM). All diets were isonitrogenous and diets within each concentrate to roughage ratio were isocaloric. The composition of all diets are presented (Tables 1 and 2). Lambs

Table 1. Ingredients and calculated composition of experimental diets[a]

	High concentrate			High roughage		
	Levels of poultry offal meal					
Ingredients, %	0	5	10	0	5	10
Poultry offal meal	–	5.0	10.0	–	5.0	10.0
Soybean meal	10.0	5.0	–	10.0	5.0	–
Barley	29.3	34.0	38.0	4.5	9.2	13.0
Corn starch	8.7	4.0	–	8.5	3.8	–
Yellow corn	20.5	20.5	20.5	–	–	–
Wheat straw	6.1	10.1	13.6	28.4	32.4	35.4
Alfalfa hay	23.9	19.9	16.4	48.1	44.1	41.1
Salt and minerals[b]	0.5	0.5	0.5	0.5	0.5	0.5
Sodium bicarbonate	1.0	1.0	1.0	–	–	–
CP, %	14.9	14.9	14.9	14.9	14.9	14.9
Ca, %	0.40	0.53	0.66	0.76	0.89	1.02
P, %	0.31	0.39	0.46	0.22	0.29	0.36
ME/kg DM, MJ	11.7	11.7	11.7	9.0	9.0	9.0

[a] Dry matter basis.

[b] Contained 10% Mn, 10% Fe, 10% Zn, 1% Cu, 0.3% I and 0.1% Co.

Table 2. Chemical composition of experimental diets[a], % dry matter

		High concentrate			High roughage		
		Levels of poultry offal meal (POM)					
Ingredients, %	POM	0	5	10	0	5	10
Dry matter, %	95.9	92.7	93.1	92.9	94.1	93.9	94.1
Crude protein, %	54.0	15.5	15.1	16.7	15.5	16.4	16.4
Ether extract, %	31.5	1.3	2.5	4.4	0.9	2.5	3.9
Crude fiber, %	0.0	14.0	13.0	13.4	28.4	26.3	26.6
TDN[b], %		69.7	68.5	68.2	55.2	53.2	52.0

[a] Laboratory determined.
[b] Total digestible nutrients.

were individually fed *ad libitum* in shaded pens and slaughtered after a 120-day feeding period to provide estimates of daily dry matter intake and body weight gain. Slaughter weight was taken after a 18-h shrink without feed; thereafter, each lamb was shorn and the wool weight recorded.

The lambs were slaughtered at the university abattoir. Hot carcass weight 30 to 45 min. after slaughter was recorded. Tail fat in each carcass was removed and recorded. Thereafter, carcass was split down the center of the backbone into two sides, and the right side was ribbed between the 12th and 13th ribs. After ribbing, an acetate tracing was made of the longissimus dorsi muscle, and a planimeter was used to determine the area. Fat thickness over the center of the logissimus dorsi muscle, and body wall thickness (11 cm lateral to the midline between the 12th and 13th ribs) were also measured. Right side of the carcass was dissected into its components of lean, bone and separable fat including attached kidney and pelvic fat. Each carcass component was then multiplied by 2 to provide an estimate of total carcass component. Detail description of the experimental design, digestibility trials and management of the lambs were previously reported [4,5].

Carcass characteristics and feeding performance data were analysed statistically by GLM, fixed-model procedures [6, p.433]. Treatment means were separated by Duncan's multiple range test.

Results and Discussion

Means for various body and carcass characteristics are presented (Table 3). All studied traits data were significantly influenced by the level of concentrate to roughage ratio in the diets; being higher (P < 0.01) for the lambs fed high concentrate diets than for the lambs fed high roughage diets. Similar results were reported by Ray and Mandigo [1] and Burton and Reid [2] who concluded that diet had been shown to have pronounced effect on lamb carcasses; lambs fed high energy diets typically were heavier, more efficient grower and produced carcasses with higher amounts of fat and protein as compared to those produced by lambs fed on lower energy roughage-based diets. For the lambs fed high concentrate diets, the data revealed that as the level of POM supplementation increased, the slaughter weight, empty body weight and wool weight significantly (P < 0.01) increased; however, dressing percent was not significantly influenced by the level of POM supplementation. In this regard, Najdi lambs fed on high concentrate diet supplemented with 10% POM produced 9.17, 4.39 and .45 kg more body, carcass and wool weight respectively, over the 120 days feeding period than the comparable 0% POM fed group.

Table 3. Means for various body and carcass characteristics from Najdi ram lambs as influenced by concentrate to roughage ratio (C:R) and level of poultry offal meal (POM) supplementation

Traits	C.R.	High concentrate			High roughage				Sifgnficance	
	POM:	0	5	10	0	5	10	SEM	C:R	POM
Slaughter wt.,kg		43.30^{b}	46.16^{c}	52.47^{d}	36.89^{a}	38.22^{a}	37.32^{a}	1.01	**	**
Empty body wt.,kg		37.72^{b}	41.12^{c}	46.76^{d}	29.76^{a}	30.36^{a}	30.27^{a}	1.12	**	**
Hot carcass wt.,kg		22.20^{b}	23.62^{b}	26.59^{c}	15.71^{a}	16.11^{a}	16.29^{a}	0.76	**	**
Lean wt.,kg		11.37^{b}	11.91^{b}	13.55^{c}	8.86^{a}	8.85^{a}	9.13^{a}	1.11	**	*
Fat wt.,kg		6.71^{b}	7.55^{bc}	8.36^{c}	3.28^{a}	3.46^{a}	3.17^{a}	0.67	**	NS
Bone wt.,kg		4.12^{b}	4.16^{b}	4.68^{c}	3.57^{a}	3.80^{a}	3.99^{ab}	0.56	**	*
Dressing %		51.3^{b}	51.2^{b}	50.7^{b}	42.6^{a}	42.2^{a}	43.6^{a}	1.27	**	NS
Tail fat wt.,kg		3.07^{b}	3.11^{b}	3.59^{b}	1.43^{a}	1.69^{a}	1.45^{a}	0.40	**	NS
Wool wt.,kg		1.27^{b}	1.45^{c}	1.72^{d}	1.30^{ab}	1.28^{ab}	1.15^{a}	0.42	**	**
Longissimus dorsi area, cm^2		12.87^{bc}	13.13^{cd}	13.49^{d}	12.04^{a}	12.13^{ab}	12.17^{ab}	0.62	**	NS
Body wall thickness, cm		2.01^{b}	2.15^{b}	2.50^{c}	1.62^{a}	1.60^{a}	1.58^{a}	0.14	**	*
Fat thickness, cm		0.60^{b}	0.65^{b}	0.78^{c}	0.32^{a}	0.34^{a}	0.34^{a}	0.10	**	*

a,b,c,d Values in the same row bearing different superscripts are different (P < 0.01).
** (P < 0.01); * (P < 0.05); NS = p > 0.05.

Accordingly, the corresponding increases in carcass components were 2.18, 1.65 and .56 kg of lean, fat and bone, respectively. These results are in accordance with those reported by Garrett *et al.* [7] who found that fat weight of the carcass increased as the rate of live-weight gain increased. Also Black [8, p.21] suggested that fat content of the carcass showed a curvilinear response to the feed intake of a well balanced diet. Therefore, from the foregoing results, it may be concluded that the differences in fat and lean weight due to POM supplementation in high concentrate diets were caused by differences in feed intakes (Table 4). Also, it should be pointed out that within the high concentrate diets, level of POM supplementation did not affect the chemical composition of lamb carcasses. The respective percentages of lean, fat and bone averaged 50.8, 31.2 and 18.0%, respectively. However, the same conclusion was also found for the chemical composition of the carcasses from the lambs fed on high roughage diets; the percentages of lean, fat and bone averaged 55.8, 20.6 and 23.6% respectively.

Table 4. Means for performance data from Najdi ram lambs as influenced by concentrate to roughage ratio (C:R) and level of poultry offal meal (POM) supplementation

Traits	C.R. POM:	High concentrate 0	5	10	High roughage 0	5	10	SEM	Significance C:R	POM
Daily dry matter intake, g		1174^{b}	1220^{b}	1354^{c}	1094^{a}	1077^{a}	1023^{a}	48.1	**	**
Daily body gain, g		165^{b}	188^{c}	241^{d}	111^{a}	122^{a}	115^{a}	8.4	**	**
kg DM/kg gain		7.1^{b}	6.5^{b}	5.6^{a}	9.8^{c}	8.8^{c}	8.9^{c}	0.4	**	*
MJ ME/kg gain		75.6^{b}	67.3^{b}	54.5^{a}	85.8^{c}	73.9^{b}	73.3^{b}	5.2	**	**

a,b,c. Values in the same row bearing different superscripts are different ($P < 0.01$).
** ($P < 0.01$); *($P < 0.05$).

It is important to note that the diets were formulated so that within each level of energy (concentrate: roughage ratio), the three diets were isonitrogenous and isocaloric. The calculated ratios for daily digestable protein intake (g) to daily ME intake (MJ) did not significantly change between the three studied diets within each level of energy, averaging 9.2 and 11.7 for the high concentrate and high roughage diets, respectively [4]. From the foregoing results, it may be postulated that changes in body gain composition between the two levels of energy diets were probably due to changes in protein to energy ratio. This postulation appears to agree with those reported by Butler-Hogg and Cruickshank [9, p.87] and Van Houtert and Leng [10].

The M. Longissimus drosi area increased significantly ($P < 0.01$) as the level of POM supplementation in the high concentrate diets increased. The corresponding areas per kg of empty body weight for the 0, 5 and 10% POM fed groups were 0.34, 0.32 and 0.29 cm^2, respectively. Fat measurements, namely, body wall thickness and body fat thickness increased non-significantly as the level of POM in the high concentrate diets increased from 0 to 5% and significantly ($P < 0.01$) from 5 to 10%. On the other hand, there was no significant effect due to the dietary levels of POM on all studied body and carcass characteristics of the lambs fed on high roughage diets.

Means for feeding performance data are presented (Table 4). All studied traits were significantly influenced by the levels of concentrate to roughage ratio and by the levels of POM supplementation in the diets. Generally, the high concentrate fed lambs consumed higher ($P < 0.01$) amounts of dry matter daily, produced greater ($P < 0.01$) daily body gain and required less amounts of dry matter intake per kg of body gain than the comparable lambs fed high roughage diets. For the lambs fed high concentrate diets, the results showed that as the level of POM supplementation increased, daily body gain significantly ($P < 0.01$) improved. In this regard, the lambs fed high concentrate diet supplemented with 10% POM consumed 1.5 kg or 21.1 MJ less dry matter intake or metabolizable energy (ME) intake respectively, per kg of body gain than those lambs fed on POM-free group. Except for ME intake required for kg body gain production in the high roughage-fed groups, there were no significant effects due to the dietary levels of POM supplementation on all studied performance data during the 120 days feeding period.

Generally, the lambs fed on high roughage diets supplemented with 5 and 10% POM consumed 11.9 and 12.5 MJ of less ME intake respectively, per kg of body gain production compared with those lambs fed on POM-free diet. Alshaikh *et al.* (Personal communication) reported that the inclusion of POM in the diet did not alter the plasma concentration of the triiodothyronine (T_3), while the concentration of thyroxine (T_4) was significantly ($P < 0.01$) declined only with the increasing level of POM in the high concentrate fed lambs. They concluded that the increases in the conversion of T_4 to T_3 in the 10% POM lamb leads to more utilization of food by the lambs fed on high concentrate diet; thyroid hormones could play a permissive role with other gluconeogenic and/or glycogenolytic hormones such as insulin, growth hormone and epinephrine [11, p.222].

The chemical analysis of POM showed that it contained 540 g protein/kg DM and 315 g ether extract/kg DM (Table 2). In that connection, Annous [3] found that POM showed a low fractional degradation rate similar to fish meal in the rumen of 4 adult rams. In the experiment described here, there appears to be scope for two mechanisms to be operating, depending upon the concentrate: roughage ratio and the level of POM supplementation of each particular diet. When high concentrate diets were given, it was obvious that the increased level of POM supplementation was associated with concomitant increased in lambs performance. The use of POM protein which probably has a low degradability can be expected to improve the performance of the growing lambs, especially during the starting phase, when there is, relatively, a high rate of protein deposition and protein requirements are high. This line of reasoning is supported by the fact that the inclusion in the diet of proteins resistant to microbial degradation in the rumen, increased the rate of protein absorption in ruminants [12]. Van Houtert and Leng [10] found that wool growth, feed intake, food conversion efficiency, and the deposition of fat and protein were increased due to supplementation with protected casein. In work where calves had been given heated soya products in two growth trials of about 120 days, daily weight gain was improved from 556g to 871g in one trial and from 640g to 844g in another. At the same time, there was an increased in feed intake with the treated soya group, and feed conversion was improved from 9.8 to 7.3 and from 8.1 to 6.8 in the two trials, respectively [13, p.36].

When high roughage diets were given, it was possible that fat content and/or fat type in the POM supplemented diets was a determinant factor. Dietary fat can adversely affect digestion of high fibrous diet in the rumen [14]. Various explanations for this phenomenon seem possible. Free fatty acids may adhere to certain strains of cellulolytic bacteria and inactivate them [15]. Alternatively, it has also been suggested that lipids inhibit the growth of rumen protozoa, and thus they inhibit the degradation of structural carbohydrates [16]. Also, Devendra and Lewis [17] stated that the adverse effects of fat on digestion of fiber in the rumen, often resulting in a reduced dietary intake. In the current study, however, voluntary intakes of high roughage diets were reduced non-significantly as the level of POM supplementation in the diet increased. On the other hand, the presence of large amounts of ground free particles containing non-structural carbohydrate in the studied high concentrate diets seems to prevent the negative effect of POM fat [18, p.4].

Certain amino acids are known to influence serum hormone concentrations. The amino acids profile of POM (unpublished data) revealed that it contains a considerable level of alanine (3.8%) in comparison of soybean meal (0.3%). Alanine is the primary amino acid utilized for glucose production by the liver and it is also reported to have good relationship with blood growth hormone level in sheep [19]. Kuhara *et al.* [20] suggested that the amino acid alanine stimulates growth hormone secretion via increase of plasma glucagon concentration. Therefore, there is a possibility that the intake of great amount of alanine from the 5 and 10% POM diet stimulates growth hormone secretion in high concentrate fed lambs but not in high roughage group, presumably due to an insufficient energy supply [4].

In conclusion, the inclusion of POM in the high concentrate diets used in this trial represented a potentially high quality by-product for use in finishing lambs. When POM was included in high roughage diets, although effects were not significant, the most obvious finding was improvement of the feed conversion ratio of the lambs offered a diet supplemented with POM at an incorporation rate of 100 g/kg DM. However, further experimental work is required to elucidate completely the mode of action of POM when it included in high concentrate and high roughage diets.

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تأثير إضافة مستويات مختلفة من مسحوق أحشاء الدواجن إلى الأعلاف المركزة أو المالئة على جودة الأداء في الحملان النامية

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(ورد البحث في ١٤١٥/٥/٥هـ؛ وقُبل للنشر في ١٤١٥/١٢/٢٩هـ)

ملخص البحث. استخدم في التجربة ٦٠ حملاً نجديًا متوسط أوزانها ٢٣,٥كجم، وقد وزعت الحملان عشوائيًا وبالتساوي على مستويين غذائيين من الطاقة (٧٠ : ٣٠ و٢٥ : ٧٥ مركزات : مالئ) وبداخل كل مستوى طاقة أضيف مسحوق أحشاء الدواجن إلى الغذاء بثلاث نسب مختلفة (صفر، ٥٠، ١٠٠جم/كجم غذاء جاف). وتركت الحملان للتغذي على النظم الغذائية التجريبية بصورة حرة وفردية ولمدة ١٢٠ يومًا، وبعد ذلك تم ذبح الحملان وقدرت أوزان الذبح، أوزان الذبائح الحارة، كمية الغذاء الجاف المأكول يوميًا، نسبة الغذاء إلى الزيادة في وزن الجسم، تركيب الذبائح ومحتواها من اللحم الأحمر والعظام والدهون المفصولة. أوضحت النتائج أن نسبة المركزات إلى العلف المالئ في العليقة كان لها تأثير معنوي إحصائيًا (P < 0.01) وبحيث تفوقت الحملان التي تغذت على نسبة عالية من المركزات على الحملان المغذاة على علائق تحتوي على نسبة عالية من المادة المالئة. وقد أدت زيادة إضافة مسحوق أحشاء الدواجن في العلائق عالية المركزات إلى ١٠٪ بالمقارنة مع العليقة الخالية من مسحوق الأحشاء إلى زيادة مقدارها ٩,١٧كجم في وزن الجسم، ٤,٣٩كجم في وزن الذبيحة و ٤٥٠جم في وزن الصوف، وقد صاحب هذه الزيادات نقص مقداره ١,٥كجم من العلف الجاف المستهلك واللازم لكل كجم زيادة في وزن الجسم لهذه الحملان. وعلى النقيض من تلك النتائج فإن إضافة مسحوق أحشاء الدواجن إلى العلائق ذات النسبة العالية من الأعلاف المالئة لم يكن له تأثير معنوي إحصائيًا على أية من الصفات السابقة للحملان.