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Ryegrass pasture supplementation strategies for lactating ewe performance

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Abstract: Optimal ewe health and well-being favors good reproductive performance and, as a consequence, assures good growth of the offspring. Thus, the aim of this study was to evaluate three production systems using commercial concentrate supplementation on Italian ryegrass pasture (*Lolium multiflorum*) on the metabolic profile and body condition score (BCS) of ewes, from those recently postpartum to 75 days in lactation. The total lamb production per ewe was also evaluated. Eighteen adult twin-bearing ewes, Texel × Ile de France crossbreeds, and their offspring were divided into three groups: without supplementation – control (CON); supplemented ewes and lambs at 1% of body weight (SEL); and creep-feeding supplemented lambs at 1% of body weight (CSL). The glucose concentration was higher for the SEL group ($P < 0.05$) and the SEL group showed less BCS variation from the first to the last evaluation, which suggests better nutritional adjustment in that system. The SEL and CSL groups showed the highest total lamb production per ewe, differing from CON ($P < 0.05$). These results suggest that the supplementation of ewes and lambs on ryegrass pasture allows the highest performance of both categories compared to exclusive supplementation of lambs and the animals exclusively on pasture.

Key words: Creep-feeding, body condition score, metabolic profile, postpartum, recovery

1. Introduction

A ewe's nutritional requirements rise in critical periods, such as in late gestation and during lactation, and they are more significant with multiple gestations (1). Thus, in these reproductive phases strategies have to be adopted to optimize lamb performance and the ewe's well-being. Optimal management ensures less productive wear on the ewe and allows her to more easily recover for the subsequent reproductive season.

Improving ewe nutrition during lactation is an efficient method to improve lamb performance (2). This is because ewes that have adequate energy levels have better corporal conditions and body weights. As a consequence, this assures higher average milk yields, which leads to a higher weight gain of the lambs (2,3).

On the other hand, another method that has been used to improve lamb performance is creep-feeding. Creep-feeding improves lamb growth and the time it takes to achieve ideal fattening (4). In addition, creep feeding also influences ewe performance because it shortens the lactation period, minimizing ewe wear and overload during the suckling period (5).

However, only a few studies have evaluated the effect of the supplementation provided for ewes and lambs, or for lambs alone, on weight, body condition score (BCS), metabolic profile, and lamb production per ewe in order to determine a system that can assure the best performance for both categories. Thus, the aim of this study was to evaluate the supplementation system with the best impact on performance for ewes on ryegrass pasture.

2. Materials and methods

2.1. Experimental area, animals, and experimental procedures

The study was approved by the Ethics Committee for the Use of Animals of Midwestern State University (UNICENTRO) under protocol number 018/2015.

The experiment was performed in the crop-livestock area of 2.4 ha, and the test animals were allocated into 12 paddocks of 0.2 ha each. Three raising systems were established in Italian ryegrass pasture (*Lolium multiflorum* 'Ponteio'): without supplementation – control (CON); supplemented ewes and lambs at 1% of body weight (SEL); and creep-feeding supplemented lambs at 1% of body weight (CSL).

A completely randomized block arrangement was adopted in factorial 3 × 6, with three forms of supplementation and six evaluation dates (0, 15, 30, 45,

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60, and 75 days postpartum) in three repetitions. Each repetition consisted of a paddock with two twin-bearing ewes and four lambs. The studied ewes were multiparous adults, Texel and Ile de France crossbreeds, with an average weight of 70 kg.

For the supplemented systems a balanced commercial concentrate was used (Agrária, Guarapuava, Brazil). The concentrate feed had the following nutritional composition: dry matter (DM) 89.2%, crude protein 20.02%, total digestible nutrients 77.53%, neutral detergent fiber (NDF) 29.42%, acid detergent fiber 14.17%, ash 8.44%, calcium 1.44%, and phosphorus 0.54%.

The SEL group was supplemented by offering concentrate based on 1% of body weight (BW), following recommendations for the product. Supplementation began when animals arrived in the experimental area (3 June 2015) and continued until the end of the experiment (10 September 2015), with an adaptation period of 15 days.

In the paddocks of supplemented lambs (CSL), supplementation was supplied in a private trough (creep-feeding) starting from their first week of life. The ewes did not receive supplementation at any time. The commercial concentrate was offered ad libitum to the lambs, performing adjustments based on 10% leftovers up to 1% BW of the lambs. The concentrate supplementation was supplied twice a day at 0700 and 1700 hours. All groups had free access to the water and mineral salt troughs.

Animals were managed in a continuous grazing system with a variable stocking rate through put-and-take stocking, where a variable number of regulator animals were added or taken from the area to maintain a grazing height between 10 and 15 cm. This management provided an average allowance of 2552.7 kg DM ha^{-1}.

The nutritional composition analysis of the forage (Table 1) was averaged every 24 days to determine the values of crude protein (by micro-Kjeldahl method), ash (by incineration at 550 °C/4 h) (6), and NDF according to Van Soest et al. (7). The analysis of ruminal disappearance rate of DM and NDF was also performed (8). The value of total digestible nutrients was estimated according to the equation TDN = 83.79 – 0.4171 × NDF (r^2 = 0.82), as proposed by Capelle et al. (9).

2.2. Health management, blood samples, and biochemical analysis

The health of the animals was assured by performing fortnightly evaluation of the herd using the Famacha method (10) and counting the eggs per gram of feces (EPG) (11). The animals with Famacha values equal to or higher than 3 or EPG equal to or higher than 1000 were dewormed with the active principle monepantel.

The energy, protein, and mineral metabolic profiles were monitored by collecting 3 mL of blood by cephalic venipuncture, always in the morning (0700 to 1000 hours). The blood samples were stored in tubes with

Table 1. Average levels of nutritional Italian ryegrass forage composition during pasture use period.

Parameter	Stocking period (days)					Regression equation
	0	24	48	72	96	
DM, % NM	11.4	10.2	16.2	17.3	20.7	0.1069x + 10.009 R^2 = 0.86**
CP, % DM	17.7	19.1	16.5	12.5	11.4	–0.0802x + 19.305 R^2 = 0.82**
Ash, % DM	15.0	14.0	11.0	9.0	8.0	–0.0795x + 15.23 R^2 = 0.96**
NDF, % DM	58.5	57.6	55.5	63.0	68.7	$0.0028x^2 - 0.1582x + 58.697$ R^2 = 0.94**
TDN, % DM	59.4	59.8	60.6	57.5	55.1	$-0.0012x^2 + 0.0654x + 59.327$ R^2 = 0.94**
DM–DR, % DM	76.2	69.7	80.6	71.8	59.6	$-0.0037x^2 + 0.2199x + 73.675$ R^2 = 0.66**
NDF–DR, % DM	56.3	47.1	60.2	52.9	40.9	$-0.003x^2 + 0.1817x + 53.148$ R^2 = 0.47**

DM = Dry matter; NM = natural matter; CP = crude protein; NDT = neutral detergent fiber; TDN = total digestible nutrients; DM–DR = dry matter disappearance rate; NDF–DR = neutral detergent fiber disappearance rate. **Significant at the 1% level.

fluoride anticoagulant for glucose evaluation and without anticoagulant for evaluation of the other parameters.

A total of six blood collections were performed. The first collection was performed in the recent postpartum period (12 to 24 h postpartum) and the other collections were repeated fortnightly, on days 15, 30, 45, 60, and 75 postpartum. The blood samples were centrifuged to obtain serum and plasma, which were stored in identified plastic microtubes and maintained at –20 °C until the biochemical analysis.

The energy profile analysis consisted of glucose and cholesterol measurements; the protein profile consisted of total protein, albumin, and urea measurements; and the mineral profile consisted of calcium, phosphorus, and magnesium measurements. These analyses were performed using commercial kits (Labtest, Lagoa Santa, Brazil) following the manufacturer's recommendations for reading in a semiautomatic machine.

2.3. Animal performance and statistical analysis

The BCS evaluation of ewes was performed at the same times as the blood collection. The BCS was assessed through palpation of lumbar vertebrae and evaluation of the amount of muscle and fat. Values from 1 (for emaciated animals) to 5 (for excessively fat animals) were assigned (12, 13).

Weight monitoring of ewes and lambs was performed according to the times established for the other parameters. Aiming to evaluate the ewe production efficiency, these weight data were used to measure total lamb production per ewe (LPE). LPE was calculated using the sum of the final weight of the lambs and expressed in kilograms of lamb produced per ewe.

The data were submitted to analysis of variance followed by Tukey's test at the 5% significance level for the group factor and regression for the period factor, which was tested with linear and quadratic models. The BCS data were analyzed using the $\sqrt{x+1}$ transformation option. The analysis was performed using the statistical program SISVAR (Federal University of Lavras, Lavras, Brazil).

3. Results

The interaction between group and evaluation times was not verified for the parameters in ANOVA testing. Statistical differences between the studied groups were not observed in biochemical analysis, with the exception of glucose, as shown in Table 2.

In the energy metabolic profile, the SEL group showed the highest glucose values and differed from CSL and CON ($P < 0.05$) (Table 2). Glucose remained within the reference values at all evaluated times. A negative linear behavior was observed for glucose, while cholesterol did not show significant regression (Figure 1).

Regarding the protein profile parameters (Table 2), it was verified that urea levels were above the reference values in all of the studied periods, but like total protein and albumin, urea did not differ between the evaluated times ($P > 0.05$).

Table 2. Average of the energy, protein, and mineral profiles and performance of lactating ewes with different concentrate supplementations on ryegrass pasture.

Parameter	Group			Reference values[1]
	CON	SEL	CSL	
Glucose (mg dL^{-1})	61^{b}	66^{a}	62^{b}	50–80
Cholesterol (mg dL^{-1})	66 ^{ns}	64	68	52–76
Urea (mg dL^{-1})	63 ^{ns}	68	69	17–43
Total protein (g dL^{-1})	7,0 ^{ns}	6.8	6.9	6.0–7.9
Albumin (g dL^{-1})	2.73 ^{ns}	2.66	2.77	2.4–3.0
Phosphorus (mg dL^{-1})	4.4 ^{ns}	4.4	4.4	5.0–7.3
Calcium (mg dL^{-1})	9.7 ^{ns}	9.5	9.5	11.5–12.8
Magnesium (mg dL^{-1})	2.2 ^{ns}	2.3	2.3	2.2–2.8
Body condition score	1.94^{ns}	2.04	1.96	-
Total lamb production per ewe	60.3^{b}	71.1^{a}	70.6^{a}	-

$^{a, b}$ Line means with different superscripts differ significantly by Tukey's test ($P < 0.05$). ^{ns} Not significant by Tukey's test ($P > 0.05$). [1]Reference values by Kaneko (20).

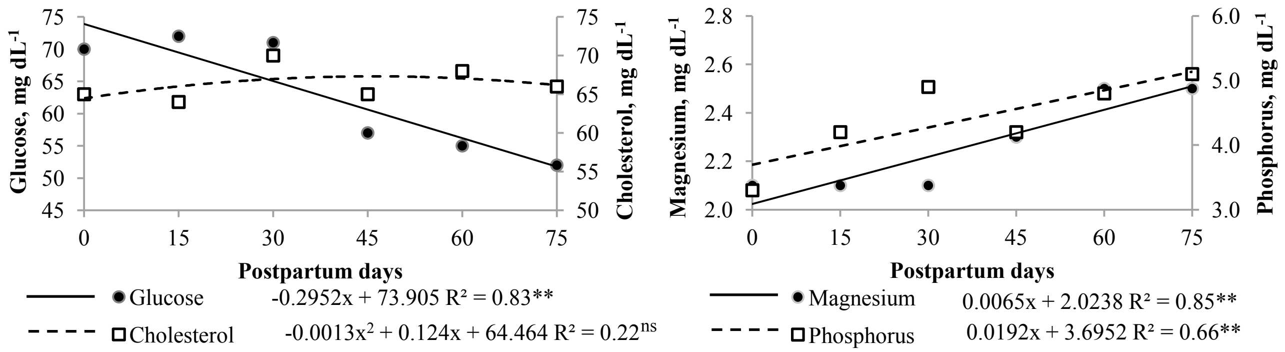

Figure 1. Energy and mineral metabolic profiles of lactating ewes from recently postpartum to 75 days in lactation. **Significant at the 1% level; ns = not significant.

Parameters of the mineral profile did not differ between groups ($P > 0.05$) (Table 2). Calcium did not show significant regression while the other parameters showed a positive linear behavior along the evaluated times (Figure 1). The concentration of magnesium was within the reference values during the last three evaluation periods, while phosphorus was within the reference interval only at the last evaluation. The calcium concentration was below the reference values at all evaluation times.

Figure 2 shows the ewes' weight and BCS data. Statistical analysis did not show differences between groups (Table 2) or interaction between group and evaluation times. All groups showed initial weight and BCS loss and then recovery by 30 days postpartum (Figure 2).

The CSL group showed the highest BCS variation from the first to the last evaluation with a reduction of 16.2%. The CON group showed a BCS reduction of 8.3% while the SEL group showed the lowest BCS loss of 6.3% from the first to the last evaluation.

Regarding ewe production efficiency, the total LPE was higher ($P < 0.05$) in supplemented groups compared to CON (Table 2).

4. Discussion

Although a difference between groups was observed for glucose (Table 2), the concentrations remained within the ovine reference values at all evaluated times. Thus, we suggest that although better nutritional adjustment occurred in the SEL group, all of the groups were in a sufficient condition for the physiological stage of the animals.

For all groups, the highest glucose value was measured immediately postpartum and the regularization of glucose levels observed throughout the lactation period led to a negative linear behavior (Figure 1). This finding can be explained by the higher maternal glucose released due to fetal demand or because of the ewe's need for readily available energy during parturition (14,15). The highest glucose levels were observed until 30 days postpartum, which corresponded to the lactation peak of the ewes. In ruminants, the tissue capacity to respond to insulin is reduced during lactation; thus, the temporary increase in glucose level stimulates milk production (16,17).

The cholesterol values remained stable during all periods and this agrees with the findings of Lima et al.

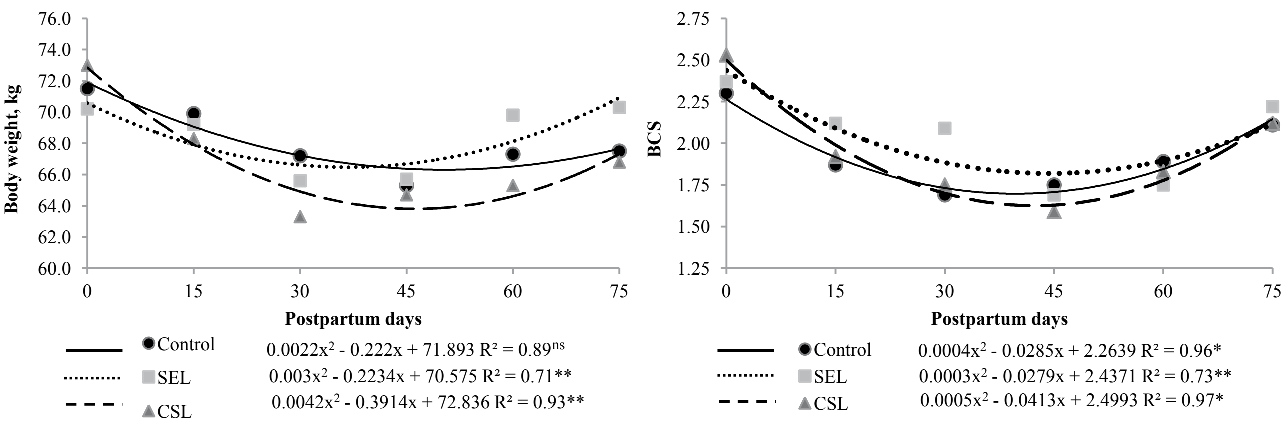

Figure 2. Average body weight and body condition score (BCS) of lactating ewes with different concentrate supplementation on ryegrass pasture from recently postpartum to 75 days in lactation. Significant at the 1% (**) and 5% (*) levels; ns = not significant.

(18). The stability of cholesterol concentrations in the groups was due the animal's energy efficiency to the milk production. In such a way, the lactation cycle and its intensity did not have an effect on serum cholesterol (16).

Urea concentration was raised in all groups and evaluation times. The urea concentration is directly related to protein input and the dietary energy–protein relationship (19). Therefore, the increased urea values observed can indicate an energy deficiency along with a high protein content provided by the high quality of the ryegrass forage (Table 1). Also, the increase in urea concentration can be related to urea recycling, which aims to complement the milk synthesis (14).

The total protein and albumin concentrations remained stable throughout the evaluation, and the values were within reference intervals (20). Similarly, other studies did not demonstrate variations in total protein levels during the lactation period (14,15). Albumin is a good long-term indicator of protein metabolism. Therefore, the results of our study reinforce that a protein deficit did not occur.

With regard to the mineral profile, calcium showed concentrations below the reference range values (20) (Table 2) and similar behavior and calcium concentrations were verified from immediately postpartum to 140 days in lactation (21). That decrease occurred as a consequence of increasing calcium secretion through the milk (17).

The low phosphorus concentration observed at the first evaluation could reflect the actions of parathormone in increasing calcium values (15). Also, that decrease occurred as a consequence of increased phosphorus secretion through the milk (17).

The magnesium data demonstrate that the balance was adequate, because the level of that mineral remained practically constant during evaluations (Figure 1). The stability in magnesium values was also verified in lactating ewes (22). The fact that the highest values were noted in the final periods of evaluation indicates a low requirement of that nutrient in this physiologic period.

Regarding ewe performance, a loss of BW and BCS was observed in the initial evaluations. However, reestablishment of BW and BCS was demonstrated by day 30 of lactation (Figure 2), which indicates that the nutritional level was above that required and the excess was directed to the ewe's recovery. The same behavior was observed by Castro et al. (3), who justified the loss of weight as a consequence of high nutritional demand in that phase and inability of some diets to meet that demand. Similarly, BCS loss was also verified in other studies (3,23).

A decrease in ewes' BCS is expected during the initial postpartum period because that period involves physiological factors of imbalance between lactation demand and the dry matter intake ability (24). However, from 30 days in lactation ewes started to recover their BCS. That finding suggests that ewes' demand after this period is lower due to the decrease in milk production.

The CSL group had higher BCS variation than the other groups. That behavior indicates that the applied creep-feeding system did not decrease ewe wear. Similar findings were observed in ewes raising lambs in a ryegrass pasture system with creep-feeding supplementation for lambs starting at 40 days of age (25).

These results indicate that a replacement effect of the concentrate feed for milk did not occur, but instead a complementary effect was observed. In a ryegrass pasture system, Piazzetta et al. (26) and Ribeiro et al. (27) studied exclusive supplementation systems in lamb intake behavior. The authors verified that the suckling times of these lambs were not different from that of the lambs that did not receive supplementation. This demonstrates the initial dependence of lambs on the maternal milk.

Regarding the LPE, ewes of the SEL and CSL groups were the most efficient because they produced more lambs per ewe on a kilogram basis and were superior to CON (Table 2). In SEL, that positive effect was due to the higher milk yield of the ewe, because the use of concentrate feed during the lactation period positively affects milk yield and, as a consequence, lamb performance (2,23).

However, the production of CSL was similar to that of SEL, and this could be due to the addition of concentrate, which did not substitute the milk and equally assured higher nutritional intake for these lambs. However, the lambs of CSL gained more weight with the detriment that the ewes experienced higher wear during lactation. Bigger lambs suckle more and, as a consequence, stimulate higher milk yield (28), which requires more corporal reserve mobilization from ewes to supply the milk yield.

A higher lamb performance and higher ewe milk yield in systems of exclusive supplementation of lambs were verified by Ferreira (29). Thus, we believe that this same behavior could have occurred in this study, justifying the observed results.

In the CON group, ewes showed a smaller reduction in BCS; however, the ewe efficiency on lamb production was significantly lower. That probably occurred due to the lower milk yield, which promoted a decreased wear of the ewes during lactation in that group. Although the ewes suffered reduced wear, it generated negative impacts in the efficiency of the productive parameters.

In conclusion, supplementation of ewes and lambs, beyond promoting higher production and weight gain of lambs, promotes better postpartum recovery conditions for the ewes. Although exclusive lamb supplementation does not exercise the same influence on the ewes' recovery, higher lamb gains favor early finishing of the animals and, as a consequence, allows the ewes to finish lactation earlier. Thus, as cited, the best performance of both categories occurred with supplementation of ewes and lambs when compared to the creep-feeding system and the system without supplementation.

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