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Inclusion of maize in the grazing diet of goats during the last 12 days of gestation reinforces the expression of maternal behaviour and selectivity during the sensitive period

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ABSTRACT

The objectives of this study were to investigate if partial substitution of a grazing diet with maize during the last 12 d of gestation in goats bred under semi-arid grazing conditions improves maternal behaviour and reinforces the exclusive mother–kid bond at 3 h after birth. For the first objective, 20 pregnant goats and their single kids were randomly assigned to 1 of 2 treatments (10 per group): (1) only grazing (control group); and (2) grazing plus 0.6 kg/d of supplemental maize during the last 12 ± 1.0 d before parturition (maize group). Frequency of amniotic fluid and amniotic membrane consumption and invitations to suckling were higher in the maize group than in the control group during the first 30 min after birth ($P \leq 0.049$). Duration of invitations to suckling tended to be higher in the maize group than in the control group ($P=0.07$). For the second objective, 81 pregnant goats were randomly assigned to the same treatments as above to evaluate the effect of dietary treatment on maternal selectivity. During the maternal selectivity test (5 min), frequency of low-pitched bleats and udder acceptances to their own kids was higher in the maize group than in the control group ($P \leq 0.03$). The control goats emitted more low-pitched bleats and tended to show more udder acceptances to alien kids than the maize group ($P \leq 0.06$); emission frequency of low- and high-pitched bleats towards their own and alien kids did not differ in the control goats ($P \geq 0.22$). The number of udder rejections and aggressive behaviours towards their own kids was higher in the control goats than in the maize group goats ($P \leq 0.005$). At 3 h postpartum, 93% of the goats fed maize were maternal, whereas only 78% of the control goats were maternal ($P=0.048$). Of the maternal mothers in each group, 88% of the goats in the maize group were selective at 3 h postpartum (36/41), whereas only 52% of the goats in the control group were selective (15/29, $P=0.001$). Finally, at birth, kids born from maize goats were significantly heavier than the kids born from control goats ($P=0.003$). We concluded that feeding supplemental maize during the last 12 days of gestation to goats maintained under semi-arid grazing conditions improves maternal behaviour at birth and significantly reinforces maternal selectivity at 3 h postpartum, which may increase the survival of kids during the first days after birth.

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1. Introduction

Ewe and goat mothers show a sensitive period after parturition, during which time maternal–filial bonding occurs (Poindron et al., 2007a,b). This maternal–filial bond is commonly called 'maternal selectivity', and once established, mothers tend to accept only their own young and actively reject alien young. Literature clearly shows that for an adequate mother–young bond to be consolidated, at least 4 h of previous mother–young interaction is necessary during the sensitive period (Bordi et al., 1994; Terrazas et al., 2009). A higher proportion of goats accept alien kids at 2 h than at 4 h postpartum, and aggressive behaviour towards alien kids increases over time (Bordi et al., 1994). In ewes, 80% have already established maternal selectivity at 4 h postpartum, and they reject any alien kid that tries to suckle under undisturbed conditions (Keller et al., 2003; Otal et al., 2009). However, the adequate display of maternal care (maternal behaviour) and the development of maternal selectivity can be modified by factors such as consumption of amniotic fluid, early mother–young contact, and nutrition of the mothers during gestation.

Nulliparous ewes that received only 65% of their nutritional requirements during the last 4 months of pregnancy spent less time licking and were more aggressive towards their lambs at birth than adequately fed ewes (Dwyer et al., 2003). In addition, Langenau and Lerg (1976) reported that in pregnant white-tailed deer does submitted to a nutritional stress during winter, most common form of postnatal fawn mortality resulted from a depressed maternal behaviour such as failure to lick fawns at birth, fear of neonates and refusal to nurse fawns. In contrast, in Merino ewes, providing a high level of nutrition using lupin grain six weeks prior to parturition improves subsequent maternal behaviour (Putu et al., 1988). Pregnant ewes and goats, kept under poor grazing conditions mobilise their body reserves during the last 6 week of gestation due to fast foetal growth and colostrum yield which diminish their body condition score (BCS; Hussain et al., 1996; Meyer et al., 2011). However, when an energetic supplementation using maize was provided to the grazing goats during the late gestation the BCS at birth was higher than in non-supplemented goats (Ramírez-Vera et al., 2012). Moreover, in goats as in ewes, the addition of maize in the grazing diet during late gestation increased the blood glucose concentrations, which in turn, increased lactose synthesis and thus, quantity of colostrum available at parturition (Banchero et al., 2004a,b, 2007; Landau et al., 1999).

Research about maternal behaviour in goats maintained under natural grazing conditions is limited, even though 80% of Caprine population in the world inhabits subtropical, semi-arid regions (Knights and Garcia, 1997). The subtropical, semi-arid area of northern Mexico, for example, supports 2 million goats (SAGARPA, 2007). In this region, the rainfall season lasts from June to September and the dry season occurs from October to May, when food availability in natural grazing areas decreases dramatically (Ramírez et al., 1991; Sáenz-Escárcega et al., 1991). In goats from this region, about 80% of parturitions occur between November and February, during the dry season; therefore, pregnant animals could suffer from undernutrition, which could have important consequences for both mothers and newborns. In semi-arid northern Mexico, kid mortality rates can reach up to 25% because of factors related to the undernutrition of goats during late gestation (Mellado et al., 1991).

Therefore, we investigated if partial substitution of the grazing diet with a high-starch feed, maize, during late gestation may have a beneficial effect on early mother–young interaction. Our hypothesis was that in the first 3 h after birth, during which the sensitive period and selective behaviour development takes place, partial substitution of the grazing diet with maize during late gestation may improve the expression of the maternal behaviour and the maternal selectivity after 2 h of mother–young interactions.

2. Materials and methods

The procedures used in the present study were in accordance with the guidelines for the ethical use of animals in applied ethological studies (Sherwin et al., 2003).

2.1. Location and grazing conditions

The study was conducted in the Comarca Lagunera region in subtropical northern Mexico (25° 36′N, 103° 27′W). This region has a semi-arid climate with a mean annual rainfall of approximately 266 mm from June to September. The dry season is characterised by a dramatic decrease in food availability for goats under natural grazing conditions, with a shortage of pasture from October to May (Sáenz-Escárcega et al., 1991). In this region, animals graze daily in the natural available pasture from 0900 to 1300 h. At this time, they return to their pen (approximately 2 km) in order to take water and rest under the shadows of the pen before leaving to grazing again from 1600 to 1800 h. When grazing ends, the animals are returned to their pen and remain there during the night. Throughout the year, goat diets in the grazing areas are composed of about 82% shrubs, 12% herbaceous plants, and 6% grasses (Ramírez et al., 1991). Previous studies have shown that animals from grazing areas consume an average of 135 g crude protein (CP)/kg dry matter (DM) and 2.1 Mcal/d metabolisable energy (ME) (Cerrillo et al., 2006; Juárez-Reyes et al., 2004).

2.2. Animals, experimental groups, and peripartum management

Multiparous pregnant goats ($n=81$) 3–4 years old were used. Twenty days before the mean expected date of delivery, goats were assigned to 1 of the 2 treatment groups balanced for initial body weight (BW) and BCS. Pregnant goats assigned to the control group ($n=37$, BW 54.0 ± 2.2 kg, and BCS 2.1 ± 0.1 points) received no additional feed. Pregnant goats assigned to the maize group ($n=44$, BW 55.3 ± 1.8 kg, and BCS 2.1 ± 0.1 points) received a daily average of 0.6 kg of flaked maize/goat, a high-starch feed (as fed), during the last 12 ± 1.0 d of