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Effects of concentrate supplementation on forage intake, metabolic profile and milk fatty acid composition of unselected ewes raising lambs

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ABSTRACT

The physiological response to concentrate supplementation in low milk potential ewe breeds has been scarcely studied. The aim of this experiment was to evaluate the effects of concentrate inclusion on feed intake, blood metabolites and milk yield and milk fatty acids (FA) composition of ewes raising lambs under forage-based diets. During the last 10 weeks of pregnancy (pre-partum period) and the 6 weeks of lactation (post-partum period), ewes were fed forage hay *ad libitum* with or without concentrate (inclusion of 300 g/day in pre-partum period and 750 g/day in post-partum) in a 2×2 factorial arrangement. The inclusion of concentrate did not affect the forage intake in pre-partum period ($P>0.05$), whereas during the post-partum feed intake was similar between treatments during weeks 1 and 2 of lactation, but thereafter it was greater in ewes receiving concentrate supplementation ($P<0.05$). The replacement rate was steady during the pre-partum period and it was not affected by concentrate supplementation or the number of carried foetuses (average 9.1 ± 2.0%, $P>0.05$). During lactation, ewes supplemented with concentrate showed a replacement rate between 16% and 31%, being greatest during the first 3 weeks of lactation than afterwards ($P<0.05$). Concentrate supplementation during pregnancy did not affect subsequent milk yield ($P>0.05$) but this practice increased milk yield during lactation ($P<0.05$). The main milk FA groups did not differ between treatments ($P>0.05$) except PUFA n-3 content ($P<0.001$), which was greater in purely forage-fed ewes than in their concentrate-supplemented counterparts especially during early lactation ($P<0.05$). Likewise, the inclusion of concentrate in the diet hardly affected the blood energy metabolites concentration ($P>0.05$), except plasma β-hydroxybutyrate during the pre-partum period, which was greater in purely forage-fed ewes ($P<0.05$). In conclusion, the inclusion of concentrate in forage-based diets fed to unselected sheep breeds hardly affected forage intake but increased milk yield. During the last third of pregnancy, concentrate supplementation (300 g/day) improved blood ketone status, whereas concentrate supplement (750 g/day)

Abbreviations: LW, live weight; BCS, body condition score; DM, dry matter; CP, crude protein; NDF, neutral detergent fibre assayed with a heat stable amylase and corrected for ash-free content inclusive of residual ash; ADF, acid detergent fibre expressed inclusive of residual ash; DMI, dry matter intake; BHB, β-hydroxybutyrate; NEFA, non-esterified fatty acids; FAME, fatty acid methyl esters; FA, fatty acids; VAC, vaccenic acid; CLA, conjugated linoleic acids; SFA, saturated fatty acids; UFA, unsaturated fatty acids; MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SCFA, short-chain fatty acids; MCFA, medium-chain fatty acids; LCFA, long-chain fatty acids.

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during the 6 weeks of lactation did not improve the ewe nutritional status. A mild decrease in milk polyunsaturated fatty acids n-3 was observed due to concentrate feeding. In this context, concentrate supplementation should only be recommended to improve the nutritional status before lambing but this practice failed to counteract lactation demands during the post-partum period.

1. Introduction

The highest nutritional requirements of the ewe are registered during the last weeks of pregnancy and the very early period after lambing (INRA, 1978). In contrast, voluntary feed intake decreases during late pregnancy (Thériez et al., 1987) and just after lambing (Bocquier et al., 1987a), which may result in a shortage of nutrients. This response is normally faced by feeding more concentrates and/or by mobilizing body reserves during these periods (Bocquier et al., 1987b), in case of a negative energetic balance.

Feeding concentrates helps high-producing dairy ewes to meet nutritional requirements and sustain their milk production, but several changes in milk composition may arise when varying the dietary forage to concentrate ratio (Gómez-Cortés et al., 2011). Increasing concentrate leads to changes in the rumen bacteria populations. As an example, it increases the relative importance of ruminal amylolytic bacteria and impairs on growth of cellulolytic bacteria rich in odd-branched fatty acids (iso-fatty acids) (Vlaeminck et al., 2006). Also, increases of milk medium-chain saturated fatty acids in ewes fed high proportions of concentrate have been reported (Martini et al., 2010). Whether the use of concentrate in low-yielding ewes turns into noticeable milk yield increase without detrimental effects on its quality remains unclear. In such context, the productive and physiological response due to concentrate supplementation in low milk potential ewes raising lambs has been scarcely studied, although it is known that forage-based diets produce more healthy meat (Ädnoy et al., 2005), with high contents of conjugated linoleic acid (CLA) and omega 3 polyunsaturated fatty acids compared to meat from ruminants fed on concentrates (Enser et al., 1998).

The aim of this experiment was to evaluate the effects of concentrate supplementation (300 g/day during last third of pregnancy and 750 g/day during 6 weeks of lactation) and prolificacy (single *vs*. multiple) on feed intake, blood metabolites and milk yield and quality of ewes raising lambs under forage-based diets.

2. Materials and methods

2.1. Animals and experimental design

The experiment was conducted in inside facilities at La Garcipollera Research Station, in the mountain area of southern Pyrenees (North-Eastern Spain, 42°37′ N, 0°30′ W, 945 m a.s.l.), during winter 2009–2010. The mean temperature inside facilities was 6.9 ± 2.0, 3.8 ± 3.3, 3.0 ± 2.6 and 3.4 ± 3.3 °C in November, December (2009) and January, February (2010), respectively.

At the end of July, thirty-two multiparous ewes from Ojinegra de Teruel breed were synchronized using intravaginal sponges containing 30 mg flugestone acetate (Sincropart, CEVA, Spain) for 14 days followed by intramuscular injection of 250 IU PMSG (Folligon, Intervet, Spain) to be mated in the middle of August. Thirty-five days after mating, pregnancy and the number of carried foetus were diagnosed by a real time B-mode linear array ultrasound scanner, equipped with a 7.5 MHz transducer (Aloka SSD-500V, Aloka Co. Ltd., Japan). Twenty-one ewes were diagnosed pregnant (aged 4.3 ± 2.4 years) and they were then enrolled in the experiment.

Prior to the beginning of the trial, during early and mid-pregnancy, ewes were kept under permanent grazing on mountain pastures [460 ± 14 g neutral detergent fibre (NDF)/kg dry matter (DM); 226 ± 33 g acid detergent fibre (ADF)/kg DM and 177 ± 11 g crude protein (CP)/kg DM]. Eleven weeks before the target lambing date, ewes (50.9 ± 1.3 kg of live weight, LW, and body condition score, BCS, 2.50 ± 0.06) were allocated in sixteen paddocks (2 m × 2 m; 1–2 ewes) in order to adapt them to the experimental facilities and diets. The care and use of animals followed the European guidelines (European Union Directive No. 86/609/CEE, 1986).

The treatments were carried out during the last 10 weeks of pregnancy (pre-partum period) and the 6 weeks of lactation (post-partum period) in a 2 × 2 factorial arrangement. During the pre-partum period, 10 ewes were fed sainfoin hay *ad libitum* (PRE-HAY) and 11 ewes were fed the same plus 300 g of concentrate (Table 1) (PRE-CON). Pre-partum feeding treatments were balanced by the number of carried foetus (multiple, $n = 12$ *vs*. single, $n = 9$). After lambing (12 January ± 3.5, 45.9 ± 1.7 kg LW and BCS 2.44 ± 0.05), half of the ewes were exchanged from their pre-partum treatment and the rest remained in the same treatment during the 6 weeks of lactation. During the post-partum period, 11 ewes were fed pasture hay *ad libitum* (POST-HAY) and 10 ewes were fed the same plus 750 g of concentrate (POST-CON). Post-partum feeding treatments were balanced by the number of raised foetus (multiple, $n = 6$ *vs*. single, $n = 15$) and lamb sex (females, $n = 13$ *vs*. males, $n = 14$). Lambs did not receive any concentrate supplement during the experimental period.

Experimental diets consisted of chopped sainfoin hay (pre-partum) or pasture hay (post-partum) (average particle length of 5 cm) offered *ad libitum* (fixed at 1.2 of the previous day's consumption) and distributed twice a day (at 9 am and 5 pm).