Effect of early creep feeding in the performance of Chilota breed lambs

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Abstract

The transition from monogastric (pre-ruminant) to ruminant is a critical stage in the weight gain of lambs. Supplementation in the early life can improve this transition and the future performance, and familiarizes the animal with concentrate consumption. In Chiloé, where the native sheep breed Chilota is widely distributed and used for productive purposes, the creep feeding is still an unknown practice, and its effect in the performance of Chilota breed lambs has not been assessed. The aim of this study was to evaluate the effect of creep feeding supplementation from 10 to 48 days of life on the daily weight gain of Chilota breed lambs. Early creep feeding showed a positive effect on body weight gain and facilitated the transition from monogastric to ruminant, buffering the weight loss of the lambs after the milk production peak of their dams.

Key words: creep feeding, lambs, small ruminants, Chilota breed, Chile

Introduction

In Chiloé Archipelago, sheep production is mostly carried out in extensive conditions. Ewes are dependent on low quality natural pastures all over the year, and there is no grazing management or monitoring of the nutritional status of the sheep. Lambs are fed exclusively with milk from their dams (Martínez et al, 2011). Despite the fact that concentrate supplementation should be used to increase lamb individual performance and productivity in grazing systems (Araújo et al, 2014), sheep do not receive supplements before lambing nor during lactation period, although some recent experiences in Chiloé that have shown a positive effect of supplementation (Martínez et al, 2012; Martínez et al, 2015; Peña et al, 2015). Under Chiloé´s small-scale productive system, lactation period usually lasts 16 to 18 weeks (110-130 days), when the lambs are not weaned but slaughtered.

In the first 30 days after birth, the sheep produces half of the milk of the whole lactation period (Banchero, 2006). When lambs are 10 days old, they begin to consume small amounts of solid food (in Chiloé, only natural pasture is available). From day 30 onwards, the intake of these feedstuffs increases progressively at the same time that milk production decreases. At this point, the efficiency of feed conversion is usually reduced (Banchero, 2006), and lambs often suffer a decrease in the growing rate; here, preferential feeding of lambs can play an important role. The creep feeding (CF) is a practice consisting on providing suckling lambs with nutritive feedstuffs while their dams have no access to these supplements. To date, there is no scientific information about the efficiency of CF in the weight gain of Chilota breed lambs under the productive conditions of Chiloe´s Archipelago. Therefore, the objective of this study was to evaluate the effects of CF concentrate supplementation on the daily weight gain in Chilota lambs from day 10 to 48.

Materials and Methods

The study was conducted in late winter- early spring (7th September-16th October) at the INIA Butalcura experimental Center in Chiloé, Chile. Thirty-eight single birth male lambs, born the same day, coming from the same Chilota breed herd were used. Sheep were three years old and had a BCS of 2.5 at lambing. Lambs were randomly allocated into two treatments: C (Control, without supplementation, n = 18), and S (Supplemented, n = 20), and both groups were kept with their dams in two adjacent paddocks with similar characteristics (naturalized grasslands, 1 ha each). The lambs assigned to treatment S received a commercial concentrate formulated for lambs (Table 1) *ad libitum* from day 10 to 48. Samples of pasture were taken every 9 days by means of exclusion cages. The mean chemical composition[1] of pasture for the whole period was 89,90% DM, 13.6% CP, 2.67 Mcal/Kg ME, 75,9% IVD; 3% ASH; 73,6% DV; 1,60 Mcal/Kg NEL. The analysis of forage and concentrate were performed at the laboratory of food quality at INIA Remehue (Osorno, Chile).

Table 1. Mean levels of dry matter and nutritional composition of the concentrate offered to Chilota lambs

	mean	s.d.		mean	s.d.
DM	89,40	0,00	**EE**	4,20	0,00
DIG	87,20	0,62	**N**	3,13	0,06
D val	80,40	0,79	**ME**	2,89	0,03
NNE	61,73	0,51	**NEL**	1,72	0,01
NSC	44,73	0,45	**K**	1,23	0,04
NDF	22,70	0,00	**P**	0,83	0,02
CP	19,73	0,35	**Ca**	0,73	0,02
ASH	8,63	0,12	**Mg**	0,34	0,01
CF	5,70	0,10	**Na**	0,30	0,02

DM: Dry matter; DIG: *in vitro* digestibility; D val: digestibility value; NNE: non-nitrogen extract: NSC: Non-structural carbohydrates; NDF: neutral-detergent fiber; CP: crude protein; ASH: ashes; CF: crude fiber; EE: ether extract; ME: metabolisable energy; NEL: net energy of lactation. All values are expressed in % except for ME and NEL (Mcal/ Kg).

Management for both lots was identical except for the supplementation. In one of the paddocks, a simple wooden construction was set up (Fig 1a and b). Grouped feeders were placed inside the structure (Picture 2). Three

[1] Mean values for 4 sampling times (day10, 19, 28 and 37). DM: dry matter; CP: crude protein; ME: metabolisable energy; IVD: in vitro digestibility; ASH: ashes; DV: D value; NEL: Net energy of lactation.

days before the starting of the experiment (day 7 after lambing), all the animals (sheep and lambs) had free access to the creep feeding structure, in order to let the lambs see how their dams ate concentrate. Concentrate consumption of lambs on these three days was negligible. Afterwards, the creep feeding structure was closed for sheep, and only lambs on treatment S could get into the structure (Fig 3 a, b and c) and had access to the feeders containing a known amount of concentrate. The adjustments of supplement offer when refusals were less than 100 g/day. Animals had free access to clean, fresh water and vitamin-mineral blocks throughout the experimental period.

Fig 1 a

Fig 1b

Fig 2

Fig 3a

Fig 3b

Fig 3c

The variables measured were live weight (LW) at birth, at 34, 41 and 48 days old and daily consumption of concentrate. Collection and weighing of supplement leftovers were carried out daily to estimate the supplement daily intake per lamb. Performance was assessed based on birth weights (day 0) and weights after fasting (food and water) for 12 h at 34, 41 and 48 days of age. Average Daily Gain (ADG) (g/d) for each period was calculated as the final weight minus the initial weight, divided by the number of days. Averages were also obtained for the whole experiment (day 0 to 48). Weight records for day 10 were not available when analyzing the data; therefore the birth weights were taken as initial weights for the experiment. LW data were analyzed by means of an ANOVA with the XLSAT program (Microsoft). The hypothesis test for the effect of concentrate intake was performed with a T-Student test.

Results

The average daily intake of concentrate per lamb throughout the whole experiment (from day 10 to 48) was 57.4 g (Table 2), very low on the first 20 days and increasing sharply towards the end of the experiment, when consumption was more than 100 g per day after day 41. The average daily weight gain in the full study period was 137.9 g for the control treatment, while in the S treatment was significantly higher (180.8g; P <0.001). On the first 23 days, no differences were found between ADG of C and S lambs. The biggest difference appeared in the period from 34 to 40 days, where C lambs showed negative growth (loss of weight); however, S lambs increased on average 85 g per day over the same period (190.7% more, P<0.05). Afterwards, from day 41 to 48, supplemented group gained almost 100g more than control group did.

Table 2. Average concentrate intake and daily weight gain in Chilota lambs

Period	ADI (g/day/lamb)	ADG (g/day/lamb)		Increment (%)
		C	S	
10-33d	27.2	136.3	151.3	11NS
34-40d	95.4	-44.6	85.0	190.7*
41-48d	105.5	347.7	441.4	26.9**
Global	57.4	137.9	180.8	31.1***

NS: Not significant;* P< 0,05;**P< 0,01;***P< 0,001

ADI: average daily concentrate intake of lambs in S treatment; ADG: Average daily weight gain; C: control treatment; S: supplementation treatment (access to concentrate *ad libitum* from day 10 to 48).

Table 3. Hypothesis test for the effect of concentrate consumption in the live weight of lambs.

Variable (Kg)	Mean±s.d.		Difference (S-C)
	C	S	
LW	3.617± 0.284	3.192±0.247	-425**
W34	8.114± 0.284	8.184±0.247	69NS
W41	7.802± 0.336	8.779±0.392	996*
W48	10.236± 0.375	11.869±0.249	1.633***
WG 0-48	6.619± 0.312	8.678± 0.222	2.059***

NS: Not significant;* P< 0,05;**P< 0,01;***P≤ 0,001. T- Student.
s.d.: standard deviation; LW: Birth weight; W34, 41 and 48: weight at 34, 41 and 48 days after birth; WG 0-48: weight gain between days 0 and 48.

At birth, the lambs on C treatment were significantly heavier than S lambs (3.6 vs. 3.2 kg; P <0.01). By day 34, the difference between groups had disappeared, and from that moment onwards, S treatment lambs gained weight to a greater extent than those in treatment C. Towards the end of the experiment, significant differences were found

in the variable weight at 41 days, where supplemented lambs weighed on average 1 kg more than C lambs ($P < 0.05$); also, differences were found in the variable weight at 48 days, where the lambs with access to CF weighed on average 1.6 kg more ($P \leq 0.001$). Due to the effect of supplementation, the S lambs group had a higher ($P \leq 0.001$) overall growth (2.059 grams/lamb)(Table 3). The graph in **Figure 4** shows how the difference in LWs at birth tended to equalize when the CF began, and from here onwards, S lambs gained significantly more weight than C lambs.

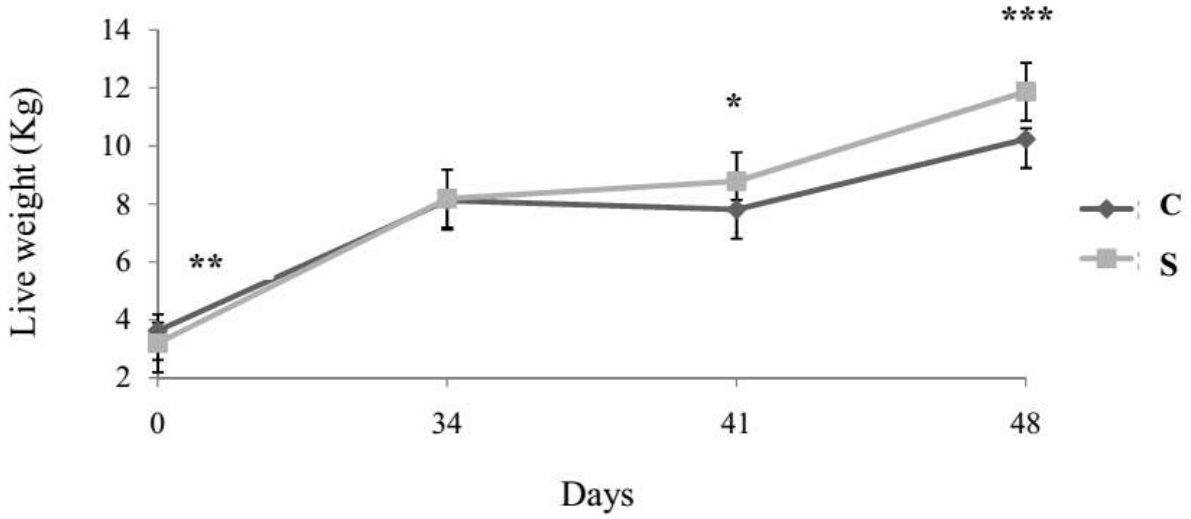

Fig 4. Changes in the live weight of the lambs for the whole period

Discussion

The sheep post lambing and / or lamb supplementation are very important for the optimization of the productive efficiency of a sheep farm (Da Silva et al, 2015). However, in Chiloé this practice is not usually carried out (Peña et al, 2015).

When providing suckling lambs with a high-quality feed other than dams' milk and forage (e. g. concentrate or cereal grains), lambs gain weight while their mothers recover from lambing and the decrease in the live weight loss of ewes is alleviated (Brand and Brundyn, 2015). The provision of CF may therefore be economically more profitable when pastures decline in quality and quantity (the level of grazing available to the ewe and lambs becomes limited and they compete for the food) and the growth potential of lambs is not being met with milk and natural forage (Brand et al., 1999), as well as when there is high levels of parasite contamination on pasture (Doane, 1979). All these situations are common in sheep productive systems in Chiloé (Peña et al 2011, 2012; Martínez et al 2012; de la Barra et al 2012a, 2015a), where lambing usually occurs at the end of the winter season (with very low amounts of pasture available for sheep) and lambs start to eat pasture at the beginning of the spring, in coincidence with the rise on the parasite burden. In addition, it is widely known that early exposure to starchy feedstuffs as grain has some advantages: it improves acceptance of these feeds later in life (Thorhallsdottir et al., 1990), stimulates the early rumen development, which, in turn, allows earlier weaning (Gate, 1988; Ganzábal and Pigurina, 1997; Ortega-Reyes et al., 1992), optimizes the development stage in which feed conversion into muscle is higher and promotes high growing rates, especially in multiple birth lambs.

Other aspect to consider is the fact that the transition from monogastric (pre-ruminant) to ruminant is a critical stage in the weight gain of lambs, and declines in the growth rate usually occur when dams´ milk production drops; the CF can facilitate this transition, preventing or buffering this decline (Bernardi et al. 2005). In Chiloé, where the application of productive technologies is scarce (Peña et al, 2015), the CF remains unknown as productive tool. Along with Suffolk Down, the predominant sheep breed in the archipelago is the native breed Chilota (De la Barra et al 2011; De la Barra, 2015b), which have shown a high level of hardiness and adaptation to the environmental conditions (Martínez et al, 2012). In this context, it is necessary to provide producers with tools in order to improve the performance of their farms and to verify the applicability of previously proven techniques under the special small-scale productive conditions and sheep breeds of Chiloé (De la Barra et al 2015; Peña et al 2015).

The weight of lambs on the 10th day was not available when analyzing the data for reasons beyond the experimental protocol, and therefore it was not used. However, we estimate that at ten days old, without supplementation, and with their dams in the same feeding conditions, the weight differences found at birth (treatment C heavier than S) would be almost the same by day 10. The graph in Figure 1 shows how the weights tend to equalize approximately from day 10, when the CF began.

Literature shows that the individual performance of grazing lambs is positively affected by concentrate supplementation offered daily at levels equal to or higher than 20 g/kg of their body weight (BWt) (Carvalho et al., 2007). Nevertheless, we found a positive effect with an average level of 6.6g/Kg, and if we take into account only from day 34 onwards, when lambs started to eat higher amounts of concentrate, the average consumption was higher but still about 10 g/Kg BWt. Results from Terblanche et al (2012) showed that the BWt of lambs that received creep feed differed in 3.5 kg over the trial period compared to those without. Brand et al. (1999) and Brundyn (2002) reported similar results. Brand and Brundyn (2015) reported that lambs consuming an average of 0.58 kg creep feed/lamb/day for a period of 96 days improved their ADG by 25%, (0,25 vs. 0,20 kg/d), without affecting the body weight of their dams.

According to the literature, the quantity and quality of the pasture may also play an important role in the results from providing supplementary feed to ewes and creep feed to lambs (Terblanche et al., 2012). For example, these authors found a 28.5% increase in the live weight change of lambs supplied with creep feed whose dams grazed a medic *(Medicago parrabinga)* pasture and 81.6% when dams grazed a kikuyu (*Pennisetum clandestinum*) pasture. The values of MP and ME for the pastures used in the present study are fairly good, but productivity in late winter is low and sheep do not find high amounts of available pasture.

The natural development of the rumen is a result of the gradual change from a predominantly milk diet in the young lamb to a solid diet in the mature animal. This period is longer or shorter depending mainly on the lamb´s feeding. At birth, lambs are monogastric, with a transition period of approximately eight weeks when they´re fed on pasture (Wardrop and Coombe, 1961). At birth, the omasum and abomasum (third and fourth stomachs) represent 70% of total stomach capacity in the lamb. In the mature animal, this position is reversed, with the rumen and reticulum accounting for 70% of stomach capacity (Greenwood 2005); the rate of' the ruminal volume increase is most marked from 3 weeks of age onwards. The volume of the rumen contents, relative to both the live weight and the volume of the abomasum contents, remains constant from 8 weeks of age onwards (Wardrop and Coombe, 1961). This delay and the shift from suckling to grazing are crucial items to sustain the growth rate and the ability to gain weight as ruminants.

It is recommended that the lambs are initiated in CF at about 10 days old (SIDP 1990) although the low consumption in the early days is a well known fact, and lambs will not consume significant amounts of supplementary food until 3-4 weeks of age (Banchero et al, 2006). These small amounts of supplement consumed in early life are important to establish both the functionality of the rumen as the habit of supplement intake.

The average birth weight and 48 day-weight in the present study are in the range previously reported for Chilota breed, despite initial differences between treatments (De la Barra et al., 2012b). The critical period of transition from monogastric to ruminant was found between 34-40 days of life, and the CF lightened the negative growth that occurred in this time in the control group, in concordance with Banchero et al (2006). The highest ADG for the supplemented lambs occurred in the penultimate and final week of the experiment, in coincidence with the increased consumption of concentrate. This, coupled with the fact that it is at this time when the lambs have already fully developed their rumen, suggests a better feed utilization (both concentrated as fibrous feed), which enabled them for a faster weight gain. As such, we would expect this trend to continue, and therefore further studies with longer periods of CF supplementation are needed to assess the impact and cost effectiveness of this practice in the productive conditions of Chiloé.

The positive response to CF observed in this study is consistent with the results obtained by others as Lamarca et al. (cited by Piaggio, 2011), who found an effect of + 172 % in the weight gain of Corriedale lambs under CF. In other experiments of CF , the rate of weight gain of lambs supplemented Witness exceeded the average values between 47.2 g / lamb / day and 61.5 g / lamb / day (Banchero and Montossi 1995a and b; Costa et al., 1991; Nicola and Saravia, 1995). This general trend would be explained by greater total consumption (milk + grass and / or concentrate) achieved by CF lambs compared to control lambs (Banchero et al, 2006).

In lambs, the concentrate intake begins to be relevant from 20 to 25 days after the supplementation starts (Banchero et al, 2006). Increased access to CF structure and supplement intake is achieved from at 4-6 weeks of lactation, after the peak on milk production of sheep (Banchero et al, 2006), according to this study observations.

However, early habituation to consumption is vital to ease the subsequent supplement intake, being the right handling of this period still very important in determining the success of the CF technique. The average consumption of concentrate in the cited works ranged from 98.7 g / lamb / day to 332 g / lamb / day (167 ± 85 g / lamb / day). These intakes are higher than those observed in the present study, but it must bear in mind that in all these works

measurements began at 20 days of life and extended until 60 days minimum, while in this work, creep feeding began and finished 10 days before (from 10 to almost 50 days old). After the fourth week from the beginning of the experiment, lambs began to consume increasing amounts of supplement and entering more often into the CF structure, in coincidence with the observations by Banchero et al (2006) who supplemented lambs with oats in a very similar way. Daily consumption of oats for the period assessed by these authors was 124 g oats / lamb / day.

Between the second and sixth week of life (from 7 to 42 days), the lamb´s supplement intake is affected by its palatability, composition and method of delivery, and is favored by low milk production from mothers and low forage availability. At this age, lambs prefer grounded feedstuff; after 5 weeks, the preference changes for pelleted food, and after 6 weeks they prefer whole grains (Nicola and Saravia, 1995). This may also explain the low consumption in the first 5 weeks (up to 34 days) observed in this study, since the concentrate was given in the form of pellets.

In the productive conditions of Chiloé, the CF would have even better response than in other conditions or systems, as forage has a low nutritional value for the lambs, and usually low availability and quality of forage arise due to adverse weather conditions and management (water deficit, low temperatures, overgrazing, low milk production, and/or sheep with poor body condition) (Banchero et al 2006).

Additionally, in Chiloé lamb production is heavily seasonal, marked by the natural reproductive cycle of the sheep, the shortage of food in autumn and winter and the spring pasture growth. Lambs are mainly born in August and weaned in December for Christmas and summer festivals, while the rest of the year is difficult to find lambs for slaughter. Bearing in mind that there is an active demand for lambs throughout the year in Chiloé, mainly in middle of September, coinciding with the Chilean Independence Day holidays, (Peña et al, 2012), and this technique appears as an instrument to achieve this objective, promoting the growth of lambs out of the spring period.

The CF option presented in this study is well suited to the requirements of small-scale sheep producers in Chiloé, since this technique allow them to increase the load capacity of their grazing system. The relative low cost of feed and infrastructure and the simplicity in use allow us to suggest that the CF would have a great adoption potential by sheep producers of Chiloé, increasing lamb individual performance and productivity and creating favorable market conditions for the lambs and favorable relationships supply / product.

Conclusions

Under the conditions of this study, the early creep feeding with concentrate *ad libitum* from day 10 to day 48 exerts a positive effect on daily weight gain of Chilota lambs and facilitates the transition from monogastric to ruminant, strengthening the growing potential. Further studies with longer periods of creep feeding are required to assess the impact and cost effectiveness of this practice in Chiloé.

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