Concentrate supplementation strategies in ryegrass pasture for productive performance in lambs

Sthefany K. Santos1, Margarete K. Falbo2,3, Itacir E. Sandini, Fabiano Pacentchuk2, Mikael Neumann1,3 and Gabriela Garbossa3

1Universidade Estadual do Centro-Oeste, M.S Program in Veterinary Sciences, Brazil. 2Universidade Estadual do Centro-Oeste, PhD Program in Agronomy, Brazil 3Universidade Estadual do Centro-Oeste, Veterinary Medicine, Brazil

Abstract

This study evaluated the effect of two concentrate supplementation strategies on performance, metabolic profile and economic evaluation of suckling lambs and ewes in ryegrass (Lolium multiflorum) pasture. Twenty-seven ewes and 45 lambs were divided into three groups: (1) ryegrass pasture without supplementation - control (CON); (2) CON plus supplemented ewes and lambs at 1% of live weight (SEL), and (3) CON plus creep feeding supplemented lambs at 1% of live weight (CSL). Concentrate use increased (p<0.05) average daily gain (ADG) by 19.95% over CON (21.6 and 18.3% for SEL and CSL, respectively). Concentrate use contributed to minimizing forage quality fluctuation and provided greater ADG stability, mainly when ryegrass nutritional content and digestibility decreased. Blood metabolites profiles did not differ between groups, with exception of phosphorus which was higher for CON than SEL, and calcium which was higher for CSL than CON (p<0.05). Compared to CON, stoking rate values were greater to SEL (p<0.05). Compared to CSL, ewe and total stocking rate were greater (p<0.05) to SEL. Considering the control group as break even feed investment, SEL strategy had a positive economic return, while CSL showed economic losses. Concentrate use increased ADG of lambs and decrease the impact of nutrient quality changes of forage on daily gains, but must be considered that supplemental strategy used could affect negatively economic return.

Additional keywords: creep feeding; economic return; metabolic profile; sheep.

Abbreviations used: ADG (average daily gain); CON (control group); CP (crude protein); CSL (creep feeding supplemented lambs group); DM (dry matter); EPG (eggs per gram of feces); LW (live weight); NDF (neutral detergent fiber); SEL (supplemented ewes and lambs group); TDN (total digestible nutrients).

Authors’ contributions: Experiment design: MKF, IES. Acquisition of data: SKS, IES, FP, GB. Analysis and interpretation of data: SKS, IES, FP. Wrote the paper: SKS, MKF. Critical revision of manuscript: MKF, IES, MN.

Citation: Santos, S. K.; Falbo, M. K.; Sandini, I. E.; Pacentchuk, F.; Neumann, M.; Garbossa, G. (2018). Short communication: Concentrate supplementation strategies in ryegrass pasture for productive performance in lambs. Spanish Journal of Agricultural Research, Volume 16, Issue 1, e06SC02. https://doi.org/10.5424/sjar/20181614-11067

Received: 16 Jan 2017. Accepted: 26 Feb 2018

Copyright © 2018 INIA. This is an open access article distributed under the terms of the Creative Commons Attribution 4.0 International (CC-by 4.0) License.

Funding: Authors did not receive specific funding for this work.

Competing interests: Authors have declared that no competing interests exist.

Correspondence should be addressed to Sthefany K. Santos: stthefanykamile@hotmail.com

Introduction

Nutritional management is a major influencing variable in the success of a production system. Indeed, new techniques are being introduced to optimize production, including strategic supplementation practices to meet higher nutritional requirements for ewes and lambs.

Pasture is considered a low-cost feed, however, forage does not have constant productivity and quality during the year. Therefore, supplementation may be used both to meet nutritional deficiencies and to mitigate the fluctuation of dry matter production of forage over the year (Farinatti et al., 2006).

Besides, lamb weight is related to the ewes’ nutritional history during pregnancy and lactation periods. Thus, ewe supplementation at these physiological stages is primordial, due to the relationship between good nutrition and higher milk yield and their effect on the improved development of lambs (Galvani et al., 2014).

Exclusive concentrated supplementation for lambs (creep feeding) can contribute to reduce the time to achieve ideal weight and finishing to slaughter, providing younger animals with better quality carcasses (Zundt et al., 2014; Sousa et al., 2016).

Several authors have reported results regarding the use of creep feeding (Silva et al., 2012; Borges et al., 2013) and supplementation of ewes in late pregnancy and during lactation (Chaturvedi et al., 2010; Castro et al., 2013). However, little research has compared these systems to determine which is more feasible. Thus, this
study aimed to evaluate the effect of supplementation of ewes and/or lambs in development and metabolic profile of lambs and to analyze which system provide better productivity and economic return in an area of Southern Brazil.

**Material and methods**

The study was performed in the crop-livestock area of Midwestern State University (Guarapuava, Paraná, Brazil) and approved by Ethics Committee for use of Animals (protocol number: 018/2015). The climate is characterized as mesothermal humid subtropical according to Köppen classification, and the altitude is approximately 1,100 m (Maak, 1968).

The experimental area was 2.4 ha planted with Italian ryegrass (*Lolium multiflorum* cv. Ponteio) and was divided into 12 paddocks. Sowing was performed with no-tillage and seeding rate of 40 kg seed/ha. Base fertilization was performed with 260 kg/ha of a formulated fertilizer 04-20-20 (N-P₂O₅-K₂O). Topdressing nitrogen fertilization was performed in a single application after emergence using urea (45-00-00) to obtain 150 kg/ha of nitrogen. During the experimental period average maximum temperature was 21.6 °C, the minimum temperature was 11.4 °C, average rainfall was 140 mm/month and average humidity was 72.5%.

Twenty-seven adult ewes of Texel × Ile de France crossbreed were used; animals had average weight of 70 kg (± 8.9 kg) and were multiparous (second to fifth parity) in late pregnancy. The animals were divided into three groups of nine ewes: control without supplementation (CON), supplemented ewes and lambs (SEL) and creep feeding supplemented lambs (CSL).

A complete randomized block arrangement was adopted in three repetitions. Each repetition consisted of a paddock with homogeneous distribution of animals relative to parturition date and sex of lambs, being one ewe that gave birth to singleton and two ewes that gave birth to twins, totaling five lambs. Lambs were born from 11 June to 28 June 2015.

Supplementation feed consisted of a commercial concentrate (Golden Sheep, Cooperativa Regional Mista Agrária®, Paraná, Brazil) with nutritional composition: dry matter (DM) 89.2%, crude protein (CP) 20.02%, total digestible nutrients (TDN) 77.53%, neutral detergent fiber (NDF) 29.42%, ash 8.44%, calcium 1.44% and phosphorus 0.54%. The SEL group received concentrate based on 1% of live weight (LW), and began when the animals arrived in the area (03 June 2015) until the end of the experiment (05 October 2015). Lambs had access to the ewes’ trough and benefitted from the supplied amount equivalent to 1% LW of lambs. For CSL group, supplementation was supplied in a privative trough (creep feeding) from the first week of life of the lambs. Concentrate was offered *ad libitum*, performing adjustments based on 10% leftovers up to 1% LW of lambs. The concentrate was supplied at 07:00 and 17:00. All groups had free access to water and mineral salt.

Animals were managed in a continuous grazing system with a variable stocking rate (put-and-take method) to maintain a grazing height between 10-15 cm. This management provided 2,552.7 kg DM/ha average allowance.

On average, forage samples were collected every 24 days for nutritional composition analysis through cuts close to the ground in nine areas of 0.25 m². These samples were homogenized to make one subsample for analysis (Marchesan et al., 2015). Sample was pre-dried in stufe with laminar flow at 55°C for 72 h and ground to 1 mm in a Wiley-type mill. Total dry matter, CP and ash was determined according to AOAC (1995) and NDF according to Van Soest et al. (1991). Ruminal digestibility of DM and NDF was performed through *in situ* digestibility technique (Vazant et al., 1998). TDN was estimated according to the equation TDN=83.79-0.4171*NDF (r² = 0.82) as proposed by Capelle et al. (2001).

Health of the animals was assured by fortnightly clinical evaluation using Famacha method (Malan et al., 2001) and eggs per gram of feces counting (EPG) (Gordon & Whitlock, 1939). Animals with Famacha values ≥ 3 or EPG ≥ 1,000 were dewormed.

Metabolic profile of lambs was performed in a single collection of blood at the end of the experiment. By cephalic venipuncture, 3 mL of blood were collected and stored in tubes without and with fluoride anticoagulant. Analysis of the energy profile consisted of glucose and cholesterol dosage; protein profile consisted of total protein, albumin and urea; and mineral profile consisted of calcium, phosphorus and magnesium dosage using commercial kits (Labtest®, Diagnostica SA, Minas Gerais, Brazil) following the manufacturer's recommendations.

Individual weighing of animals began at an average age of 11 days, and was performed every 15 days. Animal stocking rate (kg LW/ha) was calculated using average weight of test animals plus weight of regulator animals, multiplied by the number of days in pasture. The result was divided by the number of days in the grazing period.

Economic analysis was based on production per hectare and was made using a revenue simulation of the sale of lambs, based on average sale price in the region (US$ 30.26 kg/LW) subtracted from
supplementation total cost. Return over feed cost was calculated subtracting total feed cost from total revenue. Finally, considering control group as break even feed investment, return over production gain was calculated from difference between total revenue by animal sale for SEL and CSL subtracted from CON.

Data were submitted to Bartlett’s test, and then to analysis of variance followed by Tukey’s test for qualitative factor (group) and regression for quantitative factor (period), which tested linear and quadratic models. The analysis was performed using the statistical program SISVAR® (version 5.6 for windows; Lavras, Minas Gerais, Brazil).

Results and discussion

Nutritional values of forage did not show interaction \(p>0.05\) between group and period. Also, pasture characteristics did not differ between groups \(p>0.05\) but showed differences during period. Changes in nutritional composition of forage with advance of pasture use affected DM and NDF digestibility (Fig. 1).

Nutritional variation is likely due to physiological modifications in forage cycle, which causes reduction in leaves proportion, increased stem participation and lignification of plant. This reflects in increased DM and NDF (Marchesan et al., 2015), reduction in ash, CP and TDN (Soares et al., 2013; Marchesan et al., 2015), as verified during evaluations. Furthermore, NDF increases have a negative impact on DM intake and feed digestibility (Allen et al., 2009). Thus, nutritional variation impacted in DM and NDF digestibility, which decreased during the period.

Supplementation produced higher ADG (0.301 and 0.289 kg/day for SEL and CSL, respectively) compared to CON (0.236 kg/day) \(p<0.05\). The period influenced ADG of lambs \(p<0.05\), and regardless of group, ADG reduced as evaluation period progressed (Fig. 2).

As ryegrass pasture was the base of diet, its fluctuation may be reflected in performance of the animals as a result of DM intake and the quality parameters of forage. Equivalent findings were confirmed by Ribeiro et al. (2009) at similar procedures and climatic conditions.

In addition to pasture variation, authors such Tonetto et al. (2004) and Frescura et al. (2005) justify ADG reduction due changes in eating habits and less reliance on mother’s milk for lambs. It is consistent with the findings of this study because despite ADG reduction, it only becomes significant \(p=0.10\) after 60 days (Fig. 2). Lactation peak in a ewe occurs around one month after lambing; at 60 days, ewe has reached 75% of its total milk production (Pacheco & Quirino, 2008), and thus, ADG of lambs becomes more dependent on solid feed.

Despite variations in pasture quality, SEL and CSL groups sustained ADG better, as CON decreased 75.4% in ADG from first to the last weighing, while SEL and CSL reduced 34.2% and 48.4%, respectively. This is justified by concentrate contribution, which, in addition to promoting higher nutritional level, reduced seasonal effects of grazing variations (Farinatti et al., 2006).

Regarding metabolic profile (Table 1), there were significant differences \(p<0.05\) only for calcium which was higher for CSL than CON, and phosphorus which was higher for CON than SEL. Also, parameters presented the same behavior in all groups, indicating that the different systems did not promote significant changes in the profiles.

Calcium values were lower than the reference range proposed by Kaneko (2008), however, in reference limits cited by González et al. (2000), from 8.1 to 10.02

Figure 1. Average levels of crude protein (CP), ash, dry matter (DM), neutral detergent fiber (NDF), total digestible nutrients (TDN), DM digestibility and NDF digestibility during the pasture use period. **Significant at \(p<0.01\).
Table 1. Mean values of metabolic profiles, stocking rate and economic analysis of lambs under different supplement strategies

| Blood metabolite | Group | CON (mg/dL) | SEL (mg/dL) | CSL (mg/dL) |
|------------------|-------|-------------|-------------|-------------|
| Glucose          | 63    | 68          | 67          |
| Urea             | 45    | 50          | 50          |
| Albumin          | 2.37  | 2.53        | 2.59        |
| Total protein    | 6.2   | 6.0         | 6.0         |
| Cholesterol      | 76    | 86          | 77          |
| Phosphorus       | 9.9a  | 8.6b        | 8.8ab       |
| Calcium          | 9.2a  | 9.5b        | 9.9b        |
| Magnesium        | 2.1   | 2.2         | 2.1         |

| Stocking rate    |       |             |             |
|------------------|-------|-------------|-------------|
| Average lamb stocking rate, kg LW/ha | 379.9a | 495.5a | 425.7ab |
| Average ewe stocking rate, kg LW/ha    | 1,028.7b | 1,342.9b | 1,068.7b |
| Average total stocking rate, kg LW/ha  | 1,408.7b | 1,834.4a | 1,494.4b |

| Economic analysis |       |             |             |
|-------------------|-------|-------------|-------------|
| Total feed intake, kg | --- | 1,594.3 | 472.1 |
| Total feed cost, US$ | --- | 8,274.41 | 2,450.19 |
| Lamb production, kg LW/ha | 440.7 | 722.0 | 472.4 |
| Production gain, kg LW | --- | +281.3 | +281.7 |
| Total revenue by lamb sale, US$ | 13,335.58 | 21,847.72 | 14,294.82 |
| Return over feed cost, US$ | 13,335.58 | 13,573.31 | 11,844.63 |
| Return over production gain, US$ | --- | 237.73 | 1,490.95 |

---

Groups: CON, Control; SEL, supplemented ewes and lambs; CSL, creep feeding supplemented lambs.

1Reference values according Kaneko (2008): glucose (50-80 mg/dL), urea (17-43 mg/dL), albumin (2.4-3.0 g/dL), total protein (6.0-7.9 g/dL), cholesterol (52-76 mg/dL), phosphorus (5.0-7.3 mg/dL), calcium (11.5-12.8 mg/dL) and magnesium (2.2-2.8 mg/dL).

2Significant at p<0.01; ns = not significant (p>0.10). Different letters differ by Tukey’s test (p<0.05).

Figure 2. Average daily gain (ADG; kg/day) of lambs in the CON (Control), SEL (supplemented ewes and lambs) and CSL (creep feeding supplemented lambs) groups. **Significant at p<0.01; ns = not significant (p>0.10). a-b Different letters differ by Tukey’s test (p<0.10).
mg/dL, results of this study are within normal limits. Higher phosphorus may be due to animal category, and its bone mobilization due growth (Borburema et al., 2012). Furthermore, discreetly elevated cholesterol concentration observed is likely due to milk intake, which offers large energy amounts as fat. Higher urea concentration is likely due to protein quality of ryegrass and the relationship between energy and protein in diet (Oliveira et al., 2016).

The SEL showed higher stocking rate in all items and presented an average stocking rate higher (p<0.05) than CSL and CON (Table 1). Stocking rate of lambs did not differ between CSL and CON (p>0.05), similarly to verified by Ribeiro et al. (2009).

Higher stocking rates in SEL are due to a forage intake substitution effect by ewes, and it is in accordance with Farinatti et al. (2006). However, when supplementation is performed exclusively for lambs, Silva et al. (2012) also did not find changes in stocking rate because lambs have lower forage intake, which is not large enough to change this parameter.

Concerning the profitability (Table 1), supplemented groups had higher lamb production. However, only SEL gains was enough to pay the investment in concentrate feed (US$ 5.19/kg), leading to revenue US$ 237.73 higher than CON, while CSL supplementation did not show economic benefits.

In conclusion, supplementation had a positive economic return, being a strategy to improve lamb production in raising systems at similar climatic conditions.

References

Allen MS, Bradford BJ, Oba M, 2009. The hepatic oxidation theory of the control of feed intake and its application to ruminants. J Anim Sci 87: 3317-3334. https://doi.org/10.2527/jas.2009-1779

AOAC, 1995. Official methods of analysis. Assoc. Offic. Anal. Chem., Washington, D.C., 1094 pp.

Borburema JB, Cezar MF, Marques DD, Cunha MG, Pereira Filho JM, Sousa WH, Furtado DA, Costa RG, 2012. Effect of diet on the metabolic profile of Santa Inês sheep feedlot. Arq Bras Med Vet Zootec 64: 983-990. https://doi.org/10.1590/S0102-09352012000400027

Borges GDS, Macedo VDP, Baiffus FSB, Atoji K, Hill JAG, Batista R, Bianchi AE, Ortiz S, 2013. Performance in vivo and biometric of goatling infant with access creep feeding at different ages. Rev Bras Saúde Prod Anim 14: 745-754. https://doi.org/10.1590/S1519-99402013000400018

Cappelle ER, Valadares Filho SC, Silva JFC, Ceccon PR, 2001. Estimates of the energy value from chemical characteristics of the feedstuffs. R Bras Zootec 30: 1837-1856. https://doi.org/10.1590/S1516-35982001000700022

Castro FAB, Ribeiro ELA, Mizubuti IY, Silva LDDF, Freitas Barbosa MAA, Marson B, Grandis FA, Fernandes Junior F, Pereira ES, 2013. Dietary energy in late pregnancy and during lactation and performance of Santa Inês sheep in an accelerated mating system. Semina 34: 4187-4202.

Chaturvedi OH, Mann JS, Karim SA, 2010. Effect of concentrate supplementation to ewes grazing on community rangeland during late gestation and early lactation. Ind J Small Rumin 16: 97-100.

Farinatti LHE, Rocha MG, Poli CHEC, Pires CC, Potter L, Silva JHS, 2006. Performance of sheep fed different supplements or only Italian ryegrass (Lolium multiflorum L.) pasture. R Bras Zootec 35: 527-534. https://doi.org/10.1590/S1516-35982006000200027

Fernandes SR, Freitas JA, Souza DF, Kowalski LH, Dittrich RL, Junior PR, Silva CJA, 2012. Serum lipid profile in the community rangeland during late gestation and early lactation. Arq Bras Med Vet Zootec 64: 983-990.

Freitas Barbosa MAA, Marson B, Grandis FA, Fernandes Junior F, Pereira ES, 2013. Dietary energy in late pregnancy and during lactation and performance of Santa Inês sheep in an accelerated mating system. Semina 34: 4187-4202.

Hora Vet 20: 59-62.
Gordon HMCL, Whitlock HN, 1939. A new technique for counting nematode egg in sheep faeces. Aust J Sci Res 12: 50-52.

Kaneko JJ, 2008. Clinical biochemistry of domestic animals. Academic Press, San Diego. 896 pp.

Maak R, 1968. Geografia física do Estado do Paraná. Banco de Desenvolvimento do Estado do Parana, Curitiba, Brazil, 350 pp.

Malan FS, Van Wyk JA, Wessels CD, 2001. Clinical evaluation of anaemia in sheep: early trials. Onderstepoort J Vet 68: 165-174.

Marchesan R, Paris W, Tonion R, Martinello C, Molinet ML, Paula FLM, Rocha R, 2015. Nutritional value of ryegrass cultivars intercropped or not with oats under two waste. Rev Ciênc Agrovet 14: 254-263. https://doi.org/10.5965/223811711432015254

Oliveira RPM, Assante RT, Silva AF, Oliveira FF, Cruz FGG, Rufino JPF, 2016. Evaluation of metabolic profile at different stages of peripartum of Santa Inês ewes in the Western Amazon. Rev Bras Saúde Prod Anim 17: 37-44. https://doi.org/10.1590/S1519-99402016000100004

Pacheco A, Quirino CR, 2008. Study of growth traits in ram. Pubvet 2: 1-11.

Ribeiro TMD, Monteiro ALG, Poli CHEC, Moraes AD, Silva ALP, Barros CS, 2009. Ryegrass pasture characteristics and lamb productivity in grazing. R Bras Zootec 38: 580-587. https://doi.org/10.1590/S1516-35982009000300025

Silva CJA, Monteiro ALG, Fernandes SR, Poli CHE, Prado OR, Souza DF, 2012. Effect of creep feeding and creep grazing on the characteristics of tifton and italian ryegrass pastures and on sheep performance. Ci Anim Bras 13: 165-174.

Soares AB, Pin EA, Possenti JC, 2013. Nutritive value of five cool-season forage species under four sowing dates. Ciência Rural 43: 1-6.

Sousa DA, Selaive-Villarroel AB, Pereira ES, Silva EMC, Oliveira RL, 2016. Effect of the Dorper breed on the performance, carcass and meat traits of lambs bred from Santa Inês sheep. Small Rumin Res 145: 76-80. https://doi.org/10.1016/j.smallrumres.2016.10.017

Tonetto CJ, Pires CC, Müller L, Rocha MG, Silva JHS, Neto D, 2004. Weight gain and carcass characteristics of lambs finished in a natural supplemented pasture, ryegrass pasture (Lolium multiflorum Lam.) and feedlot. R Bras Zootec 33: 225-233. https://doi.org/10.1590/S1516-35982004000100004

Van Soest PJ, Robertson JB, Lewis BA, 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J Dairy Sci 74: 3583-3597. https://doi.org/10.3168/jds.S0022-0302(91)78551-2

Vazant ES, Cochran RC, Titgemeyer EC, 1998. Standardization of in situ techniques for ruminant feedstuff evaluation. J Anim Sci 76: 2717-2729. https://doi.org/10.2527/1998.76102717x

Zundt M, Oliveira KPD, Ambiel AC, Rego FCDA, Castilho C, Firetti R, 2014. Performance crossbred lambs dorper males and females, in creep feeding fed pelleted diets at weaning. Colloquium Agrariae 10: 26-32. https://doi.org/10.5747/ca.2014.v10.n1.a097