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Original article

The effect of constant dietary energy supply during late gestation and early lactation on performances of prolific D'man ewes

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Abstract – A total of 42 prolific D'man ewes were used to study the effect of the dietary energy supply on their performances during the last 45 days of pregnancy and the first 60 days of the suckling phase. The ewes were fed 1 kg of hay and supplemented with either 200 (treatment L), 570 (treatment M) or 840 g (treatment H) of a barley and soyabean-based concentrate. The proportion of soyabean was adjusted so that the crude protein (CP) content of the three diets was similar (120 g CP·kg^{-1}). The energy contents of the diets were 1.2, 1.8 and 2.2 of the daily net energy requirements for maintenance in respectively the L, M and H treatments. Daily hay intake averaged 829 ± 18 g dry matter (DM) per ewe and was not affected by the level of the concentrate distributed. The body condition score of the ewes in all treatment groups was low at the beginning of the experiment (1.9 ± 0.3) and continued to decline throughout the period of treatment application. Nevertheless, the rate of decline was higher for the L and M ewes ($P < 0.05$). The live weight of the ewes after lambing was higher ($P < 0.05$) for ewes in the H treatment group (43.2 ± 6.9 kg) in comparison to the other ones (37.7 ± 7.8 and 40.0 ± 7.3 kg for the L and M groups respectively). Daily milk production over the first 40 days of lactation (959 ± 399 g·day^{-1}) was not affected by the energy level of the diet. Similarly, fat (8.9 ± 2.4%) and protein (4.5 ± 0.9%) contents of the milk were not affected by the diet energy content. The weights of the lambs at birth, at 10, 30 and 50 days of age were not influenced by the diet energy content. In contrast, average daily growth (ADG) between 10 and 30 (ADG10–30) and also between 30 and 50 days of age (ADG30–50) were significantly affected by energy allowances in the diet (95 ± 23, 133 ± 25, and 152 ± 27 g·day^{-1} for ADG10–30 and 76 ± 22, 135 ± 24 and 136 ± 24 g·day^{-1} for ADG30-50 in L, M and H groups respectively). It is concluded that the energy requirements of prolific D'man ewes during late gestation and early lactation are likely to be higher than the levels attempted in this study.

energy / prolific / sheep / late gestation / early lactation

Résumé – **Effet du niveau énergétique de la ration sur les performances de la brebis prolifique D'man en fin de gestation et début de lactation.** Quarante deux brebis de la race prolifique D'man

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ont été utilisées pour étudier les effets du niveau énergétique de la ration sur leurs performances de production pendant 45 j en fin de gestation et 60 j après la mise-bas. Les brebis ont reçu 1 kg de foin complémenté avec 240 g (lot bas : B), 570 g (lot moyen : M) ou 840 g (lot haut : H) d'un concentré à base d'orge et de tourteau de soja. La proportion de ce dernier a été ajustée pour obtenir 3 rations iso-azotées (120 g MAT·kg^{-1}). Les apports énergétiques sont estimés à 1,2, 1,8 et 2,2 fois le besoin d'entretien pour les lots L, M et H respectivement. L'ingestion du foin (829 ± 18 g MS·j^{-1}) n'est pas affectée par la quantité de concentré distribuée. La note d'état corporel des brebis est très faible au début de l'essai (1,9 ± 0,3) et continue à baisser tout au long de l'expérience. Cependant, la baisse est plus prononcée ($P < 0,05$) chez les brebis qui reçoivent les niveaux L et M. Le poids vif des brebis après la mise-bas est aussi affectée ($P < 0,05$) par le niveau énergétique de la ration (37,7 ± 7,8, 40,0 ± 7,3 et 43,2 ± 6,9 kg pour les lots L, M et H respectivement). La production laitière (959 ± 399 g·j^{-1}), les teneurs en matière grasse (8,9 ± 2,4 %) et protéique (4,5 ± 0,9 %) ne sont pas influencées par le niveau énergétique de la ration. Les poids à la naissance, à 10, 30 et 50 j sont similaires pour les trois traitements. En revanche, les gains moyens quotidiens entre 10 et 30 j (GMQ10–30) et entre 30 et 50 j (GMQ30–50) sont significativement ($P < 0,05$) améliorés par l'accroissement du niveau énergétique de la ration (95 ± 23, 133 ± 25 et 152 ± 27 g·j^{-1} pour GMQ10–30 et 76 ± 22, 135 ± 24 et 136 ± 24 g·j^{-1} pour GMQ30–50 respectivement dans les lots L, M et H). Il est conclu que les besoins énergétiques des brebis prolifiques D'man sont vraisemblablement plus élevés que les niveaux testés dans cet essai.

énergie / brebis / prolifique / fin de gestation / allaitement

1. INTRODUCTION

In several countries, prolific breeds of sheep are commonly used to improve flock productivity [1, 21, 27]. In Tunisia, the Moroccan D'man breed is selected because of its adaptation to local climatic conditions. Following its introduction into Tunisia in 1994, the breed population has increased from 100 to approximately 6 000 breeding ewes in 2001 according to the latest published statistics [30].

There is a wealth of information related to the breed's reproductive performances [10, 26, 27] as well as the genetic parameters of its main production traits [6, 12]. In contrast, its nutritional requirements were not so thoroughly investigated especially during critical physiological stages such as late gestation and early lactation. In the southern areas of the Mediterranean sea, sheep are often undernourished during these two physiological stages as a result of quantitatively and qualitatively limited feeding resources [31] in their traditional management. Undernutrition during late gestation is known to diminish foetal growth, weight at birth, dam milk production and post-natal growth [9] and could delay restoration of post-partum reproductive activity [24]. In addition, the occurrence of metabolic disorders, such as pregnancy toxaemia, linked to excessive mobilisation of the body fat reserves, becomes more frequent. The likelihood of these disorders seems to be more important in the case of prolific breeds [2]. Furthermore, Tunisian breeders do not generally change feeding regimens of sheep between pregnancy and early lactation. Their diets are based on hay and concentrate in these two stages.

Feeding strategies of prolific sheep during late gestation and early lactation are to be different from other non-prolific breeds and must be in accordance with the climatic and economic conditions of each area [19]. The same author reported that during late gestation and early lactation, prolific ewes like the Finnsheep and the Outaouais could be fed diets based on stored forages supplemented with grains at levels varying between 18 and 30%. However, Guerouali [23] pointed out that diets based on bulky feeding resources are unsuitable for pregnant D'man ewes if they are not supplemented with a high proportion of concentrates in their diets. In all these reported data, no direct measurements of the effect of nutrient allowances (energy, nitrogen, minerals…) during late pregnancy or early lactation on the performances of the ewes were reported. Hence, this study was undertaken to study the effect of maintaining constant different energy levels, while maintaining the same nitrogen allowances during late gestation and the early lactation period on the performances of prolific D'man ewes.

2. MATERIALS AND METHODS

2.1. Animals and general management

A total of 42 adult pregnant D'man ewes were used in this study. The animals weighed 45 ± 6.8 kg and were allocated to three treatment groups balanced for age (2.8 ± 0.9 years), body condition score (1.9 ± 0.5 out of a scale ranging from 0 to 5) and litter size (1.95 on average) determined by ultrasonography at approximately 3 months of pregnancy. The ewes were then individually housed and fresh water was available at all times. All the ewes included in the experiment are regularly run in an accelerated lambing rhythm (3 lambings in two years). For the particular reproductive period that corresponded to the present experiment, mating took place in July and the lambings were spread between the 7th and the 30th of December (23 days). After lambing, all lambs suckled their mothers and no milk was drawn out. The ewes were vaccinated against enterotoxaemia and were drenched for internal worms and parasites.

2.2. Nutritional treatments

On a daily basis, the ewes were individually fed 1 kg of hay (*avena sativa*) and 200 g (treatment L), 570 g (treatment M) or 840 g (treatment H) of concentrate. The 3 concentrates included barley, soyabean meal, a supplement of vitamins and minerals whose composition is shown in Table I. The quantities of concentrate were calculated for the energy allowances in the diets to achieve 1.2, 1.8 and 2.2 of the daily net energy maintenance requirements estimated at 0.033 UFL·kg live weight $(LW)^{-0.75}$ [4, 22] in respectively treatments L, M and H. The three regimens were kept constant from late pregnancy (–6 weeks) until 8 weeks of lactation. The net energy value of the feeds was determined according to the French system based on equations established by Vermorel [38] and in vitro organic matter digestibility [37]. The chemical compositions of the feedstuffs used in this experiment are reported in Table II. The diets were fed twice daily at 08.30 and 16.30. The feeding regimes were distributed for a period of 2 weeks of adaptation prior to the experimental period that lasted 105 days and corresponded to the last 45 ± 13 days of pregnancy and the first 60 days of lactation.

Table I. Quantities ($g{\cdot}day^{-1}$) of the feed and composition (% DM) of the concentrates distributed to D'man ewes receiving three levels of energy during late gestation and early lactation.

Dietary energy supply	Low	Moderate	High
Hay	1000	1000	1000
Concentrate	200	570	840
Concentrate composition			
Barley	15.8	68.5	78
Soyabean meal	79.2	26.5	17
SVM	5	5	5

SVM: supplement of vitamins and minerals including per kg: 100 g Ca, 35 g P, 80 g Na, 2 g Fe, 2 g Mn, 4.4 g Mg, 4 g S, 40 mg Co, 80 mg I, 400000 I.U. vit A, 80000 I.U. vit D_3, 160 mg vit E, 40 mg vit K.

2.3. Measurements

2.3.1. Food intake, body score and ewe live weight

Food intake was determined daily by the weighing of the distributed and the refused feeds. Assessment of the ewes body condition was carried out by attributing a score (scale from 0 to 5) according to the method

Table II. Chemical composition (% DM) and net energy content (UFL·kg^{-1} DM) of the feedstuffs distributed to D'man ewes in late gestation and early lactation.

	DM	Minerals	OM	CP	CF	UFL
Hay	87.9	8.1	91.9	6.5	36.7	0.60
Barley	88.6	3.7	96.3	12.9	6.7	1.10
Soyabean meal	87.5	7.3	92.7	46.8	7.1	1.15
SVM	98.3	70.3	29.7	5.2	3.0	–

UFL: Unité Fourragère Lait (1700 kcal NE·kg^{-1} DM, French Energy System, equations [36]).

of Russel et al. [35]. In total, 6 measurements were taken from 4 weeks before until 8 weeks after lambing. The ewes were also weighed 24 hours after lambing and thereafter at weekly intervals during a month.

2.3.2. Milk production

Daily milk production was determined using oxytocin (3 IU) as in the method described by Ricordeau et al. [34]. At each occasion of milk production recording (hand milking), samples of 20 mL of milk were also taken and immediately sent to the laboratory for analysis of fat and protein contents using an integrated milk testing machine (Combifoss 5300, Foss Electric, Denmark). In total, 4 measurements of milk production and composition were carried out at 10 day intervals during the first 40 days of lactation.

2.3.3. Growth of lambs

Newborn lambs were weighed at birth and then at intervals of 21 days. Weights at 10, 30 and 50 days as well as average daily growths (ADG) between 10 and 30 (ADG10–30) and between 30 and 50 (ADG 30–50) days of age were thereafter calculated.

2.3.4. Chemical analysis

The dry matter (DM), minerals, organic matter (OM) and crude fibre (CB) contents of feedstuffs were determined by reference to the official methods [3]. The protein content was also determined using the Kjeldahl method (Protein content = 6.25 × Nitrogen content).

2.4. Statistical analysis

The effect of the level of energy in the diet on all measured parameters was determined by an analysis of variance using the GLM procedure of SAS [36]. Means were then compared using the Newman and Keuls test [17]. Data on fertility and litter size were analysed using a χ^2 test.

3. RESULTS

3.1. Feed intake

On average, the ewes consumed 829 g DM·day^{-1} which is equivalent to 50.8 g DM·kg LW$^{-0.75}$ of hay with little differences between late pregnancy (810 ± 18 g DM·day^{-1}) and early lactation (847 ± 17 g DM·day^{-1}). This level of intake was not significantly affected by the level of concentrate in the diet (Tab. III). In contrast, the intake of hay tended to decrease during the last week of pregnancy (–50 g DM·day^{-1} for H group), then levelling up immediately after parturition and remaining stable after the 4th week of lactation. Moreover, no significant differences in hay ingestion were detected between the ewes bearing multiples or singles during this period.

Whatever the level of concentrate given, the ewes totally consumed their concentrate. As a result, total intake was different

Table III. Intake (g DM·day^{-1}) of hay, concentrate, net energy (UFL·day^{-1}) and protein (g·day^{-1}) in late gestating and early lactating prolific D'man ewes.

Dietary energy supply	Low	Moderate	High
Intake of hay			
Pre-partum	824 ± 25^{a}	801 ± 14^{a}	803 ± 16^{a}
Post-partum	853 ± 12^{a}	842 ± 21^{a}	847 ± 19^{a}
Intake of concentrate	174^{a}	506^{b}	746^{c}
Total intake	1013 ± 18^{a}	1328 ± 20^{b}	1572 ± 17^{c}
Net energy intake			
Pre-partum	0.68	1.01	1.26
Post-partum	0.70	1.04	1.29
Protein intake*			
Pre-partum	93.0	119.0	136
Post-partum	95.0	121.0	138.0

Means on the same line with different superscripts are different at $P < 0.05$; * Protein content of feedstuffs from Nefzaoui and Chermiti [31].

($P < 0.05$) between the treatment groups (1013 ± 18 (L) vs. 1328 ± 20 (M) and 1572 ± 17 g DM·day^{-1} (H)) which is equivalent to 62.5, 81.6 and 96.3 g DM·LW$^{-0.75}$ respectively for L, M and H groups. There were no signs of acidosis in the case of the ewes subjected to the H treatment.

3.2. Body condition

At the start of the experiment, the body condition score was low 1.9 ± 0.6 (L), 1.8 ± 0.5 (M) and 1.9 ± 0.4 (H). The body condition of all ewes further decreased until week 4 post-partum (Fig. 1). Nevertheless, the intensity of body condition losses is more important after lambing. During the two weeks preceding and the three weeks consecutive to lambing, the ewes in the H treatment achieved a higher mean body condition score of 1.6 ± 0.5 when compared to L (1.2 ± 0.4) and M (1.2 ± 0.3) ewes.

3.3. Live weight of ewes

Ewe live weight at lambing was significantly ($P < 0.05$) different between the regimens (Fig. 2). The figures reached 37.7 ± 7.8 (L), 40.0 ± 7.3 (M) and 43.2 ± 6.9 kg (H). Thereafter, live weight continued to decrease and then remained constant starting at around week 3 after lambing. Following a month of lactation, the ewes lost an average 2.6 ± 2.3, 2.7 ± 1.4 and 4.3 ± 2.6 kg of live weight in respectively the L, M and H treatments ($P = 0.27$). Across treatments, the loss of live weight was however, variable ranging from 0.5 to over 9 kg during the first month. Live weight at the end of the experiment also showed a large variability ranging from less than 26 kg in the L treatment to over 50 kg in the H treatment.

3.4. Distribution of born and suckled litters

All ewes lambed except one in the H treatment group, which died during pregnancy as a result of Coenurosis. Prolificacy (i.e. Number of lambs born per ewe lambing) and lamb mortality rate were higher in the M treatment group in comparison to the other treatment groups (Tab. IV). As a result, the average number of suckled lambs per ewe was similar for ewes in all treatment groups with, however, important differences in the distribution of the litter sizes. The number of ewes rearing more than two lambs

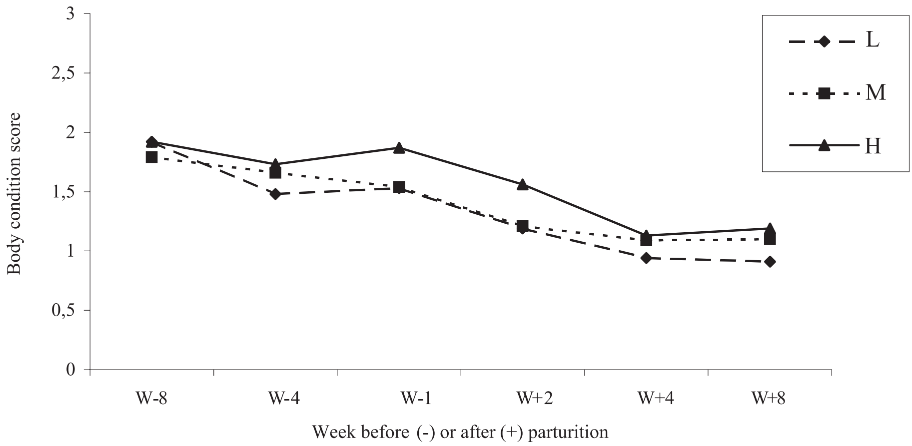

Figure 1. Variation of body condition score (scale from 0 to 5) of prolific D'man ewes receiving three dietary energy levels during late gestation and early lactation.

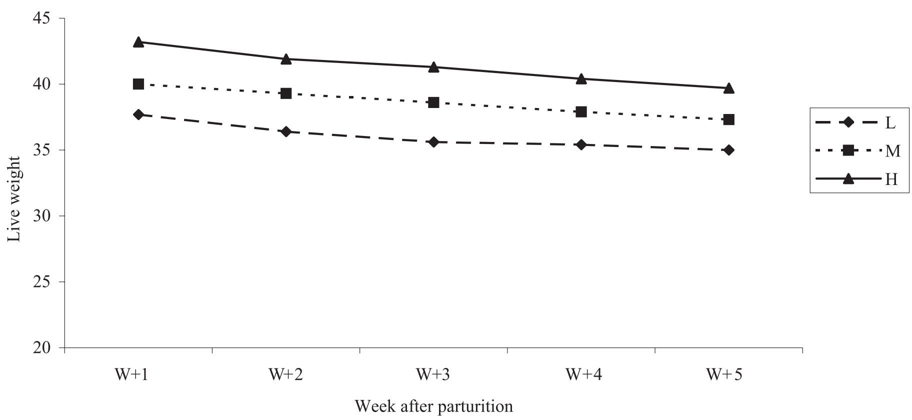

Figure 2. Evolution of live weight (kg) of prolific D'man ewes receiving three dietary energy levels during late gestation and early lactation.

was higher in the H (n = 3) treatment group when compared to the L (n = 1) and M (n = 0) ones.

3.5. Quantitative and qualitative milk production

Overall, milk production averaged 959 ± 399 g·day^{-1} (Tab. V) with a large coefficient of variation particularly at the first control (49%). As a result of this large variation, milk production was not significantly affected by the energy level of the diet. It tended, however, to be higher in the case of the most energetic diet (1098 ± 400 vs. 870 ± 369 (M) and 913 ± 400 (L) g·day^{-1}). This difference between energy levels is more marked during early lactation (1050 (L) vs. 1385 (M) and 1330 (H) g·day^{-1}) than at the end of the measurement period (675

Table IV. Reproductive performances of prolific D'man ewes receiving different levels of energy during late gestation – early lactation.

Dietary energy supply	Low	Moderate	High
Number of ewes	14	14	13
Prolificacy (%)	164[b]	200[a]	177[b]
Litter size distribution at lambing			
Singles	7	4	7
Twins	5	7	2
Triplets	2	2	4
Quadruplets	0	1	0
Lamb mortality (%)	4.6[b]	25[a]	8.7[b]
Number of lambs suckled	22	21	21
Total litter weight at lambing (kg)	4.1[a]	5.4[a]	4.8[a]
Total litter weight at 50 d (kg)	11.3[b]	13.4[b]	16.2[a]

Means on the same line with different superscripts are different at $P < 0.05$.

(L) vs. 700 (M) and 937 (H) $g \cdot day^{-1}$). When data on milk production was analysed according to the size of the suckled litter, the level of energy in the diet had a significant effect ($P < 0.05$) on milk yields in the first control only for the ewes rearing multiples.

Milk production was the highest during the first week of lactation and then decreased over the next 40 days. Milk of the D'man breed had a higher fat and protein content (Tab. V) during the first week of lactation (11% and 5.4% respectively) when compared to the last week of lactation (8.2% and 4.6% respectively). The fat and protein content of milk was not affected by the diet energy level during late pregnancy and early lactation. Average fat content was 8.7 ± 2.8, 9.1 ± 2.0 and 9.1 ± 2.3% and average protein content was 4.6 ± 1.0, 4.6 ± 0.9 and 4.4 ± 0.9% in the L, M and H treatments respectively (Tab. V).

3.6. Growth of lambs

Live weights at birth, 10, 30 and 50 days as well as ADG10–30 and ADG30–50 of the lambs are shown in Table V. None of the live weight parameters was significantly affected by the diet energy level. There was nevertheless a tendency ($P = 0.08$) for weight at 50 days to be higher in the H treatment group (Tab. V). At 50 days of age, average live weight difference between the

Table V. Effect of the diet energy level during late gestation and early lactation on milk production and composition of D'man ewes, weights at birth, 10, 30 and 50 days of age and the average daily growth (ADG) of lambs.

Dietary energy supply	Low	Moderate	High
Milk production ($g \cdot day^{-1}$)	913 ± 400[a]	870 ± 369[a]	1098 ± 400[a]
Fat content (%)	8.7 ± 2.8[a]	9.1 ± 2.0[a]	9.1 ± 2.3[a]
Protein content (%)	4.6 ± 1.0[a]	4.6 ± 0.9[a]	4.4 ± 0.9[a]
Birth weight (kg)	2.5 ± 0.5[a]	2.7 ± 0.5[a]	2.7 ± 0.6[a]
Weight at 10 days (kg)	3.8 ± 1.5[a]	4.2 ± 1.0[a]	4.5 ± 1.8[a]
Weight at 30 days (kg)	5.6 ± 2.2[a]	6.6 ± 1.9[a]	7.5 ± 2.9[a]
Weight at 50 days (kg)	7.2 ± 3.3[a]	8.9 ± 2.4[a]	10.0 ± 2.3[a]
ADG_{10-30} ($g \cdot day^{-1}$)	95 ± 23[b]	133 ± 25[a]	152 ± 27[a]
ADG_{30-50} ($g \cdot day^{-1}$)	76 ± 22[b]	135 ± 24[a]	136 ± 24[a]

Means on the same line with different superscripts are different at $P < 0.05$.

Table VI. Effect of diet energy level during late gestation and early lactation and litter sizes on litter weights (LW) at different ages of D'man lambs.

Source of variation	LW at birth	LW at 10 days	LW at 30 days	LW at 50 days
Energy level	NS	NS	*	**
Litter size at birth	***	NS	NS	NS
Litter size at 10 d	–	**	NS	NS
Litter size at 30 d	–	–	**	NS
Litter size at 50 d	–	–	–	**

NS: non significant at $P < 0.05$; *: significant at $P < 0.05$; **: significant at $P < 0.01$; ***: significant at $P < 0.001$; –: not included in the model.

lambs in the L and H treatment groups reached 2.8 kg. In contrast, ADG10–30 and ADG30–50 were affected ($P < 0.05$) by the energy level of the diet. ADG10–30 and ADG30–50 were particularly low in the case of the L treatment group and averaged 95 ± 23 and 76 ± 22 g·day^{-1} respectively. Differences up to +38 and +59 g·day^{-1} were recorded for respectively ADG10–30 and ADG30–50 when the energy level of the diet increased from L to M. When the litter weights at different ages were considered, it appeared that litter weights at birth and 10 days after were more influenced by the corresponding litter sizes than by the dietary energy supply (Tab. VI). At 30 and 50 days of age, the corresponding litter sizes still exerted a significant effect on litter weight. Nevertheless, the dietary energy supply also became important and significantly affected litter growth (Tab. VI). Litter weights were higher ($P < 0.05$) in ewes receiving the high energy level in comparison to litters in both the low and moderate groups.

Using a stepwise regression procedure of SAS [36], we demonstrated that for ewes in all treatments groups, milk production was correlated ($r = 0.46$; $n = 40$; $P < 0.01$) to the average ADG10–30 of the litter. There was a low relationship between both fat ($P = 0.36$) and protein ($P = 0.21$) contents and the ADG10–30 of the litter.

4. DISCUSSION

Despite its poor nutritional quality, the daily allowance of 1 kg·day^{-1} of hay was totally consumed by D'man ewes during late gestation and early lactation. In contrast to what is commonly reported on ruminants receiving good quality forages ad libitum [9], hay intake was never depressed by the addition of high levels of concentrate (840 g·day^{-1} i.e. 47% total DM intake). This may be due to the fact that maximum voluntary intake of this hay was not reached, since it was not given ad libitum. Hence we cannot estimate the potential intake of this hay. Inversely, due to the low crude protein content of the hay, it is even possible that the low level of concentrate increased the digestibility thus preventing any substitution of hay to concentrate even at the highest level [5, 32]. This proves that with poor quality roughage high concentrate supplementation is at no risk to depress its intake. Hence, such a diet may be well adapted to prolific ewes in late gestation and early lactation.

The D'man ewes used in this study are managed in an accelerated rhythm of three lambings in two years, thus explaining the particularly low average body condition score at the start of the experiment. This did not prevent the ewes, especially those in the L and M treatment groups to continue the depletion of their body reserves during late gestation (a mean reduction of 0.5 points of body score that is 26% of initial BCS). The determination of blood metabolite concentrations (glucose, free fatty acids, β-OH) used to measure the intensity of body reserve depletion, would have confirmed our observation of the ability of D'man ewes to loose body reserves.

According to Chilliard [16], Geenty and Sykes [20] and Khaldi [25], the energy resulting from mobilisation of body reserves is used to compensate for the increased demand for foetal development. For non-prolific breeds facing an energy deficit, the ability to deplete their body reserves is well documented in dry [4] and lactating ewes [8, 15, 28]. Our results suggest that similarly to these breeds, the prolific D'man ewe, even with low body condition, could undergo underfeeding during late gestation with no apparent signs of sanitary problems (toxemia, abortions, drastic reduction of intake, ...).

Increasing the energy level of the diet from 1.2 (L) to 1.8 (M) of the energy requirements for maintenance was not accompanied by an improvement of the ewes' body condition during late gestation. This result may be accounted for by differences in prolificacy between the two treatment groups being 200% and 164% respectively for ewes in the M and L treatment groups. However, when prolificacy was similar (case of the L (164%) and H (177%) treatments), increases in the dietary energy supply were associated to improvements in the body condition score during late pregnancy (i.e. + 0.32 points; $P = 0.046$). Most probably, the supplementary energy allowances (+ 0.58 UFL·day^{-1}) prevented body reserves from being depleted.

Whatever is the level of energy intake during late gestation, the average birth live weight of the lambs was similar around 2.5–2.7 kg (Tab. V). These figures were similar to those reported by Boujenane [11] for D'man lambs or by other authors [19, 29] for other prolific breeds under diverse feeding conditions. In this experiment, the lack of differences between treatments for this parameter could be attributed to the ability of D'man ewes to mobilise their body reserves thus insuring a normal foetal growth.

Following lambing, the body score continued to decline though more intensely in the case of ewes in the H treatment group. Ewes receiving the H energy level had more body reserves at parturition than the ewes in the other treatment groups (Fig. 1). The decline in body score was paralleled by a decrease in live weight indicating that for the three treatment groups, the dietary energy supply was lower than the whole requirements during early lactation.

Average milk production for D'man ewes as recorded in this study (959 g·day^{-1}), was similar to other reported figures for the same breed [13]. There was a tendency for the energy level of the diet to favour milk production as stated by Bocquier and Caja [7] who indicated that increasing levels of feeding are generally associated with higher milk production and inversely. In our study, however, the effect of feeding level on milk production was partially confounded by the number of suckled lambs [13] as suggested by the analysis of milk production data according to litter size (analysis not shown here). Failure to detect a clear effect of the level of energy on milk production could also be the result of the quality of proteins of the different diets. The diet in treatment L had more soyabean meal, which has a higher content in essential amino acids [22] than the other feeds (i.e. barley and hay). Furthermore, the difference of AA supply from feeds may have been used for neoglucogenesis in L and M treatments.

There is no effect of the level of energy on milk composition. This is probably the result of the natural variation of this parameter during the course of lactation but cannot be the result of an indirect effect of the quantity of milk produced [7] since milk yields were very similar. In comparison to other reported values for the same breed [11], our values of the milk fat content were higher. This may be accounted for by the intense depletion of body reserves leading to increased concentrations of free fatty acids [7]. In contrast, levels of protein content were within the range of reported values for D'man ewes [11]. It must be kept in mind, however, that the absolute values of milk composition should be taken cautiously since the oxytocin method may lead to the overestimation of milk yield as suggested by Doney et al. [18].

Average daily growth rates and litter weights at 30 and 50 days of age were affected by the diets energy level of their dams during late gestation and early lactation. Nevertheless, these growth performances remained low for the three levels of energy used, and were consistent with reported values in the literature for the same breed [14] and, in all case, are much lower than growth performances of suckling local autochthonous Tunisian breeds [33].

5. CONCLUSION

Considering the lamb growth performances, there was practically no linear response from low to high energy supply. Thus, it can be stated that lean D'man ewes can support the lowest level of energy supply in late gestation and early lactation. However, considering the body condition score evolution of ewes, it is clear that D'man ewes need, at least, to be fed at the highest level of energy supply in order to limit the use of body reserves during lactation, especially for ewes subjected to accelerated lambing rates.

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