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Effect of Roughage to Concentrate Ratio on Performance and Carcass Characteristics of Local Lambs in the United Arab Emirates

G.A. Alhadrami[1], A.A. Nigm[2], A.M. Kholif[3], and O.M. Abdalla[1]

[1]Department of Animal Production, Faculty of Agricultural Sciences, U.A.E. University, P.O. Box 17555, Al-Ain, U.A.E.
[2]Department of Animal Sciences, Faculty of Agriculture, Cairo University, Egypt
[3]National Research Center, Dokki, Giza, Egypt

ABSTRACT. Sixteen local ram lambs (18 ± 1.25 kg live weight) were divided randomly into four equal groups. Each group was offered ad libitum one of the following roughage: concentrate (R : C) ratios 100:0; 60:40; 40:60; and 20:80. Two lambs from each group were slaughtered after 3 months of feeding and the other two at the end of the trial (after 4 months).

Average daily gain ($P < .0001$), dry matter intake ($P < .0249$) and feed conversion ratio ($P < .0004$) were significantly affected by R : C ratio, Lambs receiving 60 or 80% concentrate consumed more feed, gained more weight, and converted feed more efficiently compared to the other two groups. The group fed no concentrate (100% R) gave the poorest performance.

Slaughter weight (SW) ($P < .05$), hot carcass weight (HCW) ($P < .006$), and dressing percentage (DP) ($P < .002$) were significantly influenced by R:C ratio. Groups that received 60 or 80% C had the highest SW, HCW and DP. Performance of lambs on 100% R was the poorest. Roughage : concentrate ratio had no significant effect on carcass traits or composition, except percent bone in the ribs cut ($P < .03$) was lower in animals fed 60 or 80% C (by 37 and 37.5%, respectively) compared to the group fed 100% R. Inclusion of concentrates improved significantly feedlot gain, feed conversion efficiency and carcass characteristics of local lambs. There was no advantage to extending the feeding period after 3 months.

In the countries of the Arabian Peninsula alone, there are 23 million sheep and goats (censured together) grown for meat (Phillai 1989). Local sheep (Mahali) in U.A.E. are black with small ears, long face and coarse-wooled. They are thin-tailed (with slightly thicker base), small in size and unthrifty in appearance; males and females are unhorned. They are well adapted to the prevailing harsh environment and their meat is preferred by the local population.

Their production is 13000 metric tons, representing 57% of the domestic red meat produced in U.A.E. (AOAD 1991). This contribution made by about one million heads is regarded as inefficient. This is probably due to poor genetic growth potential, poor nutrition, early slaughtering, and other environmental and management factors. Conventional production of slaughter lambs in U.A.E. depends primarily on rhodesgrass hay and pelleted concentrates. Concentrates are generally prepared from imported raw materials at local feed mills, while forage is less portable than concentrate and its local production is constrained by the scant supply of irrigation water in the Emirates (Glenn *et al.* 1992).

Although numerous studies have examined the importance of R:C ratio on fattening performance and carcass characteristics of slaughter lambs (Ranhotra and Jordan 1966, Craddock *et al.* 1974, Pope *et al.* 1984, Al-Saigh *et al.* 1988 and Hassan *et al.* 1990), none have been conducted with feeds and lambs common in U.A.E. According to Swingle and Moore (1987) "roughage: concentrate ratio can be manipulated to achieve dietary energy densities appropriate for various levels of productivity". The appropriate roughage to concentrate ratio could vary depending upon sheep breed and production systems employed.

This work was carried out to investigate the effect of roughage to concentrate ratio on average daily gain, feed efficiency and carcass characteristics of local ram lambs in UA.E. Characterization of the local sheep, for meat production, was also targeted as a prime need for developing an effective genetic improvement programme.

Materials and Methods

Animals, diets, and experimental procedures

This experiment was conducted at the U.A.E. University farm, Al-Oha, Al-Ain, United Arab Emirates. Sixteen ram lambs with mean body weight (BW) of 18 ± 1.25 Kg (twelve weeks old) were divided randomly into four equal groups to receive one of four roughage : concentrate ratios : 100:0; 60:40; 40:60; 20:80. Animals were housed in individual feeding pens two weeks prior to onset of data collection. All

animals were weighed every two weeks.

Diet consisted of rhodesgrass (Chloris gayana) as the only source of forage and pelleted concnetrate (manufactured by Abu Dhabi Flour and Animal Feed Factory). Rhodesgrass and pelleted concentrates were fed separately. Chemical composition of the rhodesgrass and pelleted concentrate is shown in Table 1. Lambs were fed diets ad libitum with free access to water and trace mineralized salt blocks. Feed was offered once daily in the morning (0700 h). Two lambs, randomly selected from each group, were slaughtered after 3 months. The other two were slaughtered a month later. The 9th, 10th and 11th ribs cut were taken from the left side of each carcass and physically dissected into lean, fat and bone. Fat thickness (FT) over the 9th rib and *Longissimus dorsi* area (LDA) were measured. Chemical composition of *L. Dorsi* muscle was analyzed according to AOAC (1986).

Table 1. Chemical composition of concentrate and rhodesgrass used in the feeding trial[1]

	Concentrate	Rhodesgrass
	% of DM	
Crude protein (CP)	14.3	5.9
Ether extract (EE)	5.0	1.7
Crude fiber (CF)	8.5	29.4
Neutral detergent fiber (NDF)	35.1	71.9
Acid detergent fiber (ADF)	11.9	40.8
Lignin	1.1	4.2
Cellulose	9.8	31.4
Ash	7.0	9.5

[1]Each value is the mean of two observations.

Data collection

The following traits were recorded or calculated : Average daily gain (ADG, g/day) calculated as (final BW-initial BW/days on feed; dry matter intake (DMI, Kg/day) calculated on DM basis as the sum of roughage and concentrate consumed daily by each animal; feed conversion ratio (FCR) calculated by dividing DMI (Kg)/

weight gain (Kg); slaughter weight (SW, Kg) recorded just prior to slaughter after fasting for 18 hours; hot carcass weight (HCW, Kg) recorded immediately after sluaghter; empty body weight (EBW, Kg) = SW + empty digestive tract – full digestive tract; cold carcass weight (CCW, Kg) taken after chilling at 5 °C for 24 hours; Dressing percentage (DP) = % CCW/SW. Physical dissection and chemical analyses were carried out only on carcasses of animals slaughtered after four months on feed.

Statistical analyses

Statistical analyses were conducted using SPPS/PC V 4 (1988). Differences among individual means were examined using Duncan's Multiple Range Test. The model used reads; $Y_{ij} = \mu + R_i + e_{ij}$. where Y_{ij} = an individual observation, μ = overall mean, R_i = an effect due to the ^{i}th class of R : C ratio and e_{ij} = the error term.

Results

Average daily gain of local ram lambs was significantly influenced by R : C ratio (Table 2). This effect was significant after one month ($P < .015$), two months ($P < .0001$) and the three months period ($P < .0001$). ADG increased progressively with increasing concentrate content up to 60% C and tended to decline slightly thereafter.

Table 2. Effect of roughage : concentrate ratio on average daily gain, dry matter intake and feed conversion ratio of local ram lambs[1]

	R : C ratio				± SEM	Probability
	100:0	60:40	40:60	20:80		
ADG						
1st month	46^b	50^b	125^a	62^b	10.9	.0015
2nd month	42^d	88^c	198^a	158^b	16.0	.0001
3rd month	51^c	99^b	162^a	153^a	12.0	.0001
DMI (g/day):						
roughage	672^a	441^b	324^c	160^d	50.1	.0001
concentrate	000^d	289^c	478^b	647^a	63.1	.0001
Total	672^b	730^{ab}	803^a	808^a	19.9	.0249
FCR (Kg DM/Kg gain)	13.0^a	7.2^b	5.0^b	6.3^b	0.89	.0004

[1]Means in the same row followed by different letters differ significantly ($P < .05$).

The following linear regression equation was fit to describe the relationship between average daily gains and R : C ratios: $ADG_i = 164 + month_i - 55\ X_i$ where X_i indicates the R : C ratio.

Dry matter intake and FCR after three months of fattening are shown in Table 2. Roughage : concentrate ratio altered DMI ($P < .025$) and FCR ($P < .0004$). Dry matter intake increased as concentrate increased from 0 to 60% but the rate of increase dropped drastically thereafter. The dry mater intake is negatively correlated with the R : C ratio as indicated by the following regression equation: $DMI_i = 800 + month_i - 54\ X_i$ where X_i indicates the R : C ratio.

The group fed no concentrate required 13.0 Kg DM/Kg BW gains, while groups fed 60 or 80% C required only 5.0 and 6.3 Kg DM, respectively. Though statistically nonsignificant ($P < .05$), increase percent concentrate from 40 to 60 or 80 resulted in 36 and 30% reduction in DM intake/Kg BW gain, respectively.

Effects of R : C ratio on carcass characteristics are shown in Table 3. Roughage : concentrate ratio affected slaughter weight ($P < .045$), hot carcass weiht ($P < .006$ and dressing percentage ($P < .002$). Also, it influenced % fill of digestive tract/SW ($P < .01$); % non-carcass fat/EBW ($P < .04$) and % fat tail/ CCW ($P < .006$). Slaughter weight and HCW increased progressively up to 60% C and decreased slightly thereafter. The inclusion of 40, 60 and 80% C increased SW by 27, 49 and 40% and HCW by 48, 87 and 76 % respectively, compared to the group fed no concentrate.

Dressing percentage increased with increasing percentage concentrate in the diet. Differences among groups received concentrate were non-significant ($P < .05$). But, differences between the group received no concentrate and groups receiving C ranged between 5.3 to 9% ($P < .0002$). Dressing percentage was influenced by differences in fill of digestive tract, non-carcass fat and % fat tail. The group fed no concentrate had the highest percentages of non-carcass components (Table 3).

Physical and chemical composition of carcasses are shown in Table 3. The only parameter influenced by R : C ratio was % bone in the ribs cut ($P < .03$). Groups fed 60 or 80% C had less bone (37%) than those received no concentrate. Increasing % concentrate from 0 to 80% resulted in increased % fat and decreased % bone while lean % remained almost constant.

Table 3. Effect of roughage : concentrate ratio on carcass characteristics and carcass composition of local lambs[1]

	R : C ratio				± SEM	Probability
	100:0	60:40	40:60	20:80		
Carcass characteristics:						
SW (Kg)	23.0^{b}	29.2^{ab}	34.3^{a}	32.1^{a}	1.59	.045
HCW (Kg)	8.5^{b}	12.6^{a}	15.9^{a}	15.0^{a}	0.93	.006
CCW/SW (%)	36.0^{b}	41.3^{a}	44.6^{a}	45.3^{a}	1.13	.002
Fill/SW (%)	25.4^{a}	20.2^{ab}	13.9^{bc}	12.9^{c}	1.68	.010
NEO[2]/EWB (%)	28.1	27.5	23.9	23.7	1.02	NS
NCF[3]/EBW (%)	5.5^{b}	6.9^{ab}	8.8^{a}	8.5^{a}	0.49	.040
Tail/CCW (%)	1.7^{b}	3.4^{a}	4.2^{a}	3.4^{a}	0.30	.006
Carcass composition[4] Physical dissection of ribs cut:						
Lean (%)	51.4	49.4	46.3	50.5	1.90	NS
Fat (%)	15.5	24.5	32.9	28.8	2.91	NS
Bone (%)	33.1^{a}	26.1^{ab}	20.8^{b}	20.7^{b}	2.06	.03
LDA[5] (cm^2)	7.1	9.7	11.2	12.0	0.93	NS
FT[6] (mm)	2.8	4.8	4.8	6.2	0.68	NS
Chemical composition of *L. dorsi* muscle (%):						
Moisture	73.0	72.4	72.9	72.8	0.20	NS
Protein	19.3	22.1	20.9	21.1	0.47	NS
Ether extract	3.9	3.9	4.2	4.4	0.40	NS
Ash	1.0	1.0	0.8	1.1	0.04	NS

[1]Means in the same row followed by different letters differ significantly ($P < .05$).

[2]Head + hide + legs.

[3]Heart fat + kidney fat + caul fat + gut fat.

[4]Measured on animals slaughtered after 4 months.

[5]LDA = *Longissimus dorsi* area.

[6]FT = Fat thickness.

Discussion

Results of the present study indicate that conventional system of lamb production in UA.E. hinders the potential of these animals. Lambs fed totally on rhodesgrass with no concentrate had the poorest performance of all groups. Inclusion of concentrates improved feed gain, feed conversion efficiency and carcass characteristics of local lambs. The results are in agreement with the findings of Ranhotra and Jordan (1966), Craddock *et al.* (1974), Al-Saigh *et al.* (1988) and Hassan *et al.* (1990) who also reported that high concentrate diet increases ADG and feed efficiency in lambs.

From this study, the optimum R : C ratio for fattening local lambs in U.A.E. seems to be 40 : 60. The group fed 60% C had the highest ADG and converted feed most efficiently. Also, our data indicated strong relationships among ADG, DMI and FCR. With those local sheep, 80% C showed no advantage over 60%C. It seems that local sheep in U.A.E. are early maturing animals with early and possibly high rate of fat deposition. Therefore, feeding 80% C in the hope of adding more muscle rather than fat seems not to be possible given the genetic growth potential of local sheep. This explanation is supported by the higher estimates of FT and % ether extract of the group fed 80% C.

The same trend can be seen for carcass characteristics; the group fed 60% C had heavier slaughter and carcass weights but nearly the same DP as lambs fed 80% C. Pope *et al.* (1984) reported that higher concentrate diet (70%) produced heavier carcasses with significantly higher DP than lower concentrate diet (25%). Percentage bone in the carcass was reduced by 37%, in 60 and 80% C groups compared with the no concentrate group. The 80% C group was relatively fatter than the 60% C group as indicated by high FT and % ether extract.

Results of this study concerning R : C ratio are in agreement with those from numerous studies. Ranhotra and Jordan (1966) recommended 25 : 75 R : C diet for lambs weaned at 7 weeks to have fast and efficient BW gains. Craddock *et al.* (1974) showed a diet containing 80% C reduced DMI and reduced gain slightly but improved feed efficiency compared with a 50 : 50 R : C diet. Pope *et al.* (1984) reported lambs fed R : C of 30 : 70 did not gain faster than those fed 70 : 30, however, HCW and DP were higher when the high concentrate diet was fed. In Egypt, Aboul-Naga and El-Serafy (1988) recommended 60 : 40 and 40 : 60 R : C ratios for growing and fattening native lambs, respectively. Economics of the feeding regime and genetic potential should also be considered in the election of the R : C ratio. In this experiment the feed costs for 1 kg liveweight gain were: 7.54, 5.09, 3.86 and 5.78 Dirhams for the R = C ratios of 100:0; 60:40; 40:60 and 20:80 respectively. Thus, the diet of 40:60 is favorable in terms of net return.

After three months of feeding, lower ADG and more fat deposition were noticed indicating early maturity of local sheep. Also, market attitude in the U.A.E. favors small carcasses with more tender and lean meat. Comparing overall means for local lambs with their corresponding means reported for temperate or fat tailed breeds may be beneficial in judging their meat production potential. Overall mean of ADG was only 116 g/day which is much less than 170, 210 and 301 g/day reported for Awassi by Lamia and Al-Jaryan 1991, Goddard 1988 and Guney and Bicer 1986, respectively, and similar to 140 g/day reported by El-Serafy *et al.* 1981 for native lambs in Egypt. However, the ADG (162 g) value obtained for the 40% R group indicates good potential for these local sheep, when feeding conditions are improved. The overall mean of feed conversion ratio (FCR, 8.1 Kg DM/Kg gain) was much higher than that reported for Awassi (3.8) by Guney and Bicer 1986, however, it was comparable to the 7.3 obtained for the same breed by Lamia and Al-Jaryan 1991.

Dressing percentage obtained for local lambs (41.7%) was, also, much lower than estimates reported for Egyptian Barki (46%, Galal *et al.* 1975), for Awassi (48.5%, Galal *et al.* 1975 in Egypt) and (53.8% Lamia and Al-Jaryan 1991 in Iraq). Also, Nigm *et al.* 1993 reported 49.8% DP for Australian Merino imported for slaughter in the U.A.E. Comparing estimates representing chemical composition with those reported by Nigm *et al.* 1993 for Australian Merino and Turkish lambs imported to U.A.E. market shwoed that local lambs had higher estimates of FT (4.61 *vs.* 3.1 and 2.61) and % ether extract (4.33 *vs.* 2.92 and 1.92%) than native, Turkish and Merino lambs, in respective order. These results support the conclusion that local sheep are early maturing animals. Possibilities are opened for improvement includes primarily effective breeding practices and efficient feeding management.

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تأثير نسبة العلف الخشن إلى المركز على اداء وخصائص الذبيحة في الحملان المحلية في الإمارات العربية المتحدة

غالب علي الحضرمي [١] و علي عطية نجم [٢] و عبد القادر محمود خليف [٣] و عمر محمد عبد الله [١]

[١] قسم الإنتاج الحيواني - كلية العلوم الزراعية - جامعة الإمارات العربية المتحدة
ص .ب (١٧٥٥٥) - العين - دولة الإمارات العربية المتحدة
[٢] قسم الإنتاج الحيواني - كلية الزراعة - جامعة القاهرة - مصر
[٣] مركز البحوث الوطني - الدقي - الجيزة - مصر

تم توزيع ١٦ من الحملان المحلية (وزن حي ١٨ ± ٢٥ ,١ كغ) عشوائياً إلى ٤ مجموعات متساوية ، غذيت كل مجموعة حتى الشبع بأحدى العلائق التالية وكانت نسبة العلف الخشن إلى المركز كالآتي : ١٠٠ :صفر ، ٦٠ :٤٠ ، ٤٠ :٦٠ و ٢٠ :٨٠) . تم ذبح حملين من كل مجموعة بعد ثلاثة شهور من التغذية والحملين الآخرين عند نهاية التجربة (بعد ٤ شهور) .

لقد أثرت نسبة العلف الخشن إلى المركز معنوياً على معدل الزيادة اليومية في الوزن (P<.0001) كمية المادة الجافة المأكولة (P<.0249) وكفاءة التحويل الغذائي (P<.0004) ، استهلكت الحملان التي غذيت على ٦٠ أو ٨٠٪ علف مركز علفاً أكثر وأظهرت زيادة في الوزن أعلى كما كان تحويلها الغذائي أكثر كفاءة من المجموعتين الأخريين . أعطت المجموعة التي لم يقدم لها علف مركز (١٠٠٪ علف خشن) أضعف النتائج .

أثرت نسبة العلف الخشن إلى المركز معنوياً على وزن الذبح (SW) (P<.05) وزن الذبيحة (HCW) (P<.006) ، ونسبة التصافي (DP) (P<.002) . أظهرت

المجمـوعـات التي أعطيت ٦٠ أو ٨٠٪ من العلف المركـز أعلى قـيم للأوزان عند الذبح ، أوزان الذبائح ونسب التصافي . كـان أداء الحملان التي غذيت على ١٠٠٪ علف خشن أضعفها . لم يكن لنسبة العلف الخشن إلى المركز تأثيراً معنوياً على صفات الذبيحة أو تركيبها ، عدا تأثيرها على النسبة المئوية للعظم في عينة الأضلاع (P<.03) حيث كانت أقل في الحيوانات التي غذيت على ٦٠ أو ٨٠٪ من المركز (بنسب ٣٧ و ٥ ,٣٧٪ على التوالي) مقارنة بالمجموعة التي أعطيت ١٠٠٪ علفاً خشناً . أدت اضافة المركزات إلى تحسيناً ملموساً في الزيادة في الوزن ، كفاءة التحويل الغذائي وصفات الذبيحة للحملان المحلية . لم تكن هناك أية فائدة من إطالة فترة التغذية لأكثر من ثلاثة شهور .