The Effect of Dietary Fat Inclusion on Nutrient Intake and Reproductive Performance in Postpartum Awassi Ewes

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ABSTRACT : The objective of this study was to evaluate the effect of dietary fat inclusion on nutrient intake, body weight, milk production, return to estrus, pregnancy and lambing of winter-lambing, postpartum Awassi ewes. Thirty multiparous, winter-lambing Awassi ewes (body weight=51±7.0 kg) were randomly assigned to three dietary treatments (n=10) for 62 days using a completely randomized design. Experimental diets were isonitrogenous, and were formulated to contain 0 (CON), 2.5 (MF), and 5% (HF) added fat, and 33% of the dietary crude protein (CP) as undegradable intake protein (UIP). On day 26 postpartum (day 0=parturition), ewes and their lambs were housed in individual pens for 28 days. Feed offered and refused was recorded daily. At the end of this period, ewes and their lambs within each treatment were combined into one group and fed their respective diet *ad libitum*. One fertile Awassi ram fitted with a marking harness was allowed with each group for 34 days. No significant (p>0.05) differences in dry matter intake, organic matter intake, and crude protein intake were observed for ewes fed the three experimental diets. No difference was observed in metabolizable energy intake (MEI) for ewes fed the CON and the MF diets (average 8.3 Mcal/d) diet. However, ewes fed the HF diet had greater (p<0.05) MEI compared with the rest of the treatments. Ewe body weights increased throughout the study, unaffected by the experimental diets. No significant differences in milk production were found among ewes fed the three experimental diets. No significant differences were observed in pregnancy rate (6/10, 5/10, 6/10 for CON, MF and HF diets, respectively), lambing rate and the number of lambs per ewe among the three treatments. These results indicate that fat inclusion to high concentrate diets does not improve postpartum reproductive performance of well-fed, winter-lambing Awassi ewes. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 10 : 1395-1399)***

Key Words : Dietary Fat, Suckling, Awassi, Sheep, Reproduction

INTRODUCTION

The normal breeding season for Awassi sheep begins between mid June and mid July (Epstein. 1982) resulting in lambing during autumn and winter. Under natural conditions. Awassi ewes undergo postpartum anestrus during the spring. As a result. one lamb crop can be acquired each year. Postpartum anestrus is caused by several factors such as lactation (Foxcroft. 1993). nutrition (Lindsay et al., 1993), season (Delgadillo et al.. 2001) and other factors. Ovarian activity. estrous behavior and pregnancy can be reestablished shortly after parturition by manipulating one or more of these factors.

Nutrition plays a key role in regulating the reproductive performance in sheep and cattle. Kridli et al. (2001) reported that well-fed postpartum Awassi ewes returned to estrus earlier. indicating the possibility of lambing every six months. Restriction of energy intake has a major role in increasing the length of postpartum anestrus in sheep and cattle (Schillo. 1992). Energy balance is an important regulator in the resumption of ovarian activity in postpartum dairy cows (Canfield and Butler, 1989). Cows receiving high level of energy during the postpartum period had increased LH pulse frequency and decreased the period from parturition to ovulation (Perry et al.. 1991). Providing ewes with adequate energy during the postpartum period may be a key regulator in the resumption of ovarian activity. For this reason. this experiment was designed to evaluate the effects of dietary fat inclusion on nutrient intake. body weight, milk production. return to estrus, conception and lambing in winter-lambing. postpartum Awassi ewes.

MATERIALS AND METHODS

The study was conducted at the Center for Agricultural Research and Production at Jordan University of Science and Technology located in the northern part of Jordan at 32 30'N and an altitude of 860 m. The experiment was conducted during the months of November through January. Average length of the day in December and January is 10 h 29 min and 11 h 12 min, respectively. Animals were maintained at ambient temperature and natural day length.

Thirty multiparous. 3 to 7 year old. winter-lambing Awassi ewes (initial postpartum body weight=51 kg) were used in the study. The experimental animals were selected based on lambing dates. Ewes with single lambs that lambed within 5 days of November 18th were selected for this study. Ewes and their lambs were randomly assigned to one of three dietary treatments (10 ewes/treatment) in a

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Table 1. Ingredient and chemical composition of the experimental diets fed to postpartum Awassi ewes for 62 days beginning on day 26 postpartum

	CON	MF	HF
Alfalfa hay	20	21	20
Wheat straw	10	7	6
Corn grain	25	25	26
Barley grain	33	32.5	30
Soybean meal	10	10	11
Fat	0	2.5	5
Mineral and vitamin supplement[1]	1	1	1
Salt+limestone	1	1	1
DM (%)	92.6	92.8	92.8
Organic matter (%of DM)	92.6	92.9	93.0
Crude protein (% of DM)[2]	15.1	15.3	15.2
Ether extract (%of DM)	2.1	4.6	7.0
NDF (% of DM)	27.5	25.5	23.9
ADF (% of DM)	16.0	14.8	13.9
Metabolizable energy[3] (Mcal/kg)	2.71	2.83	2.94

[1] Supplies per kilogram of feed: 4.9 mg of Zn, 4.05 mg of Mn, 0.45 mg of Cu, 0.075 mg of I, 0.1 mg of Se, 2,500 IU vitamin A, 400 mg of vitamin D, 2.5 IU vitamin E.
[2] 33% of the dietary protein content was ruminally undegradable. Calculated using NRC (1996).
[3] Calculated using NRC (1985).

completely randomized design on day 26 postpartum. Each treatment contained ewes of all ages. Animals were allocated to receive three experimental diets with 0 (CON), 2.5 (MF) or 5% added fat (HF) (UFAC Ltd., Newmarket, UK). The experimental diets were formulated to be isonitrogenous and contain 33% of CP as UIP. Diets were sampled upon mixing for chemical analysis. Samples were oven-dried (60°C), ground through 1 mm screen and analyzed for CP and ether extract (AOAC, 1990), neutral detergent fiber (NDF), acid detergent fiber (ADF) and lignin (Goering and Van Soest, 1970). Metabolizable energy contents of the diets were calculated by using NRC (1985).

The experiment was divided into two phases, the individual feeding phase and the breeding phase. During the feeding phase, ewes and their lambs were placed in individual pens (1.5×0.75 m) and were fed the experimental diets individually twice daily at 0830 and 1500 h for four weeks. Feed offered and refused was recorded daily. Clean drinking water was provided *ad libitum*. Animals were allowed one week in the individual pens for adjustment before receiving the experimental diets.

Body weights of all experimental ewes and their lambs were recorded at the beginning of the study and every other week thereafter. Blood samples were collected every other day from each ewe (via jugular venipuncture) into heparinized tubes to monitor luteal activity. Plasma was harvested by centrifugation and stored at -20°C until analyzed for progesterone (Diagnostic Products Corporation, Los Angeles, CA, USA) by RIA (Gamma counter, Riastar™, Packard, CT, USA). At the end of the 28 d individual feeding period, milk production was estimated in all ewes by oxytocin-induced hand milking (Said et al., 1999). Each ewe was injected intravenously with oxytocin (5 IU) and then directly milked by hand. Ewes were isolated from their lambs for four hours after which the milking procedure was repeated. At this time, milk production was evaluated using a graduated cylinder.

Table 2. Body weight, body weight change and nutrient intake of postpartum Awassi ewes fed diets with variable added fat contents*

	CON	MF	HF	SE
DM intake (g/d)	2,979	2,992	2,938	48.9
OM intake (g/d)	2,759	2,780	2,733	45.2
CP intake (g/d)	456	458	450	7.5
NDF intake (g/d)	819[a]	763[b]	702[c]	12.6
ME[1] intake (Mcal/d)	8.1 [b]	8.5 [ab]	8.6 [a]	0.1
Body weight change, kg	2.2	3.9	2.8	1.1

* Control (CON), medium fat (MF), and high fat (HF) contained 0, 2.5 and 5% of the dietary fat, respectively.
[a, b, c] Means within the same row with different superscripts differ ($p<0.05$).
ME: metabolizable energy.

At the end of four weeks of the individual feeding period, ewes and their lambs within each treatment were combined into one group and fed their respective diet *ad libitum*. Blood samples were collected every other day from each ewe via jugular venipuncture into heparinized tubes to monitor the luteal activity as described earlier. One fertile Awassi ram fitted with a marking harness was allowed with each group for two consecutive cycles (34 days). Rams were rotated among groups every three days. Estrus was monitored through checking breeding marks twice daily throughout the study. At the end of this period (end of the experiment), rams were removed and milk production was estimated again using the same procedure described earlier. Lambing data were recorded five months later.

Means for diet effects were analyzed as a completely randomized design using the general linear model procedure of SAS (1985). Differences among treatment means were detected by least significant difference (SAS, 1985). Estrus expression, pregnancy and lambing were analyzed by Chi Square.

RESULTS AND DISCUSSION

Ingredient composition, nutrient intake and body weight

Control, MF and HF diets contained 0, 2.5 and 5% added fat, respectively. Ingredient composition of the experimental diets is presented in Table 1. Crude protein content was similar among the experimental diets (15.3%). Ether extract was greater in HF than the MF and the CON diets (Table 1). Metabolizable energy content was 2.71, 2.83 and 2.94 Mcal/kg for the CON, MF and HF diets, respectively.

There was no significant difference in dry matter intake

Table 3. Growth performance (mean±SE) of lambs as affected by the fat content in their dams' diets*

	CON	MF	HF	SE
Initial weight, kg (28 d PP)	11.9	12.7	12.2	0.8
Final weight, kg (84 d PP)	26.3	27.4	28.4	0.9
Growth rate[1], g/d	250	271	288	15

* Control (CON), medium fat (MF), and high fat (HF) maternal diets contained 0, 2.5 and 5% added dietary fat, respectively.
[1] Calculated between day 28 and 84 postpartum.

(DMI) for ewes fed the CON diet (2.979 g/d) as compared with ewes fed the MF (2.992 g/d) and HF (2.938 g/d) diets. Similar results were observed for CP intake (Table 2). These results are in agreement with Sarwar et al. (2003) who reported no differences in DMI and CP intake in cows fed diets with variable fat contents. Metabolizable energy intake (MEI) was greater ($p<0.05$) in ewes fed the HF diet than ewes fed the CON diet, but there was no difference ($p>0.05$) in MEI among ewes fed HF and MF diets. The greater MEI might have accounted for the numerically greater body weight change in ewes fed additional fat compared with the controls.

Diets in the present study were formulated to contain 33% of the dietary CP content as undegradable intake protein (UIP). This percentage was selected based on the results of Al-Wadi (2003). In that study, postpartum Awassi ewes were fed diets containing 17, 25 and 33% of the dietary crude protein as UIP. Ewes fed 33% UIP had greater DMI, gained more weight and had greater pregnancy rate, lambing rate and number of lambs born/ewe compared with the other UIP levels. In the present study, the various levels of dietary fat did not influence DMI. This may be due to the high level of UIP used in this experiment. This similarity in DMI among the treatments was reflected in the similar CP and OM intakes.

By the end of the experiment, ewes in all treatments gained a similar amount of body weight (Table 2). Body weight data for animals receiving added fat (MF and HF groups) were pooled and compared with the controls (Figure 1). The initial weight was used as a covariate to eliminate pre-treatment variations. There was a treatment by week of recording interaction with respect to body weight. Body weight was greater ($p<0.05$) on the third and fourth recordings and numerically greater ($p>0.05$) on the fifth (Figure 1). De Fries et al. (1998) concluded that postpartum dietary fat supplementation had no effect on body weight or body weight change in cows. Heifers fed high-energy content diet, however, had heavier body weights and attained puberty earlier than those fed low energy diets (Bergfeld et al., 1994).

Restriction of dietary energy during the postpartum period was reported to cause a decrease in body weight in beef cows (Perry et al., 1991). In the current study, there was no difference in DMI in ewes fed the HF diet as

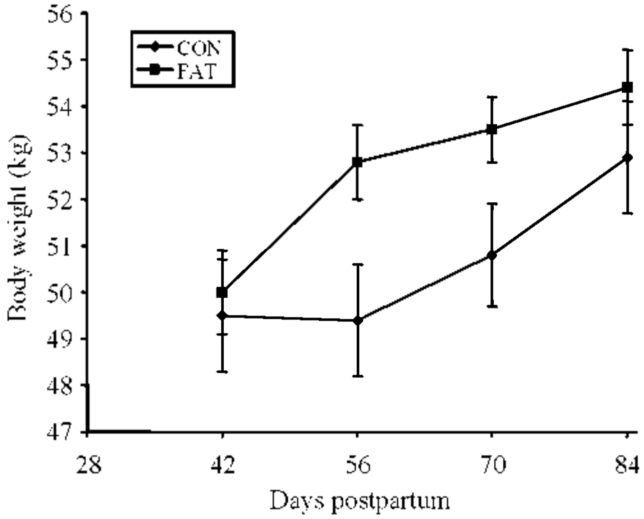

Figure 1. Body weights of Awassi ewes fed diets with (FAT) or without added fat (CON).

compared with CON and MF diets. Thus, there were no differences in the body weight or weight change among the three treatments. Body weight is considered to be a good indicator of the animal energy status (Randel, 1990) and postpartum reproductive performance (Rutter and Randel, 1984; Randel, 1990; Short and Adams, 1998; Wettemann and Bossis, 1999). At the time of parturition, ewes are faced with high nutrient demands to meet the increase in milk production. During this period the increase in nutrient demand is sharper than the increase in feed intake resulting in loss of body weight.

Milk production

Milk production was recorded on days 60 and 95 postpartum. The various levels of fat inclusion did not influence milk production. The amount of milk produced on day 60 postpartum was similar to that reported by previous studies (Said et al., 1999; Al-Wadi, 2003). Milk production on day 60 postpartum was greater ($p<0.001$) than that on day 95 postpartum (1,637 and 954 g on days 60 and 95 postpartum, respectively). This drop in milk production is expected after three months of lactation. When pooling milk production data, no differences were observed among controls and animals receiving added fat. Milk production was 1.219 g and 1.372 g for the CON and fat-receiving animals, respectively.

Lamb growth rate

Growth rate of lambs was not affected by the added fat in their dams' diets, although there was a decrease in milk production throughout the suckling period. Lambs in the HF group had an average daily gain (ADG) of 288 g/d compared with 250 and 271 g/d for CON and MF groups, respectively (Table 3). Lambs had access to their dams' feed thus allowing them to meet some of their growth needs.

Table 4. Postpartum reproductive performance of Awassi ewes fed diets with variable added fat contents for 62 days beginning on day 26 postpartum

	CON	MF	HF
Number of ewes expressing estrus	6	8	9
Days postpartum to ovulation[1]	50.4±4.4	39.4±4.4	46.1±4.4
Days postpartum to first P_4 rise	54.4±4.4	43.4±4.4	50.1±4.4
Pregnant ewes	6	5	6
Lambed ewes	6	4	4
No. of lambs per exposed ewe[2]	0.6±0.2	0.6±0.2	0.6±0.2

* Control (CON), medium fat (MF), and high fat (HF) diets contained 0, 2.5 and 5% of the dietary fat, respectively.
[1] Calculated based on progesterone concentration. [2] Lambs born or aborted during late pregnancy.

Lamb growth rate in the present study was greater than that reported by AL-Wadi (2003) (181 g/d). This difference may be due to the higher energy contents of feeds used in our study.

Reproductive performance

Plasma samples collected every other day were analyzed for progesterone concentration. No differences were observed in days postpartum to the first progesterone rise and days postpartum to ovulation among treatment groups (Table 4). The number of ewes expressing estrus was also similar among the three treatments (Table 4). Ninety percent (9/10) of ewes in the HF group expressed estrus compared with 80% (8/10) and 60% (6/10) for MF and CON groups, respectively. Restriction of dietary energy in the early postpartum period reduced the number of ewes exhibiting estrus within the breeding season (Schillo, 1992). Short and Adams (1998) reported that insufficient energy intake prolonged postpartum anestrus. This may be due to impaired ovarian response to LH, reduced pituitary responsiveness to GnRH, and reduced pulsatile release of GnRH (Schillo, 1992). Ewes with optimum body condition had high ovulation and lambing rates (Thomson et al., 2003) compared with long postpartum intervals in ewes with poor body conditions (Gonzalez et al., 1987). In the current study, body weight change was not influenced by the experimental diets and thus the postpartum interval and estrus expression were not affected. Kridli et al. (2001) reported reduced ovarian activity as a result of body weight loss in postpartum Awassi ewes. These authors hypothesized that the loss of body weight might have caused a reduction in the nutrient availability required by the pituitary gland to secrete gonadotropins.

Pregnancy was determined based on progesterone concentration on days 18 to 20 of the estrous cycle. There was no significant difference in pregnancy rate for ewes fed the CON (6/10) compared with ewes fed MF (5/10) and HF (6/10) diets (Table 4). Lambing rate was also similar among the treatment groups (Table 4). The number of lambs per exposed ewe (born or aborted during late pregnancy) was similar among the three treatments (Table 4). When pooling the data for groups receiving added fat, no significant differences were observed in the day postpartum to first progesterone rise, day postpartum to ovulation, pregnancy rate and lambing rates between CON and fat treated animals, although all of these variables were numerically greater in ewes receiving the added fat diets.

Perry et al. (1991) reported that postpartum cows receiving high level of energy had shorter interval from parturition to ovulation, and increased pulse frequency of LH. Conception rate and pregnancy rate declined when beef cows received inadequate energy during the postpartum period (Randel, 1990). De Fries et al. (1998) suggested that fat supplementation in cows enhanced the development of ovulatory-sized follicles and improved pregnancy rate. The fact that ewes in the present study maintained their body weight indicated that they received adequate nutrients (energy) in their diets. This might be the reason why reproductive parameters were similar among the three dietary treatments.

IMPLICATIONS

Results of this study demonstrate that the various levels of added dietary fat did not affect well-fed postpartum Awassi ewe performance. Dry matter intake was sufficient for all ewes to gain weight during the postpartum period, thus, no significant effects of fat inclusion were observed on productive and reproductive characteristics.

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