

Maternal Adaptation to Nutrient Restriction in Sheep Herds from Chilean Patagonia: A Random Response or a Repeatable Trait?

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Maternal nutrient restriction (NR) occurs in Patagonian sheep herds due to low quality of pastures, leading to small for gestational age (SGA) offspring. However, there are NR ewes producing lambs whose birth-weight is unaffected (Non-SGA), likely due to metabolic and placental adaptations. It is unknown whether these adaptations are repeatable across gestational seasons (GS), and if so, which traits are associated. Our objective was to determine the repeatability of the maternal programming leading to SGA or Non-SGA offspring, and evaluate associated traits. Experiments were ethically approved (CICUA 01/22), and conducted during two consecutive GS (GS1 and GS2). During GS1, 171 single-bearing ewes of similar weight and age were assigned to NR (n=136) or Control (CN, n=35) groups. Both groups grazed on natural pasture, representative of Patagonia, throughout the pregnancy (Crude Protein (CP) 6.1%, Metabolizable Energy 1.6 Mcal/Kg, stocking rate 0.9 ewes/hectare; dry matter 525 kg/hectare). The CN group additionally received concentrate supplementation (Suralim[®], CP 22%, EM 2.5 Mcal/Kg) to meet their CP requirements according to NRC, from gestational day (GD) 70 to term. Offspring birth weight (BW, Kg) was registered and animals born to NR ewes were segregated into quartiles based on BW. Lambs within the upper and lower quartiles formed the Non-SGA (n=34, 5.08±0.08 kg) and SGA (n=34, 3.61±0.08 kg) groups respectively. Lambs in the CN group (n=35, 4.72±0.07 kg) were not separated into quartiles. Mothers of Non-SGA, SGA, and CN lambs formed the mNon-SGA (n=34), mSGA (n=34), and mCN (n=35) groups respectively, and were evaluated during GS2. Within those groups, single-pregnant ewes were selected, and received the same nutritional treatment described for GS1. Maternal weights (MW, Kg) were registered on GD 70, 90, 110, 125, and 140. Plasma glucose and β-hydroxybutyrate (BHB) were analyzed on GD 70, 90, and 140. Lamb BW, placental weight, and placentome weight and number were registered at delivery. NR ewes were segregated into mNon-SGA and mSGA groups based on lamb BW as described for GS1. Data was analyzed using repeated measures analysis or ANOVA. For GS2, offspring BW differed among Non-SGA, SGA, and CN groups (5.31±0.10^a, 3.79±0.10^b, 4.95±0.09^c; P< 0.0001). In GS2, a 66.7% of mNon-SGA ewes and 80% of mSGA ewes were also identified as such in GS1. These ewes that repeated the mNon-SGA (n=10) or mSGA (n=12) condition, plus the mCN group (n=18 for GS2) were considered for statistical analysis. There were no differences (P>0.05) in MW at GD 70 and 90, while mSGA group showed lower (P<0.05) MW than mNon-SGA and mCN at GD 110 and 125, and all groups differed at GD 140 (66.10±1.70^a mCN; 59.20±1.99^b mNon-SGA; 50.70±2.20^c mSGA, P<0.005). Glucose and BHB

differed only at GD 140 ($P < 0.05$). Glucose (mmol/L) was lower in mNonSGA (2.03 ± 0.15^a) than mCN (2.56 ± 0.11^b) and mSGA (2.77 ± 0.14^b), while BHB (mmol/L) was reduced ($P < 0.05$) in mSGA (0.33 ± 0.08^a) compared to mNon-SGA (0.69 ± 0.08^b), and mCN was intermediate (0.56 ± 0.06^{ab}). Placental weight (g) was reduced ($P < 0.05$) in mSGA (375.69 ± 27.84^a) compared to mCN (507.62 ± 35.49^b) while mNon-SGA was intermediate (472.00 ± 35.50^{ab}). Placentome weight (g) was reduced ($P < 0.05$) in mSGA (105.38 ± 10.01^a) compared to mCN (159.50 ± 12.77^b) and mNon-SGA (161.50 ± 12.80^b). There were no differences in placentome number ($P > 0.05$). These results indicate that the maternal adaptation to NR is repeatable across GS, and it is mediated by a differential whole-body metabolic response and placental adaptations. FONDECYT 11220188.