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Effects of Feeding ACP® as a Bio-supplement to Ewes Pre- and Postpartum on Energy Profile and Offspring Growth Weight

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Abstract

During the transition period in sheep, which consists of pre-partum and the beginning of lactation, the demands for glucose are extremely high and its absence or reduction causes several metabolic problems to arise leading to economic losses. Looking for alternative sources to growth promoters, sources of energy precursors of natural origin are being studied. This study aims to evaluate the effects and influence on plasma levels of Glucose, BHB and NEFA in pregnant ewes supplemented with coconut powder (ACP®) during the transition period. Two groups of ewes were used, totaling 13 animals of the Santa Inês breed that were supplemented with 30 g of powder coconut water (ACP) per day from 110 days before calving to 60 days after calving. Blood samples were taken on the day of delivery, 7, 21, 30 and 60 days after delivery. It was possible to observe that the test group (ACPg) remained stable with animals maintaining glucose levels without showing changes, even on the day of delivery, despite the fact that 80% of the ewes had twin births. The levels of BHB and NEFA were also better compared to the control group (Cg). The Cg showed greater instability throughout the experiment, with moments of hyper and hypoglycemia, BHB and NEFA also showed alterations. Lambs from ACPg showed better carcass growth compared to Cg. Therefore, the collection of results support the idea that, supplementation of ACP to pregnant ewes could be an important tool to reduce negative energy balance and offspring development in pregnant ewes.

Keywords: sheep, ketone bodies, energy metabolism, tropical feed resources, coconut water

1. Introduction

Since the restrictions of antibiotic and chemical supplements use in animal farming, natural options of a bio supplement have been a common topic on animal husbandry research. As a result, the idea of a sustainable production throughout all the steps of animal farming, has forced the use for local and natural based feeding products (Silva et al., 2012; Albuquerque et al., 2020). In addition to this, prevention of metabolic diseases of the transitional periods such as ketosis, and a quick return to reproduction after parturition, are the most recommended targets on small ruminant production (De tarso, 2017).

Products derived from the coconut plant (*Cocus nucifera*) have been tested in several areas of animal production and reproduction (Cavalcanti et al., 2014; Castañeda et al., 2019; Pontes et al., 2019). The importance of coconut products for the pharmacy industry has grown substantially, and its production is strongly related to the tropical areas (DaSilva et al., 2021). In Brazil, for the northeast region the coconut production is economically significant (Mazzuchetti et al., 2020) by the fact that it has the longest extension of cost, which is substantial for coconut crops. As a result of a rich nutrient composition, the coconut properties have been listed as antioxidant, anthelmintic, anti-inflammatory, and semen extender, as well as a source of complex B vitamins, omega 6 and 9, and lauric acid (Albuquerque et al., 2007; Albuquerque et al., 2020).

For these reasons, this research was designed using powder coconut water (ACP) as a feeding supplement during the last 110 days of pregnancy in ewes, until 60 days after parturition, with an objective of elevating the metabolic energy status and reducing the negative balance impact on reproduction.

2. Method

2.1 Animals

Animal procedures were performed and approved according to the Institutional Animal Care and Use Committee of Federal Rural University of Pernambuco, Brazil (Protocol #044/2019) and conducted in accordance with the Brazilian Government Principles for the Utilization and Care of Animals Used in Testing. Thirteen Santa Inês sheep (*Ovis aries*: does, n = 3; ewes n = 10 from de Cattle Clinic of Garanhuns, Federal Rural University of Pernambuco, were used in this study. Ewes were 6-10 years old, and does were 2 years old. The body condition score was 3.5 (on a scale of 1-5, where, 1 = thin and 5 = obese (Bell and Greenwood 2016). Animals were housed in free stalls, had unrestricted access to water and mineral salt, and were fed corn silage and rations twice daily.

2.2 Research Design

Groups were randomly divided into test (ACPg: 5 sheep) and control (Cg: 8 sheep). Ewes and does were fed every day in the last 110 days of pregnancy up to and 60 days after parturition, with 30g of powder coconut water (ACP®). Five moments were established, which blood collection from the jugular vein at the day of parturition, 7, 21, 30, and 60 days after the parturition (Figure 1.). Capillary blood and plasma samples were collected for glucose, beta-Hydroxybutyric (BHB), and non-esterified fatty acids (NEFA). Samples were immediately placed on ice and centrifuged within 1 h at 1500 g for 20 min, separated and stored at -20 °C.

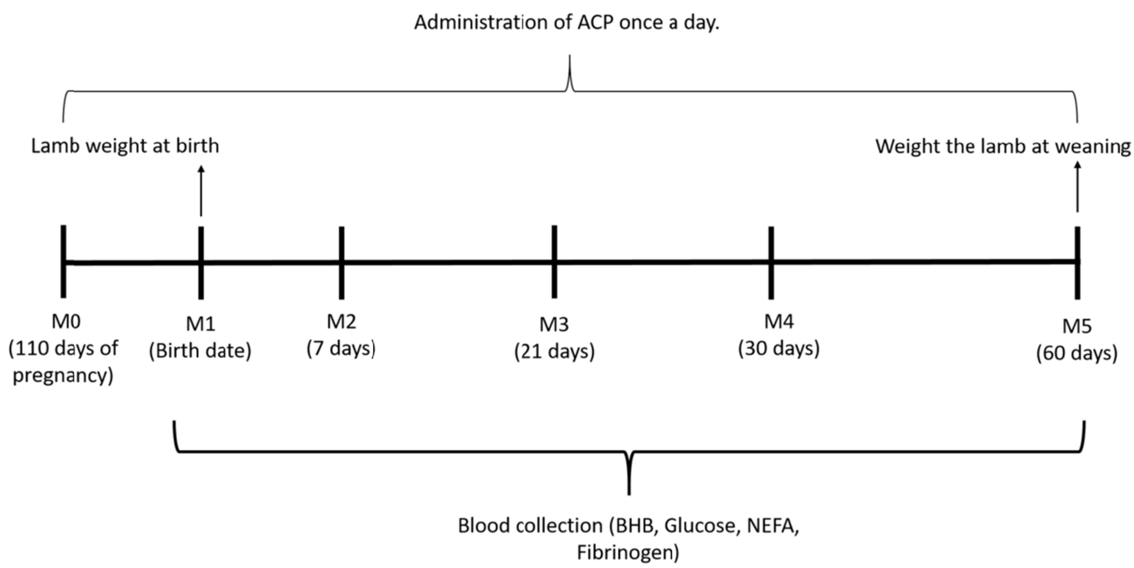

Figure 1. Experimental design—Pregnant ewes were fed with ACP® (30 g per day), starting in M0 (110 days of gestation and ending in M5 (60 days post-partum). At times M1 and M6, the lambs were weighed to obtain the average weight and comparison between groups

Plasma glucose and Beta-Hydroxybutyric (BHB) were analyzed using the enzyme kinetic method. Non-esterified fatty acids (NEFA) concentrations were assessed by wet chemistry techniques on a clinical automated analyzer. Commercial kits were used according to the manufacturer's instructions and the intra- and inter-assay coefficients of variation were below 5%.

2.3 Statistical Analyses

Data was analyzed using the SAS MIXED procedure in SAS version 9.2 (SAS Institute, Cary, NC, USA). Datasets that were not normally distributed were transformed by the natural logarithm or ranks before analysis. Data was normalized to days before and after parturition. A probability of $P < 0.05$ indicated that a difference was significant, and P > 0.05 and ≤ 0.10 indicated that a difference approached significance. Data was expressed as means.e.m., unless indicated otherwise.

3. Results

Throughout the study, ACPg ewes did not show any clinical symptom of metabolic diseases, and their body condition score was kept steady. Animals from ACPg showed twin births occurrence of 80%, compared with 25% from the Cg, however, animals from ACP group did present any signs of hypoglycemia. Plasma levels of glucose showed differences between test and control groups. At the parturition, ACPg had more consistent levels of plasma glucose, and with tendency to elevate when compared with Cg. On the other hand, there was a tendency of decline, with values close to a hypoglycemic status on Cg (Figure 2).

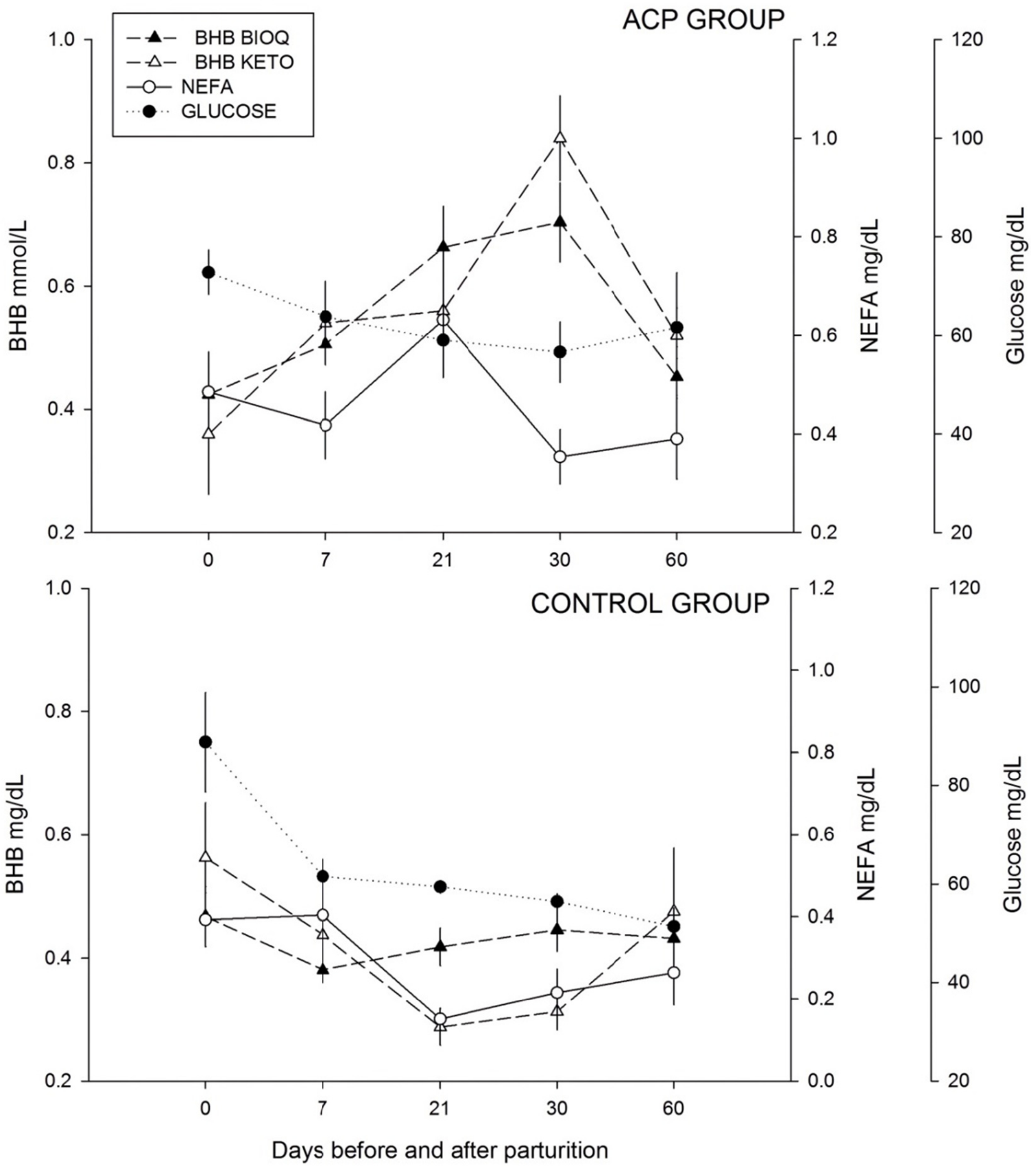

Figure 2. Mean (±S.E.M.) temporal relationships among BHB, NEFA, Glucose, levels after parturition in ewes fed with ACP supplement from the 110th day of pregnancy to the 60th day after parturition (n = 13)

Clinical interventions were made on Cg animals during the parturition. During the first 21 days after parturition, 5 lambs from different sheep died. The day of parturition revealed hyperglycemia, and subsequently decrease of glucose levels, approaching a hypoglycemic conditions on animals form Cg.

Regarding BHB values, results from both methods demonstrated lower levels on ACPg when compared with Cg at the day of parturition. However, the values turned higher compared to Cg at days 21 and 30 after the parturition. NEFA levels had no marked variations between groups. Yet values increased at 21 days post parturition on ACPg, there was no significant divergence ($p > 0.05$).

Observations after 30 and 60 days post parturition revealed that lambs born from ACP ewes were superior, developing greater growth weight. Those lambs showed a remarkable difference on body score condition at 21, 30 and 60 days after birth in comparison with Cg lambs. Cg lambs, had lower weight average after birth (2.63±1.5 kg), compared with ACPg lambs (3.38±1.2 kg). After 60 days of birth, the difference between groups was maintained, with does supplemented with ACP having heavier lambs. Consequently, ACP supplementation to pregnant sheep had effective impact on weight gain of lambs after birth (Figure 3).

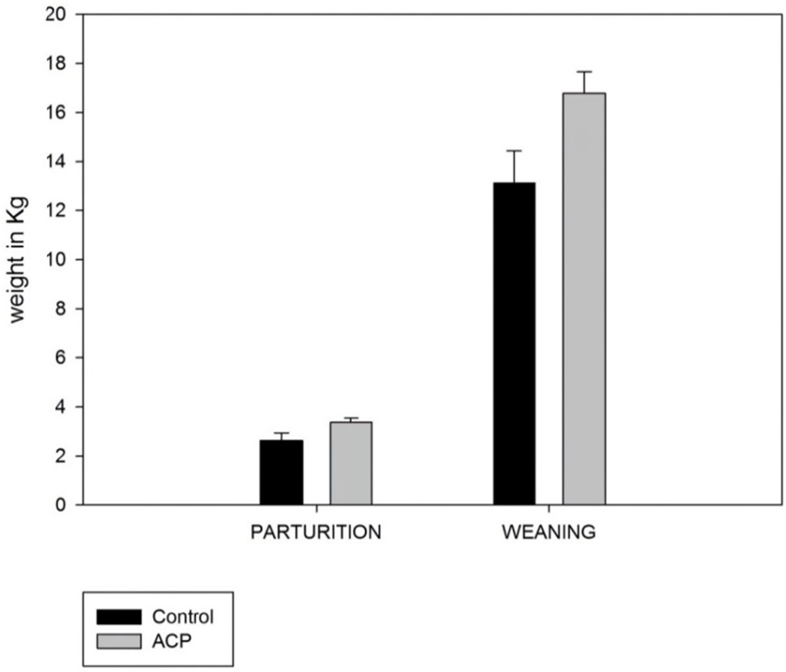

Figure 3. Graph representing the average birth weight and weaning weight of lambs from does supplemented with coconut powder (ACP) and the control group

4. Discussion

Even though it is expected that twin-pregnancies increases susceptibility of ewes to hypoglycaemic (Harmeyer & Schlumbohm 2007), nevertheless ACP animals which were expected to have a much larger metabolic challenge because of high twin pregnancies when compared with control animals, continued exhibiting constant indexes throughout the study. Under these circumstances, it suggests a positive influence of ACP supplementation on energy dynamics in twin pregnant sheep.

Studies using propylene glycol in pregnant buffaloes (Gamarra et al., 2014) displayed similar results to this study, where animals fed with propylene glycol showed an increase of glucose, improvement on metabolic indexes and a rapid return to reproductive function. Using ewes, Dos Santos et al. (2017), also fed propylene glycol during pregnancy and reported high levels of blood glucose, especially at the day of parturition.

The reason for BHB values turning to higher values in ACPg at days 21 and 30 after the parturition, could be revealed to the fact that twin births from ACP animals, increased the energy demands and trigger fat metabolizing process after 21 days of parturition. The energy demands normally arise after the 3rd week of parturition, which is the period of peak lactation in sheep (Sartori et al., 2020). Therefore, a ewe that needs to feed two lambs has to undergo a larger metabolic challenge, once energy requirements are considerably bigger than single pregnancies. Twin pregnancies are presumably more capable of triggering fat mobilization and consequently higher levels of BHB during the end of gestation and in the beginning of lactation (Harmeyer & Schlumbohm, 2006).

Considering that even 80% of sheep from ACPg had twin births; there was no significant fat mobilization or negative influences on energy dynamics of these animals. These results provide evidences that ACP could positively impact in the energy input, during pregnancy, especially in twin births. This impact was strongly observed at the ACPg regarding weight gain, which showed ACP supplementation to pregnant sheep appearing to have effective impact on weight gain of lambs after birth.

The broad conclusions we have drawn from this study are based on the superior reactions of energy indexes and inflammatory response expressed from the ACPg. Results imply that ACP supplementation to ewes, especially with twin pregnancies, could improve the energy status, enhancing the capability of females to go through the end of gestation, until postpartum period with lesser chances of metabolic imbalances. Equally important to the homeostatic status is the effect of the ACP noticed on offspring development and growth. Therefore, the collection of results support the idea that supplementation of ACP to pregnant ewes could be an important tool to reduce negative energy balance and offspring development in pregnant ewes. Nonetheless, further research is crucial to determine whether ACP is possible to improve energy status and reproductive indexes in pregnant sheep.

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