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Responses of dairy ewes before and after parturition to different nutritional regimes during pregnancy.

III. — The concentration of some metabolites in the blood during pregnancy

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Summary

Changes in the concentration of several metabolites in the blood of ewes in late pregnancy are described. The ewes were included in a 3 × 3 factorial feeding experiment described previously.

Blood glucose levels were consistently lower in twin-bearing ewes than in single-bearing ones. Differences between feeding regimes were formed only during the last 3 weeks of pregnancy. Average concentrations for day 18 *prepartum* for twin-bearing ewes were 38 ± 2, 31 ± 2 and 31 ± 3 mg/100 ml for High (H), Adjusted (gradually rising) (A), and Low (L) steaming-up regimes. The respective values for single-bearing ewes were 43 ± 10, 38 ± 3 and 37 ± 8 mg/100 ml.

Plasma free fatty acid (FFA) concentrations, on day 18 *prepartum*, were 0.5 ± 0.2, 0.5 ± 0.1 and 0.75 ± 0.3 mEq/l for H, A and L steaming-up regimes, respectively, in twin-bearing ewes, and 0.3 ± 0.2, 0.5 ± 0.1 and 0.65 ± 0.3 mEq/l in single-bearing ones. The lowest concentrations, 0.29 and 0.15 mEq/l for twin- and single-bearing ewes, respectively, were found in nnH (low basic ration-high steaming-up) regime and the highest concentrations, i.e., 0.89 and 1.00 mEq/l, in the nnL (low basic ration-low steaming-up) regime.

Blood ketones concentration showed trends similar to those of FFA. *Body weight change* during late pregnancy was positively correlated with glucose and negatively correlated with FFA and ketones. Correlations between blood glucose and FFA and the *components of the ewes' weight loss* during lambing (foetuses and fluids) were in accordance with the assumption that the foetus draws its energy mainly from circulating glucose, whereas the mother covers much of its requirements from body fat depots.

Introduction

Reduced blood glucose and elevated free fatty acids (FFA) and ketone-bodies concentrations are normally found in ewes during late pregnancy (REID, 1960, 1963, 1968; REID and HINKS, 1962 *a*, *b*; REID and HOGAN, 1959). Under deficient food supply, and mainly with twin-bearing ewes, this condition may develop into ketosis, commonly known as pregnancy toxaemia (REID and HOGAN, 1959).

ADLER (1970) postulated that the apparent energy balance of ruminants is determined by the ratio of fat precursors to glucose precursors in the blood circulation of the ruminant. If this is true, it would mean that a metabolic imbalance must not necessarily be associated with a low energy supply, but could also appear under certain circumstances in conjunction with high energy rations.

To clarify the energy requirements of pregnant dairy sheep a variety of feeding schedules was compared in a factorial experiment (STERN *et al.*, 1978 *a*). In order to gain some understanding of the metabolic processes involved, concentrations of some metabolites in the blood plasma were assessed. Body weight changes, general health and the productive response in terms of lambs and milk have been described in other communications (STERN *et al.*, 1978 *a*, *b*).

Materials and methods

General

Forty-two Awassi and Assaf ewes were divided into nine treatment groups (3 × 3 factorial). The experimental treatments were: Three sequences of basic diets from mating to parturition and three steaming-up levels of supplement in the last two months of pregnancy. The treatment period was divided into three sub-periods: (*i*) 1st month of pregnancy, which was a continuation of the last pre-mating month; (*ii*) 2nd and 3rd months of pregnancy; and (*iii*) 4th and 5th months of pregnancy.

A ration of 8.2 Megajoule (MJ) of metabolizable energy (ME) was taken as the normative maintenance level for an average ewe of 60 kg. The three basic diets, thus, were: 1) flushing and high maintenance (fh); 2) flushing and low maintenance (fn); 3) no flushing and low maintenance (nn).

The three steaming-up levels were: high (H), 10.5 MJ of ME above the basic ration; low (L), 3.5 MJ of ME above the basic ration; and adjusted (A), according to plasma free fatty acid (FFA) concentration. The ration was increased in steps, by adding 0.8-1.0 MJ of ME to the ration of a ewe whenever her plasma FFA concentration rose above 0.5 mEq/l. The experiment has been described in more detail by STERN *et al.* (1978 *a*).

Blood sampling and analyses

Sheep were bled fortnightly from about the 60th day post-mating and weekly during the last month of pregnancy. Blood was collected in heparinized bottles and placed immediately into an ice box. Preparation of filtrates was done

within 1-3 hours and all analyses were completed within 48 hours after collection. *Blood glucose* was determined by the enzymatic method described by SEIFER and GERSTENFELD (1958) using the modification of HESTRIN-LERNER and BEN-YONAH (1963). Plasma FFA concentration was determined after DOLE and MEINERTZ (1960). Blood ketone-bodies (as acetone) were determined according to BEHRE and BENEDICT (1926) and plasma free amino acids (FAA) by the method described by FRAME, RUSSEL and VILHELMI (1943).

Results

Blood glucose concentration

The data in table 1 and figure 1 *a* indicate that a possible glucose shortage appeared as early as the end of the third month of gestation (blood concentrations of 29 and 33 mg/100 ml in twin- and single-bearing ewes). The greater requirements of twin- *vs.* single-bearing ewes, thus, also became apparent. There was no consistent difference between different feeding regimes at this stage. Therefore, it was considered to justify the inclusion (in fig. 1 *a*, *b*, *c*) of the data of the last month or so before the start of steaming-up, neglecting the fact that the

TABLE 1

Average concentration of blood glucose, plasma FFA, and blood ketone-bodies (as acetone) at the end of the third month of the ewe's pregnancy prior to the beginning of steaming-up

Concentration moyenne en glucose, acides gras libres (FFA) et corps cétoniques (acétone) du plasma sanguin en fin de troisième mois de gestation, avant le début de la supplémentation

Metabolite	Type of pregnancy	Rations			Mean ± SE
		fh	fn	nn	
Glucose (mg/100 ml)	Twin	28	29	30	29.0 ± 1.0
	Single	31	33	33	32.5 ± 1.2
FFA (mEq/l)	Twin	0.7	0.7	0.6	0.67 ± 0.06
	Single	0.5	0.6	0.5	0.53 ± 0.07
Acetone (mg/100 ml)	Twin	7.6	6.5	5.5	6.5 ± 1.0
	Single	5.3	4.6	5.3	5.1 ± 0.4
Number of ewes	Twin	7	7	5	19
	Single	6	8	9	23

Analysis of variance:

Between rations — non significant for each of the three variables.
Between types of birth — $P < 0.01$ for each of the three variables.

ewes were split between three different basic levels within each steaming-up level.

Changes in blood glucose concentrations in ewes of different " steaming-up " levels during the last 3 months of pregnancy are presented in figure 1 *a*. Glucose concentration decreased during the third month of pregnancy, before the beginning of " steaming-up " (55 days before average lambing time). At this time the level rose and was followed by a second decrease towards the end of gestation. In the final weeks relatively large fluctuations were observed, and in some ins-

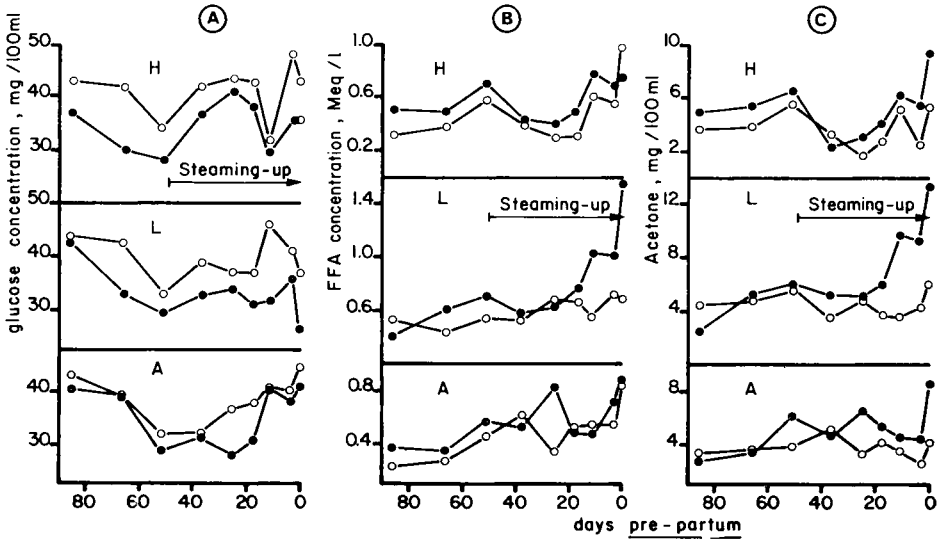

FIG. 1. — *Blood glucose concentration* (a), *blood plasma FFA concentration* (b) *and blood ketone-body concentration* (c) *during the last 90 days of gestation in twin* (● —●) *and single* (○ —○) *bearing ewes on high* (H), *low* (L) *and gradually rising* (A) *steaming-up rations.*

Concentration du glucose sanguin (a), *des acides gras libres plasmatiques sanguins* (*FFA*, b) *et des corps cétoniques sanguins* (*acétone*, c) *au cours des 90 derniers jours de gestation chez des brebis portant 1* (○ —○) *ou 2* (● —●) *agneaux et ayant reçu un complément en quantité fixe : élevée* (H), *basse* (L) *ou ajustée graduellement* (A).

tances, particularly high concentrations were noted on the day of lambing. Differences between twin- and single-bearing ewes were especially uniform and consistent in the low (L) " steaming-up " group.

To examine the existence of a possible interaction between maintenance and " steaming-up " levels, the results obtained about 18 days before lambing were chosen (table 2). In most cases the difference between types of birth (single or twins) were greater than those between the various treatments. Glucose concentration in steaming-up regime H (38 mg /100 ml for single- and 43 mg /100 ml for twin-bearing ewes) was significantly higher than in A or L (31-37 mg /100 ml). The high concentration (40-52 mg /100 ml) in the ewes which entered steaming-up in lean condition (nn) and the decline from about 35 mg (fh) to 30 mg (nn) in the maintenance levels within the low (L) steaming-up regime were particularly marked.

TABLE 2

Average blood glucose, plasma FFA and blood ketone bodies (as acetone) concentrations of twin- (T) and single- (S) bearing ewes on day 18 pre-partum *(numbers of ewes are indicated in parentheses)*

Concentration moyenne en glucose, acides gras libres (FFA) et corps cétoniques du plasma sanguin de brebis portant 1 ou 2 fœtus 18 jours avant la mise bas (entre parenthèses: nombre de brebis)

Steaming-up levels (1)	Metabolite	Basic rations (1)						Mean ± SE	
		fh		fn		nn			
		T	S	T	S	T	S	T	S
High		(3)	(2)	(4)	(1)	(1)	(3)	(8)	(6)
	Glucose (mg/100 ml)	37	44	37	32	40	52	38.0 ± 0.7	42.7 ± 3.8
	FFA (mEq/l)	0.61	0.34	0.63	0.49	0.29	0.15	0.51 ± 0.10	0.38 ± 0.10
	Acetone (mg/100 ml)	4.0	3.0	3.9	4.1	3.8	1.3	4.0 ± 0.2	2.8 ± 0.8
Low		(2)	(2)	(2)	(3)	(2)	(3)	(6)	(8)
	Glucose (mg/100 ml)	34	36	28	45	31	29	31.0 ± 1.1	36.7 ± 1.1
	FFA (mEq/l)	0.52	0.47	0.86	0.49	0.89	1.00	0.76 ± 0.12	0.66 ± 0.17
	Acetone (mg/100 ml)	6.7	2.5	6.1	1.8	5.2	6.7	6.0 ± 0.4	3.7 ± 1.4
Adjusted		(2)	(2)	(1)	(4)	(2)	(3)	(5)	(9)
	Glucose (mg/100 ml)	27	39	33	35	32	41	30.7 ± 0.9	38.3 ± 1.2
	FFA (mEq/l)	0.44	0.50	0.29	0.59	0.70	0.44	0.48 ± 0.06	0.50 ± 0.03
	Acetone (mg/100 ml)	4.0	2.4	6.9	5.9	5.4	4.5	5.4 ± 0.9	4.3 ± 1.0
Mean		(7)	(6)	(7)	(8)	(5)	(9)	(19)	(23)
	Glucose (mg/100 ml)	33	40	33	37	34	41	33.3 ± 0.4	39.3 ± 1.2
	FFA (mEq/l)	0.52	0.44	0.59	0.52	0.63	0.53	0.58 ± 0.03	0.50 ± 0.03
	Acetone (mg/100 ml)	5.0	2.7	5.6	3.9	4.8	4.2	5.1 ± 0.4	3.6 ± 0.4

(1) See text for description of rations and levels.

Analysis of variance: Between basic rations: non-significant; between steaming-up levels: glucose, $P < 0.05$; FFA, N.S.; acetone, $P < 0.05$. Between types of pregnancy: glucose, $P < 0.001$; FFA, $P < 0.10$; acetone, $P < 0.05$. Interaction between basic level and steaming-up and type of pregnancy: FFA, $P < 0.05$.

Plasma free fatty acids (FFA) and blood ketone concentration

By the end of the third month of gestation FFA concentration in singlers (0.5 mEq/l) was not much higher than in non-pregnant ewes, but it was notably higher (0.7 mEq/l) in twin-bearers (table 1).

No important differences between ewes on different maintenance levels were found. Changes in FFA concentration during the last 3 months of pregnancy are presented in figure 1 *b*. A gradual increase was seen during the third month, then a decrease accompanying start of steaming-up, and finally, a steep rise towards the end of pregnancy.

In the A regime, where feed was increased gradually according to FFA concentrations in the blood, there was no consistent difference between twin- and single-bearing ewes. There was a particularly large increase towards the end of gestation in twin-bearing ewes on low (L) steaming-up. No differences were observed between steaming-up groups on day 18 pre-lambing (table 2). There was, however, a significant interaction between maintenance level (which determined ewes' body condition) and steaming-up levels. In the high (H) steaming-up group, in ewes on the lowest maintenance level (nn), the FFA concentration was outstandingly low (0.29 and 0.15 mEq/l in twin- and single-bearing ewes, respectively). On the other hand, the concentration in ewes on this maintenance level was especially high in the low steaming-up regime. Here, as well, a relatively small difference was found between twin- and single-bearers on the A steaming-up level.

Ketone-body concentration changes in the different treatments were similar to those found for FFA (tables 1 and 2, fig. 1 *c*). A true ketotic condition developed in two ewes only, very close to lambing. One was on the lowest feeding regime: nnL, and the other on the highest: fhH.

Blood plasma amino acids (FAA) concentration

No clear differences were found between the various treatments or between twin- and single-bearing ewes. A general tendency for FAA concentration to decrease as the pregnancy proceeded was noted.

Interrelationship between the different metabolites

Significant negative correlations were found between concentration of blood glucose and FFA and ketones, and positive correlations between FFA and ketone-bodies (table 3). The correlations were higher in ewes on fixed steaming-up regimes (H and L), compared with ewes whose feed was gradually increased according to blood FFA concentrations (A). There was no correlation between glucose and FFA in this group.

Correlations between body weight changes of the pregnant ewe and the pregnancy components and blood concentrations of several metabolites

Highly significant positive correlations were found between ewes' body weight changes and blood glucose, and negative correlations between body weight changes and FFA concentration. The correlation coefficient with acetone was

TABLE 3

Correlation (r) *and regression* (b) *coefficients between blood concentrations of glucose, plasma FFA and blood ketone-bodies* (*as acetone*) *and the different pregnancy-weight-change compartments of ewes fed fixed or gradually rising* (*adjusted*) *steaming-up rations during late pregnancy*

Coefficients de corrélation et de régression entre les teneurs plasmatiques en glucose, acides gras libres ou corps cétoniques et la variation de poids des différents compartiments des brebis qui ont reçu en fin de gestation un complément offert à niveau constant (*haut ou bas*) *ou croissant*

Weight change compartment	Steaming-up ration	Number of ewes	Glucose		FFA		Acetone	
			r	*b*	*r*	*b*	*r*	*b*
Ewes body weight (1)	Fixed. . . .	28	0.57**	—	— 0.82***	— 1.90	— 0.78***	—
	Rising . . .	14	0.56*	—	— 0.73***	— 1.65	— 0.41 NS	—
Uterine contents (2)	Fixed. . . .	28	— 0.63	—	0.85***	—	0.72***	—
	Rising. . . .	14	— 0.54*	—	0.67**	—	0.56*	—
	High	14	— 0.72**	—	0.84***	—	0.80***	—
	Low	14	— 0.59*	—	0.89***	—	0.64**	
Foetal weight	Fixed. . . .	28	— 0.63**	— 1.12	0.42*	2.60	—	—
	Rising. . . .	14	— 0.42 NS	— 0.97	0.63*	3.48	—	—
Placenta and fluids (3)	Fixed. . . .	28	— 0.36 NS	— 0.43	0.82***	3.49	—	—
	Rising. . . .	14	— 0.54*	— 0.72	0.54*	1.96	—	—

(1) *Post-partum* weight less weight at 60 days of pregnancy.
(2) *Pre-partum* less *post-partum* weight of ewe.
(3) Uterine contents less foetal weight.
N.S.: non significant; * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.

most significant in ewes fed a constant steaming-up diet, but was low and non-significant in ewes on the FFA-adjusted steaming-up level (table 3).

Uterine contents were negatively correlated with glucose concentration and positively with FFA. No important differences in this respect were found between the different treatment groups, although on the whole, correlations in the adjusted steaming-up regime were of lower magnitude than those in the fixed steaming-up treatments. The picture here is particularly interesting, since a marked difference is seen in the magnitude of correlations within the constant steaming-up regimes for glucose and FFA with foetal weight as compared with those with " uterine fluids ". While foetal weight was highly significantly (negatively) correlated with glucose and only moderately and non-significantly correlated with glucose and highly significantly correlated with FFA.

Discussion

Interrelations of foetal weight, ewe weight and plasma metabolites concentration

Results obtained in the present study generally confirm those obtained previously. To the best of our knowledge, there are no data in the literature on the correlation between the ewe's net body weight changes during gestation and concentrations of glucose or FFA in the blood. In the present research a very high correlation was found between these two variables. This confirms the findings of RUSSEL, GUNN and DONEY (1968) and SYKES and FIELD (1972 *a*), who showed that the main weight loss during the last months of gestation is due to loss of body fats. These authors also showed that the contribution of proteins from the ewe's body towards glucose or protein production in the foetus is small. LINDSAY (1970) concluded that the possibility of exploiting body reserves for glucose production is most limited. Foetal tissues, on the other hand, contain almost no fat (SYKES and FIELD, 1972 *b*). These findings also explain the fact that in the constant feeding groups a higher correlation is found between foetal weight and glucose concentration compared with that with FFA; on the other hand, the highest correlation is found between foetal fluids and FFA, and the lowest between fluids and glucose. The body component called here " uterine fluids ", thereby, largely reflects the overall weight loss of the mother, resulting from exploitation of her fat reserves. This is in agreement with the finding that the weight of uterine fluids increases with increased body weight loss during pregnancy (STERN *et al.*, 1978 *a*).

Effect of ewe's body condition

By the end of the third month of gestation there was already a difference in blood glucose, FFA and ketone-bodies between single- and twin-bearing ewes. There was, nevertheless, no important difference in concentration levels between ewes on different maintenance levels, although probable fat storage in their bodies was on a different level. As ewes on the fh treatment gained weight during that period (STERN *et al.*, 1978 *a*), it may be postulated that they did not exploit the carbohydrates in the food beyond their own maintenance requirements for foetal production, but rather diverted the excess (at least when it was small) into fat storage. This may yield another possible explanation for the relatively low gross efficiency of fat ewes (STERN *et al.*, 1978 *a*).

Effects of different constant feeding levels in the last 2 months of pregnancy

Despite statements in the previous section that the maintenance level had no effect on blood metabolites concentration, it appears that towards the end of term there was an interaction between maintenance and " steaming-up " levels.

The highest glucose and lowest FFA concentrations were found in the high (H) steaming-up group in ewes from the lowest maintenance level (nn). The lowest glucose and highest FFA concentrations were found in the low (L) steaming-up

combined with low maintenance feeding. Thus, leaner ewes may have been able to produce more glucose from high feed intake than were fat ewes.

In the third week before term, there was a decline in food intake of ewes on the highest feeding level (STERN *et al.*, 1978 *a*), and this phenomenon appeared a bit later in the lower feed levels. If we examine the metabolite concentrations in these two groups, on the 18th day pre-lambing, a real difference may be observed. In lean sheep this followed a decline in glucose to below the critical concentration (REID, 1968) of 30 mg, and their FFA concentration had already risen considerably. Fat ewes at these stages showed normal concentrations of glucose and of FFA.

TABLE 4

Average blood concentration of some metabolites in the last pre-partum *sample (day 1-6* pre-partum*) in ewes of the highest and lowest feeding levels (numbers of ewes are indicated in parentheses)*

Concentration moyenne de certains métabolites dans le sang prélevés en fin de gestation (10 jours avant mise-bas) sur des brebis qui ont reçu le complément aux niveaux haut et bas (nombre de brebis entre parenthèses)

Metabolite	Type of pregnancy	Feeding treatment	
		fhH	nnN
Glucose (mg/100 ml)	Twin	33 (3)	26 (2)
	Single	39 (2)	39 (3)
FFA (mEq/l)	Twin	0.8 (3)	1.6 (2)
	Single	1.3 (2)	0.5 (3)
Acetone (mg/100 ml)	Twin	7.8 (3)	13.4 (2)
	Single	6.7 (2)	4.3 (3)
FAA (mg/100 ml)	Twin	4.3 (3)	5.0 (2)
	Single	3.7 (2)	5.1 (3)

Analysis of variance:

Between feeding treatments: FAA, $P < 0.05$.
Interaction between feeding treatment and type of pregnancy, $P < 0.05$.

This is similar to findings of REID and HINKS (1962 *b*). It is therefore interesting to follow the development of differences in metabolite concentration in these two groups up to lambing. Concentrations of some blood metabolites in these two groups 1 to 6 days pre-lambing are shown in table 4. Ewes on the low feeding levels show, in twin-bearers, typical signs of pregnancy toxaemia, and in single-bearers — a normal blood profile. In contrast, ewes on the highest feeding level showed similar clinical signs (STERN *et al.*, 1978 *a*) but a different blood profile which had changed even when compared with that found on the 18th day pre-lambing (table 2). The glucose concentration remained within the normal range, although it was lower in twin-bearing ewes than in single-

bearers, on both occasions. In the FFA concentration, on the other hand, the trend was reversed. On the 18th day before lambing, the FFA picture was still " normal ", i.e., high in ewes with low glucose (twin-bearers). Close to term, the higher FFA concentration was found in single-bearing ewes. It should also be noted that in no ewe of this group did a typical ketotic condition develop. The highest ketone-body concentration recorded was 18 mg/100 ml in the blood of a twin-bearing ewe (in the twin-bearers on the low feeding level with pregnancy toxaemia, a record 28 mg/100 ml was recorded).

REID and HINKS (1962 *a*, *b*) reported more marked inappetence, disease and changes in blood metabolite concentration in fat twin-bearing ewes than in single-bearers. This difference from the present observation may be a result of the fact that REID and HINKS fed the highest level *ad libitum* so that an equal nutritional surplus was incurred in twin- and single-bearing ewes. In our experiment, ewes of both pregnancy types received equal amounts of feed and single-bearers (whose energy requirements are lower) thus suffered from a greater nutritional surplus than twin-bearers.

REID (1968) postulated that with declining blood glucose concentration, the pregnant ewe develops an inhibition of her tissues' capacity for glucose utilization (diabetic condition), a condition not existing in the foetus. Such an inhibition may perhaps also occur in obese ewes even when blood glucose concentrations are high.

Effect of a gradually rising (adjusted according to FFA) steaming up

It was difficult to prevent an increase in FFA concentration only during the last 10 days of pregnancy in twin-bearing ewes. SYKES and FIELD (1972 *c*) ran into similar problems over a longer period. They suggested possible hormonal effects on blood FFA concentration during gestation, even in ewes kept on balanced diets. Adjusted feeding according to FFA in blood is intended to produce a uniform nutritional state regardless of the number of foetuses. If we examine the blood glucose concentration observed in this group, it seems that the aim was not achieved in full. A similar result was reported by REID and HINKS (1962 *b*). The assumption that the adjusted feed was insufficient for twin-bearers is strengthened by the fact that these ewes lost weight during the last month of gestation (STERN *et al.*, 1978 *a*) and that their twins were smaller than those twins of differently treated ewes. RUSSEL *et al.* (1967) found under similar FFA concentrations (0.75 mEq/l), representing a state of " slight undernourishment ", that single lambs were 6.5 p. 100 and twins 13.5 p. 100 lighter than lambs born to ewes on a balanced diet. Twins from the adjusted group in the present work were on the average 19 p. 100 lighter than those of non-adjusted groups, while singles were heavier than those under the other treatments. It seems, therefore, that in twin-bearers a situation was formed similar to that defined by RUSSEL *et al.* (1967) as " slight undernourishment ". A more frequent adjustment of the ration would probably be needed to meet the requirements of twin-bearing ewes. Furthermore, recent work has shown that assessments of plasma 3-hydroxi-butyrate may be a more useful indicator of nutritional state of pregnant ewes (RUSSEL *et al.*, 1977).

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Résumé

Réponses de brebis laitières avant et après l'agnelage à différents niveaux d'apports alimentaires pendant la gestation.

III. — Teneur en certains métabolites sanguins pendant la gestation

Les effets de 3 séquences d'apports alimentaires de base tout au long de la gestation (fh, fn et nn), combinées à 3 niveaux de supplémentation à la fin de la gestation (H, L et A), sur certains constituants sanguins ont été étudiés chez les brebis laitières gestantes.

Les teneurs sanguines en glucose ont été d'une manière générale plus faibles chez les brebis portant des jumeaux que chez celles portant des agneaux simples. Les différences suivant le niveau des apports alimentaires n'ont porté que sur les 3 dernières semaines de la gestation. Pour les brebis portant 2 agneaux, les teneurs moyennes 18 jours avant l'agnelage étaient respectivement de 38 ± 2, 31 ± 2 et 31 ± 3 mg/100 ml pour les niveaux de supplémentation élevée (H) ajustée (A, en augmentation constante) et faible (L). Les valeurs respectives pour les brebis portant un seul agneau étaient de 43 ± 10, 38 ± 3 et 37 ± 8 mg/100 ml.

Les valeurs correspondantes pour les acides gras libres plasmatiques (FFA) exprimées en mEq/l étaient de 0,5 ± 0,2, 0,5 ± 1 et 0,75 ± 0,3; 0,3 ± 0,2, 0,15 ± 0,1 et 0,65 ± 0,3 respectivement pour les niveaux de supplémentation H, A, L et pour les brebis portant 2 et 1 agneau. Les teneurs les plus faibles ont été trouvées chez les brebis recevant le régime nnH (ration de base faible et niveau de supplémentation élevé) et les plus élevées, soit 0,89 et 1,00 mEq/l chez celles recevant le régime nnL (ration de base et niveau de supplémentation faibles).

Les teneurs en corps cétoniques ont des variations semblables à celles de FFA.

Le poids des brebis à la fin de la gestation est corrélé positivement avec le glucose et négativement avec les FFA et les corps cétoniques plasmatiques. Les corrélations calculées entre d'une part le glucose et les FFA plasmatiques et d'autre part le poids des composants de l'utérus gravide (fœtus et annexes) semblent appuyer la supposition que les fœtus tirent leur énergie du glucose sanguin de la mère alors que cette dernière satisfait une grande partie de ses besoins énergétiques grâce à ses réserves corporelles adipeuses.

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