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Effect of sward condition on metabolic endocrinology during the early postpartum period in primiparous grazing dairy cows and its association with productive and reproductive performance

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ABSTRACT

The effect of different sward herbage allowances and a total mixed ration (TMR) management on milk production, body condition, first postpartum ovulation and endocrine/metabolic parameters were investigated. Primiparous Holstein dairy cows ($n = 44$) were randomly assigned to one of the following grazing treatments ($n = 11$ each): high (HA, 30 kg), medium (MA, 15 kg) and low (LA, 7.5 kg) estimated grass DM available/cow/d and a TMR group fed ad-lib from calving to 56 days after calving. Body condition score (BCS) was registered every 15 days from one month before to two months after calving. Non-esterified fatty acids (NEFA), β-hydroxybutyrate (BHB), cholesterol, plasma protein, albumin, urea, insulin, insulin like growth factor-I (IGF-I) and leptin were determined in plasma every 15 days from 15 days before to 56 days after calving. Progesterone was determined 2 times per week after parturition to determine first ovulation. TMR group had higher milk production in the first 56 days in milk than the HA and MA groups ($P<0.05$) which did not differ, and were in turn greater than LA cows ($P<0.01$). Overall, the TMR and HA groups had a greater BCS, protein and albumin concentrations than the other groups, suggesting a better energy balance. While HA cows presented a better metabolic status (smaller BCS losses, lower plasma NEFA and greater urea concentrations) than MA cows during the early postpartum period (15–30 days postpartum, dpp, $P<0.05$), HA cows differed (greater plasma cholesterol, albumin and urea concentrations) from LA cows later on (45–60 dpp, $P<0.05$). Greater plasma insulin and IGF-I concentrations were found in the TMR group ($P<0.05$), which is consistent with the higher nutrient density offered to this group. The reinitiation of ovarian cyclicity was delayed in MA cows one month after calving when compared to TMR and HA cows ($P<0.05$), which is consistent with the greater NEFA and lower urea concentrations in this period. The lowest probability of first ovulation throughout the study was observed in LA cows ($P<0.05$), which was associated with their endocrine and metabolic profile. In conclusion, sward allowance affects metabolic signals which in turn are associated with a different productive and reproductive performance.

Abbreviations: BCS, body condition score; BHB, β-hydroxybutyrate; BW, body weight; DHA, daily herbage allowance; dpp, days postpartum; DM, dry matter; IGF-I, insulin like growth factor I; NEB, negative energy balance; NEFA, non-esterified fatty acids; P4, progesterone; RIA, radioimmunoassay; TMR, total mixed ration; HA, MA and LA, high, medium and low herbage allowance; CV, coefficient of variation; GP, grazing paddock.

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1. Introduction

Appropriate nutrition and management strategies during the early postpartum period are crucial to maximize productivity, fertility, and to prevent metabolic diseases in dairy cows (Grummer, 1995; Drackley, 1999). While under indoor feeding conditions the manipulation of the quantity and quality of nutrients for dairy cows can be controlled, nutrient intake cannot be accurately predicted when pasture is the main component of the diet. Moreover, to achieve the best profitability in pasture based dairy production systems the optimum relation among pasture conditions, stocking rate, and animal performance must be determined. Thus, in periods of the productive cycle, dairy cows may be limited in their access to nutrients. Besides, it has been reported that grazing dairy cows do not get sufficient dry matter (DM) intake to sustain the high milk production that could be achieved with their actual genetic potential (Kolver and Muller, 1998).

It is well accepted that the critical period for dairy cows resides in the metabolic adaptation to the negative energy balance (NEB) due to lactation requirements during the first weeks of lactation. The magnitude of the NEB that occurs during the peripartum period can be monitored by metabolic and endocrine profiles in blood (*e.g.*, non-esterified fatty acids (NEFA), insulin, insulin like growth factor I (IGF-I)). Changes in these metabolites and hormones are associated with productive and reproductive performances. It has been reported that NEB is more frequently severe in primiparous than in multiparous dairy cows under grazing conditions, which has been also associated with differential endocrine patterns and longer anovulatory intervals (Meikle et al., 2004; McEvoy et al., 2009; Adrien et al., 2012). Moreover, primiparous cows graze a very low proportion of the allowed grazing time (<35%) and at a very low rate (<25 bites/min, Chilibroste et al., 2012), when compared to multiparous cows from the same herd under different grazing scenarios (Chilibroste et al., 2007), which suggest a more selective grazing process.

We have recently demonstrated in primiparous cows during early lactation, that when daily herbage allowance (DHA) is increased from low (7.5 kg DM/cow/d) to medium (15 kg DM/cow/d) a high response in milk production is obtained (0.43 L/kg extra DHA), while a high DHA (30 kg DM/cow/d) did not differ in milk production from medium DHA (Chilibroste et al., 2012). Interestingly, while the slopes for probability of grazing and bites rates were not different between high and medium DHA, they were greater than of cows on low DHA. Besides, a higher BCS loss was found in medium and low DHA when compared to high DHA (Chilibroste et al., 2012). This led us to hypothesize that the medium DHA achieved a similar milk production than high DHA by maximizing ingestive behaviour processes and energy mobilization, which should be reflected in the endocrine and metabolic parameters. Thus, in order to explain productive and reproductive outcomes after different planes of offered pasture, the present study aimed to contribute to the understanding of the adaptive and integrative responses at productive, ingestive, metabolic, and endocrine level of the primiparous dairy cow in the critical period of early postpartum.

The objective of the present study was to determine the effect of different sward herbage allowances during the first 56 days postpartum in primiparous dairy cows on endocrine and metabolic aspects and its relation with BCS evolution, milk production, and re-initiation of ovarian cyclicity.

2. Materials and methods

2.1. Animals and treatments

Animal experimentation was in compliance with regulations set by the Ethical Committee of the University of Uruguay (Montevideo, Uruguay). The experiment was completed at the EEMAC Research Station, Agronomy Faculty, Uruguay (30° S, 53 W).

Primiparous Holstein dairy cows ($n = 44$, body weight without fasting one month before calving (BW) 595 ± 41 kg, age at calving 2.96 ± 0.11 years and BCS 3.7 ± 0.3) calving between March 25th and April 15th (*i.e.*, during autumn) were selected from the herd of the experimental farm. Cows were blocked by BW, age and BCS, and randomly assigned to one of the following grazing treatments ($n = 11$): high (HA, 30 kg estimated grass DM available/cow/d), medium (MA, 15 kg estimated grass DM available/cow/d) and low herbage allowance (LA, 7.5 kg estimated grass DM available/cow/d), and a control group offered a totally mixed ration in a paddock (TMR group) fed *ad libitum* from calving to 56 days in milk. Cows grazed in a 7-day rotational system wherein the three treatments were moved weekly to a new set of plot adjacent independent grazing paddocks separated by electric fences with the same sward condition. To achieve the targeted sward allowances, the 11 cows per treatment grazed plots of 1, 0.5 and 0.25 ha for HA, MA and LA, respectively. The experiment was designed so that herbage height and mass at the end of the paddock occupation differed among treatments covering a range from restricted condition for grazing (herbage height below 5–7 cm, LA) to non restricted conditions for grazing (HA, herbage height above 10–12 cm). No GP was re-grazed during the experiment. Pre and postgrazing sward mass was estimated with a rising plate metre as described in Chilibroste et al. (2012). Actual DHA were 36.5, 17.2 and 9.1 kg DM/cow/day for HA, MA and LA respectively, values which were within the target range. Cows were milked at 5:00 and 16:00 h and allowed to graze between 8:00 and 15:00 h daily on a 2nd year pasture of 24% tall fescue (*Festuca arundinacea*), 30% birdsfoot trefoil (*Lotus corniculatus*) and 38% white clover (*Trifolium repens*). Chemical composition of pasture samples taken during the experiment varied between 135–172 g CP/kg DM, 440–482 g NDF/kg DM and 292–305 g ADF/kg DM. Mean sward mass availability before grazing was 2750 ± 275 kg/ha DM without significant differences between grazing paddocks Chilibroste et al. (2012). In the 8 weeks of the experiment, the temperature ranged from 13 to 20 °C (mean 16.8), relative humidity ranged from 67 to 95% (mean 74.3%) and precipitation from 0 to 145 mm (mean 72.8 mm), Chilibroste et al. (2012). All cows were individually supplemented at