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Short communication

Effect of sodium butyrate administered in the concentrate on rumen development and productive performance of lambs in intensive production system during the suckling and the fattening periods

S. Cavini*, S. Iraira, A. Siurana, A. Foskolos, A. Ferret, S. Calsamiglia

Departament de Ciència Animal i dels Aliments, Edifici V, Universitat Autònoma de Barcelona, Bellaterra 08193, Spain

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ABSTRACT

Sodium butyrate (SB) has been shown to improve growth rate, rumen development and health of calves. In intensive lamb production systems, the fattening period starts after a relative short suckling period, and lambs are fed a high concentrate diet. The objective of this experiment was to determine the effect of supplementing SB in the concentrate on rumen development and productive performance of lambs during the suckling and the fattening periods. During suckling, 66 lambs were distributed with their mothers in four pens. Treatments were: control concentrate (CON), and concentrate supplemented with 3.6 g of SB/kg of DM (SBC). At weaning, nine lambs were slaughtered for sample collection, and 47 lambs were distributed into 12 pens for the fattening period. Treatments were: (1) CON–CON for lambs fed CON in both periods; (2) CON–SBC for lambs fed CON in the suckling and SBC in the fattening period; (3) SBC–CON for lambs fed SBC in the suckling and CON in the fattening period; and (4) SBC–SBC for lambs fed SBC in both periods. At 88 days of age all lambs were slaughtered. In both periods, concentrate dry matter intake (DMI), average daily gain (ADG), body weight (BW), hot carcass weight (HCW), dressing percentage (DP), reticulum-rumen weight (RRW), rumen fluid pH, and density, length, width and keratinization of rumen papillae were measured. Feed conversion ratio (FCR) was calculated for the fattening period. During the suckling period, SBC lambs had higher DMI, ADG, HCW and DP ($P < 0.05$), and tended to have higher rumen papillae length and lower RRW ($P < 0.10$). During the fattening period, no difference was found among treatments. Results indicate that the supplementation of SB in the concentrate improved rumen development and productive performance of lambs during the suckling period. However, at 3 months of age, the administration of SB did not improve production in lambs reared in an intensive production system.

1. Introduction

Production of lamb for meat purpose in Spain has moved from traditionally extensive to a new intensive fattening system (MAGRAMA, 2012). Usually, during the suckling period lambs remain with their mothers. At weaning (around 45 days of life) they are slaughtered, or they are fattened up to 90 days (MAGRAMA, 2013). In the intensive system lambs are fed a high concentrate diet from 2 weeks of age to assure fast growth and high productivity. The adaptation to a high energy diet is critical and can lead to complications such inadequate rumen development,

* Corresponding author. Tel.: +34 935811456.
E-mail address: cavinisara@gmail.com (S. Cavini).

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acidosis and slow growth (Owens et al., 1998). Early solid feed intake promotes rumen development (Stobo et al., 1966). Butyrate is a short chain fatty acids produced from the fermentation of concentrate, and it had been shown to stimulate rumen papillae development (Sander et al., 1959). Supplementation of SB in milk replacer during the first 4 weeks of life improved rumen papillae development, production performance and health status in calves (Guilloteau et al., 2004; Górka et al., 2009). In addition, calves fed milk replacer supplemented with SB improved pancreatic functionality and the digestibility of most nutrients of the diet (Guilloteau et al., 2010a). Guilloteau et al. (2009) observed that when SB was administered during the first month of life, positive effects on growth occurred within the first 3 months of life, and after then, they decreased until they equated the effects of the control group. When SB was offered to calves blended with the starter diet at doses of 3 g/100 g of dry matter (DM) as soon as calves began to consume concentrate, the effects on growth were positive but not significant (Górka et al., 2011a). When SB was offered after weaning, beneficial effects were observed on pancreatic functionality and nutrient digestibility (Guilloteau et al., 2010a). However, there is no information on the effects of SB on productive performance of ruminant after weaning. Positive but weak effects have been observed in weaned piglets (Manzanilla et al., 2006; Le Gall et al., 2009). Therefore, the purpose of this experiment was to determine the effects of SB offered in the concentrate before weaning, after weaning, and before and after weaning, on productive performance and rumen development of lambs in an intensive production system.

2. Materials and methods

The experiment was carried out in the facilities of the Servei de Granges i Camps Experimentals of the Universitat Autònoma de Barcelona, Spain. Experimental and animal care procedures were approved by the Ethical Committee on Human and Animal Experimentation of the Universitat Autònoma de Barcelona (CEEAH 1567). The experiment was divided in two periods: suckling and fattening.

2.1. Animals, treatments and management during the suckling period

A total of 66 suckling lambs of Ripollesa breed (meat purpose) were used. Lambs were distributed in four pens at 18 ± 2 days of age. Pens 1 and 2 consisted of 21 lambs each one (10 males and 11 females) and pens 3 and 4 consisted of 12 lambs each one (seven males and five females for pen 3, and six males and six females for pen 4). Treatments were: CON (concentrate without SB) for pens 2 and 4, and SBC (3.6 g of SB included in 1 kg of DM of concentrate) for pens 1 and 3. Sodium butyrate was provided by Nutega (Nuevas Tecnologías de Gestión Alimentaria, S.L., Madrid, Spain). In pens 1 and 2, four lambs died for reasons not related to the experimental treatments, and at the end of suckling period pens 1 and 2 were composed of 19 lambs (9 males and 10 females) each one. In order to achieve homogeneous groups, only one lamb from double or triple births was chosen to be included in the experiment. Their brothers suckled colostrum from the ewe for 3 days, thereafter were removed and fed milk replacer. The criteria used to select the lamb were the acceptance of the lamb by the mother, birth weight and sex. The same criteria were used to set homogeneous pens, including the type of parturition (single or multiple). Lambs always remained with their mother, suckled milk and had free access to a fattening concentrate feed (Table 1) that was offered into a feeder (1 per pen) equipped with a special grid to prevent ewe's consumption. At weaning (56 ± 4 days), nine lambs were slaughtered in a commercial abattoir for sample collection: five lambs from treatment CON (three males and two females), and four lambs from treatment SBC (three males and one female).

Table 1
Ingredients and chemical composition of commercial concentrate fed to lambs during the suckling and the fattening periods.

Ingredients composition (%)	
Barley	40.2
Corn	30
Soybean	18.61
Sugar cane molasses	2
Calcium carbonate	1.99
Fat	1
Sodium chloride	0.4
Sodium bicarbonate	0.4
Premix[a]	0.35
Additives	0.05
Chemical composition (% DM)	
DM (%)	90.03
Ashes	5.17
Crude protein	19.49
Crude fiber	5.29
Ether extract	3.19

[a] Vitamin A 10 000 UI/kg. Vitamin D3 1 UI/kg. Vitamin E (alfa-tocoferol) 17 mg/kg.

2.2. Animals, treatments and management during the fattening period

Because nine lambs were slaughtered for sampling at the end of suckling period, and six lambs were selected for replacement of the farm, a total of 47 lambs from the suckling period were used in the fattening period. At weaning, a simulation of transport of lambs from the suckling farm to a fattening farm was carried out. Animals were loaded on a trailer, and transported for an hour. At arrival, lambs were allocated into 12 pens, numbered from 11 to 22. Each pen had four lambs, two males and two females, except for pen 12 which was made up of three lambs, one male and two females. Lambs of pens 11, 12, 13 and 14 of the fattening period came from pen 1 of the suckling period. Lambs of pens 15, 16, 17 and 18 of the fattening period came from pen 2 of the suckling period. Lambs of pens 19 and 20 of the fattening period came from pen 3 of the suckling period, and lambs of pens 21 and 22 came from pen 4 of the suckling period. Pens were assigned to the same two treatments of the suckling period (same concentrate, additive and doses) so that there were four treatments in the fattening period: (1) CON–CON for lambs of pens 16, 18 and 22 that were fed the control concentrate during the suckling and the fattening period; (2) CON–SBC for lambs of pens 15, 17 and 21 that were fed the control concentrate during the suckling period and the SBC concentrate during the fattening period; (3) SBC–CON for lambs of pens 12, 14 and 20 that were fed the SBC concentrate during the suckling period and the control concentrate during the fattening period; (4) SBC–SBC for lambs of pens 11, 13 and 19 that were fed the SBC concentrate during the suckling and the fattening periods. Therefore, three replications per treatment were obtained. A female lamb in pen 11 died for reasons not related to experimental treatments. Lambs in the fattening period were fed the same concentrate and SB was applied at the same doses as in the suckling period. Lambs had free access to barley straw, concentrate and water. Lambs were kept in straw bedded pens equipped with a feeder for concentrate, a rack for straw and a bucket for water. The buckets were filled with clean water every morning. All fattened lambs were slaughtered in a commercial abattoir 88 ± 11 days of age, depending on the availability of the abattoir.

2.3. Measurements and sample collection during the suckling and the fattening periods

The concentrate was distributed weekly. The amount of feed offered was calculated from intake observed the previous week, allowing a minimum of 15% refused feed. Concentrate refused within pen was removed and weighed weekly. The average daily dry matter intake (DMI) of concentrate by lamb and pen was calculated as the difference between the total amount of concentrate offered and refused, over the 7 days of the week