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Effect of concentrate feeding on milk yield and body-weight change of Awassi ewes and the growth of their lambs

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Abstract

The response of Awassi ewes to graded amounts of supplementary concentrate diet was examined for the first 12 weeks of lactation. The growth rate of lambs and their health status were also investigated. Seventy-five ewes were divided into three equal groups and given a basal roughage diet of shredded wheat straw at a rate of 750 g dry matter (DM) per ewe per day supplemented with a concentrate diet at three amounts, 950 g (low), 1150 g (medium) and 1350 g (high) of DM per ewe per day starting at the beginning of lactation. Ewes were adapted to the diet by feeding daily at a rate of 200 g per ewe during the last 6 weeks of pregnancy. The concentrate was estimated to contain 11·8 MJ of metabolizable energy and 182 g of crude protein per kg DM. Ewes and their offspring were housed in a partly enclosed yard. Lambs remained with their dams continuously except for the days of milk yield measurements, when they were separated from the dam for 11 or 12 h. The ewes were examined for subclinical mastitis and the incidence of scouring in lambs was recorded.

Ewes given the high level of concentrate produced more ($P < 0·05$) milk but differences between medium and low groups were significant only up to week 4 of lactation. Total milk yields during the 9 weeks test period were 58·5, 70·4 and 93·3 kg for the low, medium and high groups, respectively. Ewes suckling twins produced more ($P < 0·05$) milk than ewes suckling singles. The rate of weight loss was lower ($P < 0·01$) for ewes given the high feeding regime; these regained their immediate post-lambing body weight by week 10. Sex of lambs and litter size had no affect the incidence of scouring in lambs or mastitis in ewes.

On both economical and biological grounds it is recommended to offer concentrate during the first 9 weeks of lactation at levels >950 g per ewe per day in order to produce an appreciable yield of milk and restore a positive energy balance early in the ewe lactation period.

Keywords: *Awassi, body weight, growth rate, mastitis, milk yield, sheep.*

Introduction

The Awassi sheep is the most popular fat-tail dairy breed in Middle Eastern and adjacent countries. The breed has been introduced recently into New Zealand and Australia because of an increasing demand for sheep milk, cheese, other dairy products and growing preference for Awassi meat. The Awassi sheep is well known for its adaptability to harsh, semi-arid and arid environments, resistance to diseases, flocking instincts and ability to travel long distances. The breed is kept traditionally for the production of milk, meat and wool, and plays a significant socio-economic rôle, which exceeds the importance of cattle and goats in Jordan and neighbouring countries.

Milk may come after meat in importance but its demand is growing. Milk goes either into home use or processing into cheese, dried yoghurt (Jameed) and ghee which is a traditional industry in the

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Table 1 *Chemical composition of the concentrate mixture and the straw (g/kg dry matter (DM))*

	Concentrate	Straw
Crude protein	182	46
Acid-detergent fibre	128	442
Neutral-detergent fibre	422	728
Ash	65	84
Gross energy (MJ/kg DM)	18·03	17·6
Estimated metabolizable energy (MJ/kg DM)	11·8	6·6

Middle East. Prices of dairy products from sheep milk exceed those from cow milk. Limited information is available on the effect of nutrition on milk yield, body-weight change, health status of Awassi ewes and the growth of their lambs.

The experiment described here examined the effect of feeding Awassi ewes different amounts of concentrate for the first 9 weeks of lactation on milk yield and body-weight change in the ewes and growth rate of the lambs over 12 weeks of lactation. The health status of ewes and their lambs were examined also.

Material and methods

Animals

Seventy-five Awassi ewes aged between 3 and 5 years with a mean post-lambing weight of 66·6 (s.d. 8·93) kg, were allocated to three equal groups according to age, weight and type of birth (single or twins). Milk yield measurements were made over a 24-h period and repeated weekly over the first 9 weeks of lactation. Ewes and their offspring were housed in a partly enclosed yard. Lambs remained with their dams continuously except for the days of milk measurements and had restricted access to a creep diet. All lambs were weaned at approximately 12 weeks of age and their weight at weaning was recorded.

Diets and feeding

Coarsely milled wheat straw (0·5 to 1 cm) was offered to all ewes at a rate of 750 g dry matter (DM) per day. A concentrate diet was offered at the rate of 950, 1150 or 1350 g DM per ewe per day for the low, medium and high groups respectively. The concentrate consisted of (g/kg fresh basis), 500 whole barley, 250 wheat bran, 80 coarsely ground maize, 150 soya-bean meal, 14 dibasic calcium phosphate, 5 NaCl and 1 minerals and vitamins mixture. The chemical composition of the straw and concentrate is given in Table 1. Metabolizable energy (ME) contents of the concentrate and the straw were estimated using conventional digestion experiments. Gross energy (GE) content of the two foods and faeces were measured by bomb calorimeter (Parr Instrument Co., Illinois, USA). Metabolizable energy intake (MEI) was calculated as 0·81 digestible energy (DE) intake (Ministry of Agriculture, Fisheries and Food (MAFF), 1987) and DE was estimated as the difference between GE intake and output in faeces. The creep diet for lambs was formulated to provide a high level of fermentable carbohydrates and protein. It consisted of (g/kg fresh basis), 450 coarsely ground maize, 130 wheat bran, 100 coarsely ground maize, 300 soya-bean meal (US origin, 480 g crude protein per kg), 13 dibasic calcium phosphate, 5 NaCl and 2 of the same minerals and vitamins mixture as in the concentrate mixture offered to ewes. The grains were hammer milled to pass a 6·25-mm screen. The fixed amount of diet was divided equally into two portions given at 9:00 h and 16:00 h every day. Fresh water and minerals blocks were continuously available.

Measurement of milk yield

Milk yield was estimated using the method of Peart (1982) which involved weighing the lambs before and after suckling and removal of residual milk by hand. The measurement was made over a total of 24-h and repeated weekly over the first 9 weeks of lactation. On the day of measurement, lambs were removed at 20:00 h, and weighed (M1) at 7:00 h next morning before being returned to join their mothers. They were allowed 45 min to obtain milk, weighed again (M2) and the difference between M2 and M1 was assumed to be the amount of milk consumed (suckling yield). Milk remaining in the udder was removed by hand by three well trained shepherds and weighed to the nearest g. Lambs were again removed from their dams after the morning milk yield measurement and the procedure repeated on the same day at 20:00 h to measure milk yield for the other half of the day. The sum of suckling yield and hand milked yield from the two measurements was assumed to be milk yield over the 24-h period. The single weekly estimate of milk yield was assumed to represent the average daily milk yield for the week in which it was measured. Total milk yield for the first 9 weeks of lactation was calculated using the single weekly estimates.

Weighing and health observation

Ewes and lambs were weighed to the nearest 0·25 kg and 0·1 kg respectively, each week at the same time of day before feeding. The health status of ewes and lambs was checked routinely for the incidence of mastitis and scouring. A standard diagnostic procedure (International Dairy Federation, 1981) was

Table 2 *Effect*

Week
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Results

Food intake

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Table 2 *Effect of amount of concentrate offered on milk yield (kg/day) of Awassi ewes*

	Concentrate level (g DM per ewe per day)						
	950		1150		1350		
Week	Mean	s.e.	Mean	s.e.	Mean	s.e.	Significance
1	1·103[a]	0·095	1·429[b]	0·083	1·561[b]	0·097	*
2	1·394[a]	0·115	1·645[b]	0·101	1·713[b]	0·168	*
3	1·405	0·112	1·377	0·096	1·568	0·112	
4	1·030[a]	0·079	1·316[b]	0·092	1·541[c]	0·079	*
5	0·912[a]	0·076	0·967[a]	0·066	1·523[b]	0·077	*
6	0·746[a]	0·098	1·005[a]	0·086	1·514[b]	0·100	*
7	0·676[a]	0·100	0·908[a]	0·087	1·354[b]	0·102	*
8	0·599[a]	0·096	0·765[a]	0·088	1·310[b]	0·098	*
9	0·490[a]	0·102	0·648[a]	0·094	1·278[b]	0·104	*
Total milk yield	58·5[a]	2·053	70·4[a]	1·861	93·3[b]	2·248	*

[a,b,c] Different superscripts denote significant differences within rows ($P < 0·05$).

used for the detection of subclinical mastitis while a visual check was practised to record scouring.

For mastitis, the ewes were sampled twice, the first at 2 weeks after lambing and the second 2 to 3 weeks later.

Statistical analyses of data

The following linear model (Henderson, 1984) was used to evaluate the influence of concentrate intake by the ewe and sex of lamb and litter size on changes in ewe body weight, daily milk yield and growth of lambs,

$$Uijkl = u + Ni + Xj + Tk + eijkl$$

where u is an overall mean associated with each observation, Ni is the effect of ith level of feeding (low, medium and high), Xj is the effect of the jth sex of lamb, Tk is the effect of the kth type of birth of lambs (single or twins) and $eijkl$ is the random error assumed to be normally and independently distributed. Reductions in the sums of squares were calculated in order to estimate the effect of a given factor adjusted for other factors in the model, then estimable functions were calculated to test the difference among the three levels of feeding, between the two sexes and between singles and twins.

Results

Food intake

Estimated MEI of the concentrate food was 11·21, 13·57 and 15·93 MJ per ewe per day for ewes offered the low, medium and high amounts of supplement, respectively. MEI from straw was the same across treatments (4·95 MJ per ewe per day). Total MEI from concentrate and straw was estimated to be 16·2, 18·5 and 20·9, respectively, for ewes in the low, medium and high groups, respectively.

Response of ewes and their lambs

Ewes in the high treatment group produced more milk ($P < 0·05$) during the first 9 weeks of lactation than ewes in the low or medium groups. Ewes in the high group returned to immediate post-lambing weight by week 9 whereas ewes of other groups were still below their post-lambing weight at the end of the 12-week suckling period. Total milk yield for the first 9 weeks of lactation was estimated to be 58·5, 70·4 and 93·3 kg per ewe for low, medium and high treatments, respectively (Table 2). Milk production peaked 2 weeks after lambing for the medium and high groups and 3 weeks after lambing for the low group. The rate of decline in milk yield was lower in the high treatment than in the other two treatments. Sex of lamb had no influence ($P > 0·05$) on milk yield (Table 3) but there was a trend towards higher milk yield for ewes suckling male lambs. Ewes with two lambs produced more milk ($P < 0·05$) than those with one and maintained a higher level of milk yield throughout the 9 weeks of lactation (Table 3).

Ewes with two lambs tended to lose more weight during weeks 8 to 12 of lactation (Table 5) than those with one lamb. Body-weight change was small for ewes in the high group, which lost significantly less weight ($P < 0·05$) than those in the other two groups (Table 4). No differences were observed in body-weight change between ewes suckling either males or female lambs (Table 5).

Weaning weight and live-weight gain (Table 6) were slightly higher in the high treatment, but differences

Table 3 *Effect of sex and litter size on milk yield (kg/day) of Awassi ewes*

	Sex†				Type of birth			
	Male		Female		Single		Twin	
Week	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
1	1·408	0·076	1·331	0·073	1·176	0·066	1·673**	0·085
2	1·609	0·092	1·570	0·088	1·320	0·081	2·013**	0·102
3	1·519	0·087	1·355	0·084	1·336	0·077	1·589*	0·097
4	1·224	0·072	1·180	0·069	1·075	0·064	1·400**	0·081
5	1·141	0·058	1·078	0·060	0·945	0·053	1·372**	0·067
6	1·129	0·078	1·056	0·075	0·941	0·069	1·250**	0·087
7	1·004	0·080	0·891	0·077	0·837	0·070	1·117*	0·089
8	0·964	0·083	0·855	0·079	0·773	0·068	1·008*	0·087
9	0·882	0·073	0·784	0·068	0·695	0·066	0·928*	0·082

† Sex effect was not significant at any week ($P > 0·05$).

Table 4 *Effect of amount of concentrate offered on body-weight change of Awassi ewes after lambing (± kg relative to weight after delivery of lambs(s) and placenta)*

	Concentrate level (g DM per ewe per day)						
	950		1150		1350		
Weeks after lambing	Mean	s.e.	Mean	s.e.	Mean	s.e.	Significance
1	1·795	0·80	1·606	0·78	3·306	0·66	
4	0·730[a]	1·20	–2·012[a]	1·23	4·167[b]	1·22	**
8	–2·973[a]	1·29	–4·363[a]	1·32	–0·736[b]	1·31	*
10	–4·288[a]	1·48	–6·194[a]	1·51	0·319[b]	1·50	**
12	–6·123[a]	1·36	–8·106[a]	1·53	0·100[b]	1·52	***

[a,b] Different superscripts denote significant differences within rows ($P < 0·05$).

Table 5 *Effect of sex and litter size on body-weight change of Awassi ewes after lambing (± kg relative to weight after delivery of lamb(s) and placenta)*

	Sex†				Type of birth†			
	Male		Female		Single		Twin	
Weeks after lambing	Mean	s.e.	Mean	s.e.	Mean	s.e.	Mean	s.e.
1	2·208	0·64	2·263	0·63	2·046	0·52	2·767	0·84
4	0·986	1·00	0·938	0·99	1·284	0·89	0·303	1·45
8	–2·536	1·08	–1·863	1·06	–1·788	0·92	–3·300	1·51
10	–3·508	1·23	–3·267	1·21	–2·679	1·06	–5·217	1·73
12	–4·876	1·25	–4·546	1·23	–4·085	1·14	–6·283	1·86

† Sex and type of birth effects were not significant at any week ($P > 0·05$).

between groups were not statistically significant ($P > 0·05$).

The prevalence of subclinical mastitis was not associated with the treatments. Twenty-seven ewes were infected with *Staphylococcus epidermidis*, which was the most prevalent aetiological agent (0·83 of diagnosed cases). Two more infections were diagnosed during the second sampling, raising the total number of infected ewes to 29 (39% the experimental animals) and a total of 41 glands with subclinical mastitis. The incidence of scouring was

Table 6 *Birth weig amount of concentra*

Parameters
Birth weigh
Weaning w
Live-weigh
0-30 day
31-60 day
61-90 day
0-90 day

[a,b] Different supers

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Discussion

Traditionally, in ewes are given barley grain and the ewe until 10 also taken for h the ewes are of days. Milk yield suckling regime *et al.* (1980) to be lactation and 15 Similarly, Juma yield of 141·2 kg results suggest systems, Awassi per day. The a provided to lacta amounts of 2 recommended f and National Res

Results from the the traditional severely limits over 9 weeks of day supplemen compared with 1 1150 and 1350 g the traditional sy

Table 6 *Birth weight, weaning weight (90-day) and live-weight gain of lambs during the pre-weaning period of life as affected by amount of concentrate given to their mothers*

	Concentrate (g DM per ewe per day)						
	950		1150		1350		
Parameters	Mean	s.e.	Mean	s.e.	Mean	s.e.	Significance
Birth weight (kg)	4·31	0·151	4·74	0·157	4·57	0·172	
Weaning weight (kg)	22·7	1·00	23·7	0·77	26·4	1·22	
Live-weight gain (g/day)							
0-30 day	279	11	295	11	277	14	
31-60 day	209	11	188	11	204	9	
61-90 day	121[a]	10	159[b]	9	215[c]	9	***
0-90 day	203	10	214	7	232	9	

[a,b] Different superscripts denote significant differences within rows ($P < 0·001$).

also independent of the concentrate feeding level with similar numbers of lambs across treatments (four, five and five for the low, medium and high treatments, respectively) being recorded during the first 4 weeks of life.

No treatment was given and lambs were allowed to recover naturally.

Discussion

Traditionally, in the Middle East, lactating Awassi ewes are given about 950 g/day of a mixture of barley grain and wheat bran. The lambs remain with the ewe until 10 to 12 weeks of age but some milk is also taken for human consumption. After weaning, the ewes are often milked for a further 60 to 100 days. Milk yield of Awassi sheep under continuous suckling regime in Iraq has been reported by Guirgis *et al.* (1980) to be 105·4 kg during the first 3 months of lactation and 155·7 kg over 167 days of lactation. Similarly, Juma and Alkass (1996) reported a milk yield of 141·2 kg during 125 days lactation. These results suggest that, under traditional feeding systems, Awassi ewes produce a little over 1 kg milk per day. The amount of supplement traditionally provided to lactating Awassi ewes is well below the amounts of 20·1 and 22·6 MJ ME per day recommended for lactating ewes by MAFF (1987) and National Research Council (NRC, 1985).

Results from the experiment described indicate that the traditional supplement of only 950 g/day severely limits milk production. Mean milk yield over 9 weeks of lactation for the ewes given 950 g/day supplement was recorded at 0·93 kg/day compared with 1·12 and 1·48 kg/day for ewes given 1150 and 1350 g supplement daily. Ewes fed under the traditional system utilize a significant amount of body reserves during lactation and, unless such losses are regained before the next production cycle, subsequent fertility and milk yield will be severely reduced (Peart, 1982). Low food intakes appear to be the major reason for low milk yield and low fertility and twinning rate reported for Awassi sheep in Arab countries (Galal *et al.*, 1989; Harb, 1994). Mavrogenis *et al.* (1980) studied the effect of body-weight changes before and after lambing on the performance of Cyprus fat-tailed, Chios and Awassi sheep in Cyprus and found that milk production was highest for ewes on the high level of feeding and Awassi ewes produced more milk than the other two breeds. Awassi sheep in Cyprus produced more milk during the first 90 days of lactation than the local Chios sheep (114·3 *v.* 105·4 kg) and milked for a longer period (Mavrogenis, 1996). However in Israel, genetically improved Awassi ewes under good management produced 506 l milk per lactation period of 206 days or 293 l in 90 days (Gootwine *et al.*, 1995). MEI from straw and concentrate in the experiment described in this paper were estimated to be 16·2, 18·5 and 20·9 MJ per ewe per day, while recommended allowances for ewes suckling singles and twins are 23·6 and 26·5 respectively (NRC, 1985), during the first 8 weeks of lactation. Requirements for ME for maintenance and production of Awassi sheep can be calculated using data on intakes, milk yield and body-weight change. Energy values of 4·6 MJ/kg for milk and 20 MJ/kg for mobilized body tissue were used (MAFF, 1987). Constant efficiencies of 0·62 for dietary ME and 0·80 for body reserve were also used in the calculation. Estimated ME requirements for a 65 kg ewe suckling a single lamb and losing 50 g body weight per day was 20·9 MJ for the first 8 weeks of lactation. These values are in close agreement with those reported by NRC (1985), after adjusting for body weight changes. In comparison with MAFF (1987), our estimates fall

between their estimates for lactating lowland ewes suckling twins and those suckling singles during the first 8 weeks of lactation. The results presented in this paper show that feeding lactating Awassi ewes an extra 400 g of supplement daily for the first 9 weeks of lactation, or a total of 25 kg food, would increase milk yield over the period by 35 kg. The increased amount of supplement given daily also increased ewe body weight 10 weeks after lambing by 6 kg compared with the traditional feeding regime.

This reduced decrease in body weight during lactation would be expected to improve subsequent reproductive performance in ewes (Peart, 1982). Because the value of 1 kg of milk is about five times the cost of 1 kg supplementary food in Middle Eastern countries, the results reported indicate that increasing the amount of supplement given to lactating Awassi ewes by 400 g/day would improve both the economical and biological efficiency of the production system.

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Digestion a supplemen

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Abstract

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† Present addre Alimentos, Uni Brazil.