Effects of stage of lactation and dietary forage level on body composition of Alpine dairy goats

A. T. Ngwa,* L. J. Dawson,*† R. Puchala,* G. Detweiler,* R. C. Merkel,* Z. Wang,* K. Tesfai,* T. Sahl,* C. L. Ferrell,‡ and A. L. Goetsch*¹

*American Institute for Goat Research, Langston University, Langston, OK 73050

†College of Veterinary Medicine, Oklahoma State University, Stillwater 74078

‡USDA, ARS, US Meat Animal Research Center, Clay Center, NE 68933

ABSTRACT

Multiparous Alpine does (42) were used to determine how stage of lactation and dietary forage level affect body composition. The feeding and body composition portion of the study had a 2×3 factorial arrangement of treatments. Eighteen does were fed a 40% forage diet (40F) and 18 received a diet with 60% forage (60F) for approximately 2, 4, or 6 mo of lactation (59 ± 1.3 , 116 ± 1.0 , and 184 ± 1.4 d, respectively), followed by determination of body composition (6 does per diet at each time of slaughter). Does were assigned sequentially to treatments as kidding occurred. The 60F diet had 20% more dehydrated alfalfa pellets than the 40F diet, with higher levels of corn and soybean meal and inclusion of supplemental fat in the 40F diet. Initial body composition measures were made with 6 other does a few days after kidding (0 mo; 4 ± 0.6 d). Before parturition, does were fed a 50% concentrate diet free choice. Intake of dry matter was greater for 60F than for 40F, average daily gain tended to be affected by an interaction between diet and month (0, 24, 121, –61, 46, and 73 g), and 4% fat-corrected milk was less in mo 5 to 6 than earlier. Internal fat mass was greatest among times at 6 mo and greater for 40F than for 60F. Mass of the gastrointestinal tract was less for 40F than for 60F and decreased with increasing time in lactation. Concentrations of fat in the carcass (13.8, 13.1, 16.5, 11.2, 11.5, and 14.4%), noncarcass tissues (18.6, 24.2, 33.3, 14.3, 16.5, and 24.5%), and empty body (16.5, 18.7, 25.2, 12.9, 14.1, and 19.5% for 40F at 2 mo, 40F at 4 mo, 40F at 6 mo, 60F at 2 mo, 60F at 4 mo, and 60F at 6 mo, respectively) were affected by stage of lactation and diet. Based on daily change in tissue mass and energy, energy concentration in tissue mobilized or accreted was 16, 20, and 32 MJ/kg in 1 to 2, 3 to 4, and 5 to 6 mo of lactation, respectively. In conclusion,

based on tissue mass, more energy was expended by the gastrointestinal tract with 60F than with 40F. Considerable internal fat appeared to be mobilized in early lactation, particularly with the diet moderate to high in forage, with more rapid and a greater magnitude of repletion by does consuming the diet lower in forage. The concentration of energy in tissue mobilized or accreted varied with stage of lactation, being considerably greater at 5 to 6 mo of lactation than earlier.

Key words: dairy goat, lactation, body composition

INTRODUCTION

A complete understanding of the composition of tissue being accreted or mobilized is necessary to determine dietary energy needs. For lactating dairy goats, factors that may influence the composition of tissue being lost or gained are potential for milk production, diet quality, stage of lactation, and interactions among these factors. Sahl et al. (2004) and NRC (2007) used the constant concentration of energy in tissue both being gained and being lost of AFRC (1998; 23.9 MJ/kg). Conversely, Ngwa et al. (2007a) noted that the energy concentration in tissue mobilized by yearling meat goats with initially high BW and BCS was considerably lower. Furthermore, the energy concentration in tissue being gained by wethers that previously had low BW and BCS while on a high plane of nutrition was greater than that in mobilized tissue and differed markedly between 2 sequential 12-wk feeding periods.

In addition to the desirability of knowing the chemical composition of tissue lost or gained on a whole or empty body basis, it is also of interest to know how factors such as diet and stage of lactation influence the mass of specific organs and tissues, particularly ones such as the gastrointestinal tract and liver, which are metabolically expensive. Therefore, the objectives of this experiment were to determine how stage of lactation and dietary forage level would affect the mass of organs and tissues and the chemical composition of tissue of Alpine does.

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¹Corresponding author: goetsch@luresext.edu

Table 1. Ingredient and chemical composition of diets consumed by lactating Alpine does (% of DM)

Item	40F ¹	60F ²
Ingredient		
Bermudagrass hay	20.00	20.00
Dehydrated alfalfa pellets	20.00	40.00
Ground corn	21.95	12.80
Soybean meal	10.00	0.00
Wheat middlings	17.00	21.00
Molasses	5.00	5.00
Fat ³	3.00	0.00
Limestone	0.94	0.15
Vitamin premix ⁴	0.50	0.50
Trace mineralized salt ⁵	0.50	0.50
Magnesium oxide	0.11	0.05
Sodium bicarbonate	1.00	0.00
Chemical composition		
OM	89.5	90.7
CP	14.8	14.2
NDF	38.3	47.0

¹40F = 40% forage.²60F = 60% forage.³Megalac (Church and Dwight Inc., Lakewood, NJ).⁴96 to 99% NaCl and at least 0.24% Mn, 0.24% Fe, 0.05% Mg, 0.032% Cu, 0.011% Co, 0.004% I, and 0.032% Zn.⁵8,800 IU/kg of vitamin A, 1,760 IU/kg of vitamin D₃, and 1.1 IU/kg of vitamin E.

MATERIALS AND METHODS

Body Composition

The protocol for this experiment and the experiment for determination of digestibility was approved by the Langston University Animal Care Committee. Forty-two multiparous lactating Alpine does were used in the body composition experiment. Six were used for initial or 0-mo slaughter measures early after parturition (mean = 4 d, SEM = 0.6 d, minimum = 2 d, and maximum = 6 d). The other 36 does were assigned sequentially to 1 of 6 treatments as kidding occurred. This was conducted so that DIM would be similar between dietary treatments at the 3 times of slaughter and for a constant interval between slaughters. Three of the treatments entailed ad libitum consumption of a 40% forage, 60% concentrate diet (abbreviated as **40F**), and the other 3 treatments involved ad libitum intake of a 60% forage, 40% concentrate diet (abbreviated as **60F**; Table 1). The intent was to have diets high in nutritive value but that differed in ingredient composition conceivably to elicit differences in tissue mobilization, accretion, or both. The 60F diet had 20% more dehydrated alfalfa pellets than the 40F diet, with higher levels of corn and soybean meal and inclusion of supplemental fat in the 40F diet. Fat was included in the 40F diet to increase the difference in ME concentration above that resulting from different dietary forage levels. Six does from each dietary treatment were used

for slaughter measures at 2 (mean = 59 d, SEM = 1.3 d, minimum = 53 d, and maximum = 65 d), 4 (mean = 116 d, SEM = 1.0 d, minimum = 111 d, and maximum = 124 d), and 6 mo of lactation (mean = 184 d, SEM = 1.4 d, minimum = 174 d, and maximum = 189 d).

Does were treated for clostridial organisms and internal parasites (Valbazen, SmithKline Beecham Animal Health, West Chester, PA) before kidding. Does kidded in maternity pens, and kids were removed at birth. Does remained in maternity pens for 24 h and then were transferred to a facility with pens fitted with Calan feeding gates (American Calan Inc., Northwood, NH). Does slaughtered for 0-mo measures continued to receive a 50% concentrate diet given during late pregnancy. All does were accustomed to use of the Calan feeding gates.

Does consuming 40F were placed in 3 pens (6 per pen) and those consuming 60F were in another 3 pens. Diets were fed at approximately 120% of consumption on the preceding few days. Milk production was determined each day at 0400 and 1600 h, and milk samples were collected at both times 1 d weekly. Samples were stored in vials with potassium bromide as a preservative until analysis for fat, protein, lactose, TS, SNF, and SCC at the certified DHIA Laboratory for Goats at Langston University. Milk composition was determined with a MilkoScan 400 analyzer (Foss Electric, Hillerød, Denmark) and SCC was determined with a Fossomatic 5000 analyzer. Both instruments were calibrated monthly. Log-transformed SCC was statistically analyzed. At 2, 4, and 6 mo of lactation, 2 does were randomly selected from each pen for slaughter measures, which occurred over a 2-d period. Diet samples were collected daily for formation of weekly composite samples. Diet samples were analyzed for DM, ash, CP (AOAC, 1990), and NDF (filter bag technique; Ankom Technology Corp., Fairport, NY).

On the morning before slaughter, all does were weighed full or unshrunk and BCS was determined by a panel of 3 individuals, with 0.25-increments, as described by Ngwa et al. (2007b). After a 24-h period without feed or water, does were slaughtered via stunning with a captive bolt pistol and exsanguination. Blood was collected and weighed. The esophagus was ligated and the head, hooves, and skin were removed and weighed. The rectum was ligated and the entire alimentary tract was removed and weighed before separation into components (esophagus, reticulorumen, omasum, abomasum, small intestine, large intestine, and cecum) by ligation and cutting. Components were weighed with digesta and then without after washing and blotting with paper towels. Noncarcass or internal fat was the sum of visceral and perirenal depots. The carcass and noncarcass organs and tissues were

expressed in grams and relative to empty BW (**EBW**), which was the sum of these components minus mass of digesta of the gastrointestinal tract (**GIT**).

Pools of weighed noncarcass components (blood, head, hide, organs, and fat) and the carcass were ground (Model 801 Autogrinder; Austio Company, Astoria, OR) separately 3 times sequentially through each of 3 plates with different apertures (i.e., 10, 5, and 2 mm). After the final grind, the sample was hand-mixed and duplicate 250-g aliquots were collected and stored at -20°C . Carcass and noncarcass pool samples were analyzed for DM by lyophilization (Model CRVP-195P Dura Stop, FTS Systems, Stone Ridge, NY). After drying, samples were dipped in liquid nitrogen for approximately 1 min and then reground in a blender (Model CB16, Waring Commercial, Torrington, CT) and analyzed for CP, ash (AOAC, 1990), and fat. Fat was determined with the Ankom^{XT15} Extraction System (Ankom Technology Corp., Macedon, NY). Energy concentrations of 39.3 and 23.1 MJ/kg were assumed for fat and protein, respectively (ARC, 1980). Composition of accreted tissue was based on full BW of does at the time of slaughter and the composition of does of the same dietary treatment on a full BW basis at the preceding time of slaughter. To estimate tissue concentrations of ash, protein, fat, and water, the sum of mass of each constituent was estimated for the carcass and noncarcass tissue pools, rather than using fresh mass values for the carcass and noncarcass organs and tissues determined on the day of slaughter.

Data were analyzed with a 2×3 factorial treatment arrangement using the GLM procedure (SAS Institute Inc., Cary, NC), with a model consisting of diet, slaughter time (2, 4, and 6 mo), and the diet $\times$ slaughter time interaction. Interaction means are presented in tables in all cases. Main effect means for time were included when the effect was significant ($P < 0.05$) and the diet $\times$ treatment interaction was nonsignificant ($P > 0.05$). The P -value for the main effect of diet is included in tables as well. Milk production and composition data were averaged for does slaughtered at 2, 4, and 6 mo over mo 1 to 2, 3 to 4, and 5 to 6, respectively. Means were separated by least significant difference. For 0-mo slaughter measures, means and SEM were estimated.

Digestibility

Twelve additional does were likewise sequentially assigned after kidding to the 40F and 60F diets. Two does from each treatment were housed in each of the Calan feeding gate pens with animals for slaughter measures of the same diet. In the middle of mo 1 to 2 and 3 to 4, does were moved to another facility and placed

in metabolism crates for 10 d. The first 5 d was for adaptation, and total feces excreted were collected over the next 5 d. Feed and feed refusals were collected each day to form composite samples. A 10% aliquot of feces excreted was collected each day to form a composite sample and later dried by lyophilization. Samples were ground in a Wiley mill to pass a 1-mm screen and analyzed for DM, ash, CP (AOAC, 1990), and NDF (filter bag technique; Ankom Technology Corp.).

There were 6 observations per diet at each of the 2 periods of determination. Data were analyzed using the MIXED procedure (SAS Institute Inc., Cary, NC). The model consisted of the fixed effects of diet, the repeated measure of time, and the treatment $\times$ time interaction as well as the random effect of animal. Means were separated by least significant difference.

RESULTS

Diet Composition and Digestibility

Composition was similar among samples within dietary treatments collected during the experiment. The NDF concentration was greater for 60F than for 40F (Table 1). The dietary CP concentration was not greatly different between diets.

Dry matter intake in the digestibility trial tended ($P < 0.09$) to be greater for 60F than for 40F (Table 2). A similar trend was noted for intake of OM ($P < 0.07$). There were interactions between diet and time in DM and OM digestibilities ($P < 0.05$). Digestibilities of DM and OM were similar between diets in mo 1 to 2 but were greater for 40F than for 60F ($P < 0.05$) in mo 3 to 4. Digestible DM and OM intakes were not affected by diet or time. Intake of CP was similar between diets and periods ($P > 0.10$). Digestibility of CP was similar between diets and tended ($P < 0.09$) to be greater in mo 1 to 2 than in mo 3 to 4. As anticipated, NDF intake was greater for 60F than for 40F ($P < 0.05$). In mo 3 to 4, NDF digestibility was similar between diets ($P > 0.10$) but was greater for 60F than for 40F ($P < 0.05$) in mo 1 to 2.

BW, BCS, and Milk Production and Composition

Initial average BCS was 2.4 (SEM = 0.07). There were tendencies ($P < 0.07$) for interactions between time and diet in ADG ($P < 0.07$) and change in BCS ($P < 0.08$; Table 3). Nonetheless, averaged over diet ADG ranked ($P < 0.05$) mo 1 to 2 < 3 to 4 < 5 to 6, with BW gain in late lactation equivalent to loss in early lactation. Change in BCS was less in mo 1 to 2 compared with later times ($P < 0.05$), being negative in

Table 2. Effects of dietary concentrate level on intake and digestibility by Alpine does determined at 1 to 2 and 3 to 4 mo of lactation

Item	1 to 2 mo		3 to 4 mo		SEM	Effect, $P <$		
	40F ¹	60F ²	40F	60F		Diet	Time	Interaction
n	6	6	6	6				
DM								
Intake, g/d	1,695	1,987	1,415	1,855	186.6	0.09	0.30	0.71
Feces, g/d	548	622	446	638	70.6	0.10	0.57	0.42
Digestibility								
%	68.0 ^{ab}	68.8 ^b	69.1 ^b	64.6 ^a	1.02	0.15	0.11	0.02
g/d	1,147	1,365	969	1,175	127.2	0.14	0.19	0.97
OM								
Intake, g/d	1,530	1,812	1,250	1,666	167.22	0.07	0.24	0.71
Feces, g/d	477	544	373	542	623	0.10	0.43	0.44
Digestibility								
%	69.2 ^{ab}	70.1 ^b	70.9 ^b	66.5 ^a	1.07	0.18	0.34	0.03
g/d	1,053	1,269	877	1,085	115.1	0.11	0.16	0.98
CP								
Intake, g/d	266	295	208	270	29.1	0.16	0.19	0.59
Feces, g/d	71	79	57	78	9.9	0.18	0.50	0.52
Digestibility								
%	74.5	73.5	73.1	70.3	1.23	0.18	0.09	0.45
g/d	195	216	151	186	21.0	0.22	0.12	0.75
NDF								
Intake, g/d	609	920	539	830	72.9	0.01	0.30	0.90
Feces, g/d	374	436	278	412	47.6	0.08	0.25	0.48
Digestibility								
%	38.4 ^a	52.7 ^b	49.6 ^b	49.0 ^b	2.31	0.03	0.09	0.01
g/d	231	487	257	396	32.9	0.01	0.27	0.07

^{a,b}Means within a row with different superscripts differ ($P < 0.05$).

¹40F = 40% forage.

²60F = 60% forage.

early lactation and positive in mid- and late lactation. Dry matter intake was greater for slaughtered does than for does on the digestibility study, and was greater ($P < 0.05$) for 60F than for 40F.

Milk fat concentration was lower in mo 3 to 4 than in mo 1 to 2 and 5 to 6 ($P < 0.05$; Table 3). There were diet $\times$ time interactions ($P < 0.05$) in milk concentrations of protein, lactose, and SNF. Protein concentration either was lowest or tended to be lowest among times at 3 to 4 mo. Protein concentration for 40F was highest among times for 1 to 2 mo ($P < 0.05$), but for the 60F diet tended to be highest at 5 to 6 mo. There were no differences among times in lactose concentration for 40F, but for 60F lactose concentration was greater at 1 to 2 mo compared with 3 to 4 mo ($P < 0.05$). Total solids concentration was less at 3 to 4 mo compared with the earlier and later times ($P < 0.05$). Milk yield uncorrected and corrected to 4% fat was greater at 1 to 2 and 3 to 4 mo compared with 5 to 6 mo ($P < 0.05$). Fat and protein yields were greater ($P < 0.05$) at 1 to 2 mo than at 3 to 4 and 5 to 6 mo. Conversely, yields of fat, SNF, and TS were lowest among times ($P < 0.05$) for 5 to 6 mo. Log SCC was greater in 5 to 6 mo than in 1 to 2 and 3 to 4 mo of lactation ($P < 0.05$).

Slaughter Measures

Organ and Tissue Mass. Body weight and tissue and organ mass at 0 mo are given in Table 4. For measures at 2, 4, and 6 mo, mass of the carcass in percentage of EBW was less and that of total noncarcass components was greater for 40F than for 60F ($P < 0.05$; Table 5). There were no interactions between diet and time in mass of noncarcass organs and tissues in percentage of EBW. Internal fat mass in percentage of EBW was greater for 40F than for 60F ($P < 0.05$) and mass of the GIT was greater ($P < 0.05$) for 60F than for 40F. Mass in percentage of EBW of many noncarcass components decreased with advancing time (i.e., blood, head, kidneys, trachea, lungs, liver, skin, esophagus, GIT). Conversely, mass of internal fat increased with advancing time, being greater at 5 to 6 mo compared with earlier times ($P < 0.05$). There were interactions between diet and time for all expressions of GIT digesta mass ($P < 0.05$). Digesta mass was similar between diets at 1 to 2 mo but was greater for 60F than for 40F at 3 to 4 and 5 to 6 mo ($P < 0.05$). For 40F, digesta mass declined with advancing time, whereas for 60F digesta mass was greater at 3 to 4 mo than at 1 to 2 mo and tended to be greater than at 5 to 6 mo.

Table 3. Effects of dietary concentrate level on ADG, change in BCS, and milk composition and yield by Alpine does at 1 to 2, 3 to 4, and 5 to 6 mo of lactation

Item	40F ¹			60F ²			SEM	Month of lactation			SE	Diet, <i>P</i> <
	1 to 2 mo	3 to 4 mo	5 to 6 mo	1 to 2 mo	3 to 4 mo	5 to 6 mo		1 to 2	3 to 4	5 to 6		
ADG, g/d	−136	24	121	−61	46	73	25.2	−99 ^a	35 ^b	97 ^c	17.8	0.42
BCS ³ change	−0.56	0.55	0.39	−0.14	0.42	0.33	0.127	−0.35 ^a	0.49 ^b	0.36 ^b	0.090	0.48
DMI, kg/d	2.23	2.14	2.10	2.42	2.81	2.55	0.130					0.01
Milk composition												
Fat, %	3.84	2.87	3.26	2.99	2.40	3.17	0.188	3.42 ^b	2.63 ^a	3.21 ^b	0.133	0.01
Protein, %	2.84 ^d	2.39 ^{ab}	2.51 ^{bc}	2.59 ^{bc}	2.25 ^a	2.75 ^{cd}	0.088					
Lactose, %	4.23 ^{bc}	4.24 ^{bc}	4.17 ^{ab}	4.33 ^c	4.06 ^a	4.16 ^{ab}	0.050					
SNF, %	7.98 ^c	7.52 ^b	7.57 ^b	7.79 ^{bc}	7.20 ^a	7.80 ^{bc}	0.103					
TS, %	11.82	10.39	10.83	10.77	9.60	10.96	0.264	11.30 ^b	9.99 ^a	10.90 ^b	0.187	0.02
SCC ⁴	1.20	0.68	2.16	0.63	0.82	1.19	0.502					
Log SCC	5.89	5.82	6.18	5.71	5.75	6.02	0.133	5.80 ^a	5.78 ^a	6.10 ^a	0.094	0.22
Milk yield												
Uncorrected, kg/d	3.67	3.25	2.77	3.48	3.77	2.39	0.324	3.58 ^b	3.51 ^b	2.58 ^a	0.229	0.97
4% fat-corrected, kg/d	3.60	2.78	2.45	3.02	3.00	2.14	0.285	3.31 ^b	2.89 ^b	2.30 ^a	0.202	0.35
Fat, g/d	141	94	86	103	91	76	10.9	122 ^b	93 ^a	81 ^a	7.7	0.08
Protein, g/d	104	77	67	90	85	66	7.7	97 ^b	81 ^a	67 ^a	5.5	0.70
Lactose, g/d	156	138	114	151	153	99	13.4	153 ^b	146 ^b	107 ^a	9.5	0.87
SNF, g/d	293	244	206	271	271	186	23.4	282 ^b	258 ^b	196 ^a	1.7	0.81
TS, g/d	434	338	293	374	363	263	33.4	404 ^b	350 ^b	278 ^a	23.6	0.44

^{a-d}Means within a row with different superscripts differ (*P* < 0.05).

¹40F = 40% forage.

²60F = 60% forage.

³1 to 5, with 1 = extremely thin and 5 = extremely obese.

⁴×10⁶/mL.

Body Composition. The mass of internal fat in does soon after birth was considerably greater than that in the carcass, with a fat concentration in noncarcass tissues about twice as great as in the carcass (Table 6). Correspondingly, there was much more protein at 0 mo in the carcass than in noncarcass tissues.

The 40F diet resulted in greater fat mass during lactation in the carcass ($P < 0.08$) and noncarcass tissues ($P < 0.05$) compared with the 60F diet (Table 7). Mass of fat in noncarcass tissues was considerably less at 2 and 4 mo of lactation compared with that at 0 mo, although values for the carcass were not greatly different. Mass of fat was greater at 6 than at 2 and 4 mo of lactation for both the carcass and noncarcass tissues, although the magnitude of change was much greater for noncarcass tissues. At 6 mo, mass of fat in the carcass and noncarcass tissues was greater than at 0 mo. Neither diet nor month of lactation affected protein or water mass in the carcass, noncarcass tissues, or empty body. Thus, effects of diet and month of lactation on energy stores were similar to those on fat mass.

Diet did not affect ash, protein, or water concentrations in the carcass, although the concentration of fat tended ($P < 0.06$) to be greater for 40F than for 60F (Table 7). Conversely, diet affected levels of all constituents in noncarcass tissues ($P < 0.05$). Levels of fat and energy were greater and those of ash, protein, and water were less for 40F than for 60F. Concentrations of fat were greater at mo 6 than at mo 2 and 4 of lactation for both the carcass and noncarcass tissues, but the magnitude of difference was much greater for noncarcass tissues.

Despite numerous effects of diet on mass and concentrations in the carcass, noncarcass tissues, and empty body at slaughter times, there were no significant ($P > 0.10$) effects on estimates of daily change in mass (Table 8). This was a result of high variability and estimation of initial values based on averages on a full BW basis of values for the same diet at the preceding time of slaughter. In accordance, concentrations in tissue being lost or gained are not presented because of some unrealistic values for individual observations that had marked effects on means.

There was much greater mobilization of noncarcass tissues than of the carcass in the first 2 mo of lactation (Table 8). Likewise, gain of tissue in mo 3 to 6 was greater for noncarcass tissues than for the carcass. Daily gain of fat and energy tended to be greater in mo 5 to 6 compared with 3 to 4 in noncarcass tissues ($P < 0.10$ and 0.09 , respectively) and empty body ($P < 0.07$). Based on period means of daily change in wet tissue mass and energy, the energy concentration in

Table 4. Body weight, BCS, and mass of the carcass and noncarcass tissues and organs of Alpine does within 1 wk of parturition

Item	Mean	SEM
BW, kg		
Unshrunk	55.5	4.42
Shrunk	50.8	4.06
Empty	45.2	3.59
BCS ¹	2.4	0.07
Mass, kg		
Carcass	22.99	1.682
Noncarcass	22.15	1.940
Blood	2.237	0.1662
Feet	1.103	0.0758
Head	2.690	0.1088
Kidneys	0.163	0.0140
Trachea	0.089	0.0108
Lungs	0.433	0.0192
Liver	0.895	0.0378
Heart	0.234	0.0149
Spleen	0.088	0.0058
Internal fat	6.960	1.2296
Skin	2.952	0.1643
Uterus	1.273	0.1428
Esophagus	0.100	0.0098
Reticulorumen	1.118	0.1009
Omasum	0.126	0.0157
Abomasum	0.276	0.0406
Small intestine	0.660	0.0479
Large intestine	0.691	0.0373
Cecum	0.066	0.0038
Gastrointestinal tract	2.937	0.1917
Mass, % of empty BW		
Carcass	51.08	0.631
Noncarcass	48.92	0.631
Blood	4.98	0.183
Feet	2.47	0.064
Head	6.06	0.273
Kidneys	0.36	0.018
Trachea	0.21	0.035
Lungs	0.97	0.040
Liver	2.01	0.087
Heart	0.52	0.020
Spleen	0.20	0.013
Internal fat	14.88	1.617
Skin	6.61	0.215
Uterus	2.86	0.290
Esophagus	0.23	0.029
Reticulorumen	2.48	0.091
Omasum	0.28	0.033
Abomasum	0.60	0.052
Small intestine	1.50	0.121
Large intestine	1.56	0.105
Cecum	0.15	0.007
Gastrointestinal tract	6.57	0.260
Gastrointestinal tract digesta		
kg	4.44	0.761
% of unshrunk BW	7.92	1.447
% of shrunk BW	8.69	1.610
% of empty BW	9.85	1.873

¹1 to 5, with 1 = extremely thin and 5 = extremely obese.

Table 5. Effects of diet on BW and mass of the carcass and noncarcass tissues and organs of Alpine does at 2, 4, and 6 mo of lactation

Item	40F ¹			60F ²			SEM	Month of lactation			SEM	Diet, <i>P</i> <
	2 mo	4 mo	6 mo	2 mo	4 mo	6 mo		2	4	6		
BW, kg												
Unshrunk	53.4	55.4	60.1	53.2	57.4	59.0	1.96	53.3 ^a	56.4 ^{ab}	59.5 ^b	1.38	0.92
Shrunk	46.6	49.7	54.4	46.6	52.3	52.1	2.03	46.6 ^a	51.0 ^b	53.3 ^b	1.43	0.95
Empty	39.6	44.0	48.7	39.4	43.0	45.1	2.08	39.5 ^a	43.5 ^{ab}	46.9 ^b	1.47	0.37
Mass, kg												
Carcass	20.11	22.91	24.91	20.74	22.66	23.54	1.025	20.43 ^a	22.79 ^b	24.23 ^b	0.722	0.70
Noncarcass	19.51	21.04	23.77	18.69	20.33	21.59	1.131	19.10 ^a	20.69 ^{ab}	22.68 ^b	0.797	0.20
Blood	2.275	2.500	2.385	2.423	2.456	2.324	0.0822					0.82
Feet	1.119	1.113	1.102	1.074	1.153	1.196	0.0401					0.39
Head	2.716	2.727	2.765	2.611	2.770	2.950	0.0871					0.59
Kidneys	0.196 ^b	0.169 ^a	0.186 ^{ab}	0.183 ^{ab}	0.196 ^b	0.197 ^b	0.0067					0.12
Trachea	0.107	0.095	0.092	0.108	0.078	0.760	0.0089	0.107 ^b	0.086 ^a	0.084 ^a	0.0063	0.17
Lungs	0.444	0.434	0.410	0.446	0.437	0.462	0.0171					0.21
Liver	1.136	1.061	1.061	1.092	1.116	1.160	0.0402					0.27
Heart	0.247	0.272	0.252	0.238	0.244	0.260	0.0127					0.38
Spleen	0.084	0.089	0.093	0.092	0.090	0.101	0.0074					0.36
Internal fat	4.585	6.491	9.273	3.896	5.188	6.349	0.9448	4.212 ^a	5.839 ^a	7.811 ^b	0.6661	0.05
Skin	2.700	2.607	2.952	2.747	2.745	2.740	0.1247					0.96
Uterus	0.109	0.116	0.164	0.098	0.123	0.158	0.0154	0.104 ^a	0.120 ^a	0.161 ^b	0.0107	0.77
Esophagus	0.130	0.118	0.098	0.140	0.144	0.113	0.0095	0.135 ^b	0.131 ^b	0.105 ^a	0.0067	0.55
Reticulorumen	1.279 ^{abc}	1.254 ^{ab}	1.185 ^a	1.214 ^a	1.422 ^c	1.409 ^{bc}	0.0581					0.03
Omasum	0.140	0.145	0.141	0.136	0.147	0.155	0.0094					0.66
Abomasum	0.330	0.287	0.313	0.333	0.315	0.297	0.2260					0.80
Small intestine	1.040	0.814	0.711	1.018	0.920	0.932	0.0554	1.029 ^b	0.867 ^a	0.822 ^a	0.0391	0.04
Large intestine	0.803	0.670	0.523	0.823	0.709	0.629	0.0412	0.813 ^c	0.690 ^b	0.576 ^a	0.2910	0.10
Cecum	0.071	0.074	0.068	0.079	0.081	0.085	0.0060					0.05
Gastrointestinal tract	3.664 ^c	3.245 ^{ab}	2.941 ^a	3.602 ^c	3.594 ^c	3.507 ^{bc}	0.1062					0.01
Mass, % of empty BW												
Carcass	50.83	52.11	52.59	52.95	52.23	0.648						0.04
Noncarcass	49.17	47.89	48.78	47.41	47.05	0.648						0.04
Blood	5.76	5.74	4.94	6.21	5.76	5.19	0.239	5.99 ^b	5.75 ^b	5.06 ^a	0.167	0.24
Feet	2.82	2.57	2.29	2.74	2.72	2.69	0.118					0.13
Head	6.88	6.30	5.77	6.68	6.53	6.57	0.219	6.78 ^b	6.42 ^{ab}	6.17 ^a	0.155	0.14
Kidneys	0.49	0.39	0.39	0.47	0.46	0.44	0.221	0.48 ^b	0.43 ^a	0.41 ^a	0.016	0.08
Trachea	0.27	0.22	0.19	0.28	0.18	0.17	0.025	0.28 ^b	0.20 ^a	0.18 ^a	0.018	0.45
Lungs	1.13	1.01	0.86	1.15	1.04	1.04	0.064	1.14 ^a	1.03 ^{ab}	0.95 ^b	0.046	0.18
Liver	2.87	2.46	2.23	2.81	2.63	2.58	0.119	2.84 ^b	2.54 ^a	2.40 ^a	0.084	0.13
Heart	0.62	0.64	0.52	0.61	0.57	0.58	0.037					0.83
Spleen	0.21	0.20	0.19	0.24	0.21	0.23	0.016					0.10
Internal fat	11.4	14.27	18.59	9.39	11.43	13.70	1.460	10.39 ^a	12.85 ^a	16.14 ^b	1.035	0.02
Skin	6.86	5.99	6.06	7.01	6.40	6.11	0.181	6.93 ^b	6.20 ^a	6.08 ^a	0.127	0.16
Uterus	0.27	0.27	0.34	0.25	0.29	0.35	0.034	0.26 ^a	0.28 ^a	0.34 ^b	0.024	0.97
Esophagus	0.33	0.27	0.20	0.36	0.34	0.25	0.026	0.34 ^b	0.30 ^b	0.23 ^a	0.019	0.04
Reticulorumen	3.25	2.93	2.50	3.09	3.37	3.37	0.198					0.07
Omasum	0.35	0.34	0.30	0.35	0.35	0.35	0.027					0.45
Abomasum	0.83	0.67	0.66	0.86	0.76	0.66	0.067	0.85 ^b	0.71 ^a	0.66 ^a	0.047	0.47
Small intestine	2.64	1.90	1.51	2.63	2.18	2.11	0.197	2.63 ^b	2.04 ^a	1.81 ^a	0.139	0.09
Large intestine	2.00	1.55	1.10	2.11	1.66	1.40	0.099	2.06 ^c	1.60 ^b	1.25 ^a	0.070	0.04
Cecum	0.18	0.17	0.14	0.20	0.19	0.19	0.018					0.06
Gastrointestinal tract	9.26	7.56	6.21	9.24	8.50	7.87	0.468	9.25 ^c	8.03 ^b	7.04 ^a	0.332	0.04

Continued

Table 5 (Continued). Effects of diet on BW and mass of the carcass and noncarcass tissues and organs of Alpine does at 2, 4, and 6 mo of lactation

Item	40F ¹			60F ²			Month of lactation			SEM	Diet, <i>P</i> <
	2 mo	4 mo	6 mo	2 mo	4 mo	6 mo	2	4	6		
Gastrointestinal tract digesta											
kg	5.89 ^b	5.64 ^{ab}	5.15 ^a	6.12 ^b	7.96 ^c	7.38 ^c				0.335	0.01
% of unshrunk BW	11.22 ^{bc}	10.33 ^{ab}	8.76 ^a	11.53 ^{bc}	14.13 ^d	12.64 ^{cd}				0.73	0.01
% of shrunk BW	12.86 ^{bc}	11.59 ^{ab}	9.73 ^a	13.18 ^{bc}	15.49 ^c	14.35 ^c				0.853	0.01
% of empty BW	15.22 ^{bcd}	13.30 ^{ab}	11.03 ^a	15.62 ^{bc}	19.01 ^d	16.57 ^{cd}				1.092	0.01

^{a-d}Means within a row with different superscripts differ (*P* < 0.05).

¹40F = 40% forage.

²60F = 60% forage.

Table 6. Tissue mass and composition of Alpine does within 1 wk of parturition

Item	Mean	SEM
Carcass mass		
Ash, kg	1.12	0.088
Protein, kg	3.96	0.202
Water, kg	14.81	1.001
Fat, kg	3.00	0.372
Energy, MJ	209	19.2
Noncarcass mass		
Ash, kg	0.40	0.036
Protein, kg	2.32	0.113
Water, kg	13.00	0.799
Fat, kg	5.51	0.977
Energy, MJ	270	38.6
Empty body mass		
Ash, kg	1.53	0.122
Protein, kg	6.28	0.251
Water, kg	27.80	1.781
Fat, kg	8.51	1.346
Energy, MJ	479	57.7
Carcass composition		
Ash, %	4.88	0.116
Protein, %	17.42	0.662
Water, %	64.54	0.570
Fat, %	12.82	0.754
Energy, MJ/kg	9.09	0.284
Noncarcass composition		
Ash, %	1.83	0.111
Protein, %	10.79	0.924
Water, %	59.39	1.852
Fat, %	24.01	2.267
Energy, MJ/kg	12.44	0.790
Empty body composition		
Ash, %	3.46	0.124
Protein, %	14.45	0.639
Water, %	63.33	1.085
Fat, %	18.75	1.626
Energy, MJ/kg	10.71	0.528

tissue being mobilized or accreted was 16, 20, and 32 MJ/kg in mo 1 to 2, 3 to 4, and 5 to 6, respectively, corresponding to 7.5, 5.7, and 11.6% protein and 37, 47, and 75% fat, respectively.

DISCUSSION

Feed Intake and Digestibility

The differences in ingredient composition between diets allowed for greater intake of the 60F diet, which facilitated similar milk yield. If the difference in forage level had been achieved by a greater level of bermudagrass hay rather than dehydrated alfalfa pellets, or if diets varied more in dietary forage level, intake might not have been greater for 60F than for 40F. In this regard, in a 16-wk early-lactation study with different dietary forage levels achieved by varying the level of coarsely ground alfalfa hay, Goetsch et al. (2000) noted DMI by Alpine goats approximately 0.21 kg/d greater for a 40 versus 80% dietary forage. In addition, stage

Table 7. Effects of diet on tissue mass and composition of Alpine does at 2, 4, and 6 mo of lactation

Item	40F ¹			60F ¹			SEM	Month of lactation			SEM	Diet, <i>P</i> <
	2 mo	4 mo	6 mo	2 mo	4 mo	6 mo		2	4	6		
Carcass mass												
Ash, kg	0.87	0.84	1.07	0.80	0.92	1.06	0.071					0.97
Protein, kg	3.49	3.27	3.91	3.45	3.66	3.50	0.279					0.93
Water, kg	13.81	14.85	15.54	13.20	14.40	14.94	0.755					0.38
Fat, kg	3.05	3.01	4.27	2.26	2.58	3.46	0.447	2.66 ^a	2.79 ^a	3.87 ^b	0.316	0.08
Energy, MJ	200	194	258	168	186	217	22.5	184 ^a	190 ^a	237 ^b	15.9	0.15
Noncarcass mass												
Ash, kg	0.38	0.37	0.42	0.38	0.43	0.40	0.027					0.59
Protein, kg	2.78	2.72	3.24	2.77	3.01	3.40	0.273					0.53
Water, kg	13.11	11.83	12.17	11.90	12.39	12.52	0.533					0.83
Fat, kg	3.98	5.20	8.30	2.59	3.47	5.52	0.957	3.28 ^a	4.34 ^a	6.91 ^b	0.677	0.02
Energy, MJ	220	267	401	166	206	295	41.0	193 ^a	236 ^a	348 ^b	29.0	0.04
Empty body mass												
Ash, kg	1.25	1.21	1.49	1.18	1.34	1.46	0.090	1.22 ^a	1.28 ^a	1.48 ^b	0.063	0.91
Protein, kg	6.27	5.99	7.15	6.22	6.66	6.90	0.466					0.75
Water, kg	26.91	26.68	27.71	25.10	26.78	27.46	1.199					0.52
Fat, kg	7.03	8.21	12.57	4.85	6.05	8.98	1.365	5.94 ^a	7.13 ^a	10.78 ^b	0.965	0.03
Energy, MJ	421	461	659	334	392	512	60.9	378 ^a	426 ^a	586 ^b	43.1	0.06
Carcass composition												
Ash, %	4.07	3.84	4.20	4.04	4.25	4.44	0.281					0.38
Protein, %	16.29	14.89	15.24	17.40	16.84	14.66	0.979					0.32
Water, %	64.44	66.89	61.05	66.32	66.05	62.86	1.558	65.38 ^b	66.47 ^b	61.95 ^a	1.102	0.47
Fat, %	13.84	13.11	16.53	11.21	11.54	14.38	1.304	12.53 ^a	12.32 ^a	15.45 ^b	0.922	0.06
Energy, MJ/kg	9.33	8.71	10.28	8.51	8.54	9.37	0.557					0.18
Noncarcass composition												
Ash, %	1.88	1.83	1.72	2.11	2.20	1.88	0.136					0.04
Protein, %	13.91	13.54	13.11	15.55	15.66	15.44	1.207					0.05
Water, %	63.09	58.93	50.60	66.55	64.33	57.96	2.519	64.82 ^b	61.63 ^b	54.28 ^a	1.781	0.02
Fat, %	18.59	24.24	33.28	14.32	16.46	24.45	3.006	16.46 ^a	20.35 ^a	28.87 ^b	2.126	0.01
Energy, MJ/kg	10.81	12.85	16.28	9.36	10.23	13.12	1.090	10.09 ^a	11.54 ^a	14.70 ^b	0.771	0.02
Empty body composition												
Ash, %	3.05	2.92	3.06	3.16	3.33	3.29	0.198					0.14
Protein, %	15.39	14.45	14.49	16.76	16.47	15.33	0.886					0.06
Water, %	65.03	63.93	57.25	67.23	66.05	61.84	1.953	66.13 ^b	64.99 ^b	59.55 ^a	1.381	0.08
Fat, %	16.54	18.71	25.21	12.85	14.14	19.54	2.045	14.69 ^a	16.42 ^a	22.37 ^b	1.446	0.01
Energy, MJ/kg	10.05	10.69	13.25	8.92	9.36	11.22	0.770	9.49 ^a	10.03 ^a	12.24 ^b	0.544	0.03

^{a,b}Main effect means of month of lactation with different superscripts differ (*P* < 0.05).¹40F = 40% forage.²60F = 60% forage.

Table 8. Effects of diet on daily tissue loss or gain by Alpine does at 2, 4, and 6 mo of lactation

Item	40F ¹			60F ¹			SEM	Month of lactation			SEM	Diet, <i>P</i> <
	1 to 2 mo	3 to 4 mo	5 to 6 mo	1 to 2 mo	3 to 4 mo	5 to 6 mo		1 to 2	3 to 4	5 to 6		
Carcass												
Wet tissue, g/d	−86.9	48.6	47.6	−61.5	17.3	20.9	14.63	−74.2 ^a	32.9 ^b	34.3 ^b	10.35	0.38
Ash, g/d	−7.3	0.8	3.8	−6.0	1.5	2.2	1.12	−6.6 ^a	1.2 ^b	3.0 ^b	0.79	0.93
Protein, g/d	−19.2	1.6	10.5	−10.7	1.0	−3.9	4.71	−15.0 ^a	1.3 ^b	3.3 ^b	3.32	0.58
Fat, g/d	−5.2	5.2	23.2	−12.7	4.1	16.1	6.89	−9.0 ^a	4.6 ^a	19.7 ^b	4.87	0.37
Water, g/d	−55.2 ^a	40.9 ^c	10.2 ^b	−32.1 ^a	10.9 ^b	6.4 ^b	9.14					0.64
Energy, MJ/d	−0.65	0.24	1.15	−0.75	0.18	0.54	0.337	−0.70 ^a	0.21 ^b	0.85 ^b	0.239	0.37
Noncarcass tissues												
Wet tissue, g/d	−68.1	30.8	68.1	−66.2	15.2	44.1	17.68	−67.1 ^a	23.0 ^b	56.1 ^b	12.50	0.39
Ash, g/d	−1.3	0.3	0.8	−0.5	0.6	−0.5	0.45	−0.9 ^a	0.4 ^b	0.2 ^b	0.32	0.89
Protein, g/d	1.7	2.1	8.3	6.9	1.8	6.0	4.83					0.83
Fat, g/d	−37.2	29.6	57.0	−49.7	13.9	39.1	15.38	−43.4 ^a	21.8 ^b	41.8 ^b	10.87	0.24
Water, g/d	−31.3	−1.1	2.0	−22.9	−1.1	−0.6	8.61	−27.1 ^a	−1.1 ^b	0.7 ^b	6.09	0.79
Energy, MJ/d	−1.42	1.21	2.43	−1.79	0.59	1.68	0.646	−1.61 ^a	0.90 ^b	2.05 ^b	0.456	0.28
Empty body												
Wet tissue, g/d	−155.0	79.4	115.8	−127.7	32.5	65.0	30.30	−141.4 ^a	56.0 ^b	90.4 ^b	21.43	0.36
Ash, g/d	−8.6	1.1	4.6	−6.5	2.0	1.7	1.41	−7.5 ^a	1.6 ^b	3.2 ^b	1.00	0.98
Protein, g/d	−17.5	3.7	18.8	−3.8	2.7	2.1	8.03	−10.6 ^a	3.2 ^{ab}	10.5 ^b	5.68	0.85
Fat, g/d	−42.4	34.8	80.1	−62.4	18.0	55.3	21.44	−52.4 ^a	26.4 ^b	67.7 ^b	15.16	0.25
Water, g/d	−86.5	39.8	12.2	−55.0	9.8	5.8	15.38	−70.8 ^a	24.8 ^b	9.0 ^b	10.9	0.90
Energy, MJ/d	−2.07	1.45	3.58	−2.54	0.77	2.22	0.929	−2.31 ^a	1.11 ^b	2.90 ^b	0.657	0.28

^{a-c}Main effect means of month of lactation and diet × month interaction means for carcass water with different superscripts differ (*P* < 0.05).

¹40F = 40% forage.

²60F = 60% forage.

of lactation may influence effects of dietary forage level on DMI. For example, in a 16-wk late-lactation study, Goetsch et al. (2001) fed Alpine goats diets ranging from 35 to 80% forage, with differences achieved by varying the level of coarsely ground alfalfa hay, and observed similar DMI among treatments.

With a moderate to high assumed digestibility of dehydrated alfalfa pellets (NRC, 2007), a substantial dietary difference in digestibility was not expected. It is not readily apparent why OM digestibility was slightly less for 60F than for 40F in mo 3 to 4 or why NDF digestibility was markedly less for 40F than for 60F in mo 1 to 2.

Milk Composition

The absence of a diet effect on milk fat concentration reflects the moderate level of cereal grain in the 40F diet. However, Goetsch et al. (2000, 2001) also reported similar milk fat concentrations in Alpine goats consuming diets varying greatly in dietary forage level (i.e., 40 to 80 and 35 to 80%, respectively). The greater milk protein concentration in the present experiment for 40F than for 60F in mo 1 to 2 agrees with a difference noted by Goetsch et al. (2000) between 40 and 80% forage diets. Furthermore, in late lactation Goetsch et al. (2001) observed a similar protein concentration among diets 65, 50, and 35% in forage, with a slightly greater level noted for an 80% forage diet.

In accordance with the greatest log SCC among periods of measurement for mo 5 to 6, SCC in goats generally increases with advancing stage of lactation. For example, Gomes et al. (2006) reported that SCC increased from 2.56×10^5 /mL at 1 mo of lactation to 6.51×10^5 /mL in mo 8. Paape et al. (2007) found that SCC in dairy goats was 2.5 to 4 times higher at 15 than at 285 DIM.

Mass of the Carcass and Noncarcass Tissues and Organs

There was a substantial increase in liver mass of does from parturition to early lactation (e.g., 2 mo) and a gradual decline thereafter. This exemplifies the influence of tissue mobilization in early lactation, in addition to dietary nutrient intake, on liver metabolic activity. Lactating Alpine does mobilize considerable internal fat in early lactation, particularly with diets moderate to high in forage (e.g., 60F). Likewise, Eknæs et al. (2006) noted a steady decrease in mass of adipose tissue of Norwegian dairy goats from d 11 to 125 of lactation (i.e., 7.35 to 3.87 kg). Thus, it is quite important that internal fat mass at the time of parturition with diets

moderate to high in forage be adequate to realize high milk production in early lactation, to minimize mobilization of tissue protein, or both. Eknæs et al. (2006) did not observe a decrease in mass of proteinaceous tissue of Norwegian dairy goats when adipose tissue mass was declining, although Barnes and Brown (1990) noted the importance of protein mobilization to maintain milk production by Alpine goats when nutrient intake was limiting. Results of the present experiment suggest that the diet lower in forage and higher in concentrate not only lessened internal fat loss in early lactation but promoted greater internal fat accretion than the diet higher in forage in mid- and late lactation. Hence, with does in low BCS at parturition, a relatively low forage level would be advantageous to avoid depletion of this energy store and to minimize tissue protein mobilization. Conversely, with does in moderate to high body condition at parturition, a diet higher in forage can be fed without an adverse impact on milk yield because of adequate stored energy in internal fat available for mobilization in early lactation. The time taken to replenish the internal fat energy storage depot is longer with diets higher in forage, extending into late lactation and possibly the dry period. Likewise, feeding a diet lower in forage throughout lactation may result in accretion of considerable, and perhaps excessive, internal fat in mid- to late lactation. Thus, an increase in dietary forage level in mid- to late lactation may be warranted.

Even though considerable energy is mobilized in early lactation to support milk production, there is a substantial increase in mass of the GIT in the first 2 mo of lactation, followed by a steady decline. Such a change may contribute to the observation by Eknæs et al. (2006) of no change in whole body protein mass by Norwegian dairy goats in early and midlactation when fat was being mobilized. Based on tissue mass in the present experiment, it would appear that more energy is expended by the GIT with diets higher than lower in forage. Similarly, Goetsch (1998) suggested that in sheep, the physical nature of the diet influences energy expended by the GIT, with relatively high energy use relative to absorbed energy for high-forage diets and forages of low compared with high quality.

Tissue Mass and Composition

Tissue mass and composition measures support earlier interpretations based on mass of the carcass and noncarcass tissues and organs. These findings are in general agreement with those of Ngwa et al. (2007a) in a study involving yearling meat goats. That is, the energy concentration in tissue being mobilized or accreted is not constant throughout feeding periods, as

is assumed in most sets of goat nutrient requirement recommendations, such as those of AFRC (1998), Sahlu et al. (2004), and NRC (2007). For lactating Alpine does in the present experiment, the energy concentration in tissue being mobilized in early lactation and gained in midlactation was considerably less than that being accreted in late lactation, although such differences presumably would be influenced by prior ADG and plane of nutrition. Both diets of the present experiment, although differing in forage and concentrate levels, were of moderate to high nutritive value. Lower quality diets, perhaps resulting in greater tissue mobilization in early lactation, less tissue gain and energy accretion in midlactation, or both, could prevent or delay accretion of tissue very high in fat and energy, primarily in noncarcass tissues, in late lactation.

Another important consideration regarding tissue loss and gain during lactation by dairy goat breeds such as the Alpine is initial carcass mass and composition. Considerable protein was mobilized from the carcass in early lactation, whereas throughout lactation, protein mass in noncarcass tissues increased. A low body condition at the time of kidding would restrict this pool of nutrients available for use in support of milk production. However, because does of this experiment after kidding had an average BCS slightly less than the moderate score of 3.0, it would appear that a very low body condition would be necessary to minimize carcass tissue protein mobilization in early lactation for use in milk synthesis.

The AFRC (1998) reviewed literature available at that time pertaining to the energy concentration in tissue mobilized or gained by lactating dairy goats. Considerable variability in estimates was noted. Because some estimates were similar to the ARC (1980) value of 23.9 MJ/kg of live weight change used for lactating cattle and sheep, this was the recommendation presented. This concentration does seem appropriate as an average over an entire lactation. Based on findings of this experiment, its use would appreciably overestimate the tissue contribution to milk synthesis in early lactation and slightly overestimate energy accretion along with a slight underestimation of the dietary energy need for tissue gain in midlactation; magnitudes of error in late lactation for energy accretion would be much greater than in midlactation. However, as pointed out by AFRC (1998), in some cases there is a nominal change in the BW of dairy goats during lactation, which would minimize the impact of assumptions of energy concentration in tissue being lost or gained.

CONCLUSIONS

Dairy goats mobilize considerable fat from noncarcass tissues and a lesser amount of carcass protein in early lactation. Diets relatively low in forage lessen internal fat mobilization in early lactation and promote greater repletion later compared with diets higher in forage. The energy concentration in tissue mobilized in early lactation and accreted in midlactation is less than in tissue gained in late lactation.

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