

INFLUENCE OF SEASON ON SERUM PROFILES OF SOME NUTRITIONAL METABOLITES DURING THE OESTRUS CYCLE IN SAVANNAH BROWN GOATS

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ABSTRACT

The study was carried out to determine the effect of seasonal changes and oestrous cycle phase on serum levels of some nutritional metabolites in Savanna Brown (SB) goats. Twenty multiparous ($n = 20$) and cycling SB goats aged between 2-5 years (2-4 parity) and body mass index (gBMI) of 20.17 ± 0.2 kg and 6.2 ± 0.4 were used for the study. Ten animals were used per season. In each season, the animals were synchronized to the oestrus with a single injection of 7.5 mg PGF_{2α} (Lutalyse®). The animals were bled by jugular venipuncture for glucose, cholesterol and total protein determination of serum during the first oestrous cycle following treatment with PGF_{2α}. Blood sampling was done at d 0 and d 1 of the induced oestrus, twice weekly subsequently, and finally on d 0 and d 1 of the second estrus after PGF_{2α} treatment. The mean serum glucose concentration was higher ($P < 0.05$) in the cold-dry (4.3 ± 0.1 mmol/L) than in early rainy (3.8 ± 0.1 mmol/L) season cycles. The mean serum cholesterol concentration was significantly higher ($P < 0.05$) in the early rainy (3.7 ± 0.1 mmol/L) than in cold-dry (3.2 ± 0.1 mmol/L) season cycles. There was no significant difference in mean serum total protein concentrations between the cold-dry and early rainy season cycles (cold-dry season: 64.6 ± 0.8 g/L vs early rainy season: 66.2 ± 0.7 g/L; $P > 0.05$). It is concluded that season but not oestrous cycle phase affects serum concentrations of some nutritional metabolites during the oestrous cycle in SB goats. It is therefore recommended that producers and clinicians should take into cognizance the seasonal variation in serum profiles of some energy substrates in feed formulation and reproductive herd health management in SB goats in the Northern Guinea Savannah zone of Nigeria.

Keywords: Nutritional metabolites, Oestrous cycle, Season, Savannah Brown goats

INTRODUCTION

Nutritional status is a major factor determining reproductive success in mammals and can act at various levels within the hypothalamo-pituitary-ovarian axis to regulate follicular development and ovulation (Armstrong *et al.*, 2003). Malnutrition and undernutrition reduce follicular growth, peripheral GnRH and LH (Wetteman *et al.*, 2003), and progesterone (P₄) and oestradiol (E₂) concentrations (Wetteman *et al.*, 2003); and the sensitivity of the endometrium to P₄, which compromises embryo survival. Insulin-induced hypoglycaemia stimulates a decrease in peripheral oestradiol concentrations and delayed LH surge (Scherzer *et al.*, 2009).

Seasonal changes in nutritional metabolites have been documented by various researchers in small ruminants. However, there is paucity of information on the effect of season on dynamics of nutritional metabolites during the oestrous cycle. Therefore, the aim of this present study was to determine the effect of seasonal changes on dynamics of some nutritional metabolites during the oestrous cycle.

MATERIALS AND METHODS

The study was carried out at the National Animal Production Research Institute (NAPRI), Shika, Ahmadu Bello University, Zaria, Shika, Nigeria. Twenty multiparous ($n = 20$) apparently healthy and cycling Savanna Brown (SB) does, aged between 2-5 years (2-4 parity) with body weight and gBMI of 20.17 ± 0.2 kg and 6.2 ± 0.4 , respectively were used for the study. The animals were sourced from Small Ruminant Research Programme of the National Animal Production Research Institute, Shika, Ahmadu Bello University, Zaria were used for the experiment. Ten does ($n = 10$) were allotted per season of study. The does had been weaned of their kids for at least eight weeks prior to the commencement of the experiment. Each doe had shown at least one oestrus before it was included in the study. Feed and water were provided *ad libitum*. The cold-dry (harmattan), and early rainy season blood sampling were carried during the months of December-May. The does were synchronised with a single injection of 7.5 mg PGF_{2α} (Lutalyse® PHARMACIA). Heat detection was carried during the morning hours of 8.00 am-9.00 am, and in evening hours of 4.00 pm-5.00 pm. Standing to be mounted was the single

criterion used to confirm that a doe is in estrus. Does were bled at d 0 and d 1 of the first oestrus, twice weekly subsequently and the day 0 and day 1 of the second oestrus following PGF_{2α} treatment. Serum samples were assayed for three nutritional metabolites, namely glucose, cholesterol and total protein using Bayer Express Plus Clinical Chemistry Autoanalyser (Bayer[®] Germany). The analysis was done in the Department of Chemical Pathology, Ahmadu Bello University Teaching Hospital, (ABUTH) Shika, Zaria, Nigeria. Data were expressed as mean ($\pm$ SEM) and analysed using Student t-test and One-way Analysis of Variance (ANOVA) followed by Tukey's Multiple Comparison post-hoc test. The statistical package used was GraphPad Prism version 4.0 (2003) for windows from GraphPad Software, San Diego, California, USA (www.graphpad.com). Values of $P < 0.05$ were considered significant.

RESULTS

Peak serum glucose concentrations were recorded during days 7, 13 and 23 of dioestral phases of oestrous cycle during the cold-dry. Whereas, the peak glucose concentration was at days 7, 16, 19 and 23 during the early rainy season (Fig. 1). Regardless of cycle phase, serum glucose levels were higher during the cold-dry relative to early rainy season cycle. Cholesterol followed similar trend during both seasons, except for the fact that it peaked from day 4 during the early rainy season (Fig. 2). In general, cholesterol levels were higher during the early rainy season than the cold dry season cycle (Fig. 2). The serum total protein did not follow a discernible pattern during the oestrous cycle (Fig. 3).

DISCUSSION

The non-significant difference observed between oestral and dioestral phase serum glucose concentrations in both cold-dry and early rainy season cycles indicate that oestrous cycle phase may not have significant influence on body's major energy substrates. However, the results of this study may suggest that the body's homeostatic control of glucose, cholesterol and total protein ensures relative stability in the blood concentrations of these nutritional metabolites to ensure a regular and stable supply of these energy substrates to the ovaries, uterus and other endocrine glands that support the oestrous cycle and reproduction in general. However, seasonal variation in glucose metabolism, with relative hyperglycaemia

occurring in the cold-dry than the early rainy season cycles may suggest the possibility of enhanced ovarian function and cyclicity in the cold-dry than rainy season cycles. This is because of the preference for glucose by the ovaries as the main energy substrate. In addition, the relative hyperglycaemia during the cold-dry season cycles, irrespective of the cycle phase, suggests a higher demand for a readily metabolisable energy substrate by the obligatory thermogenic mechanisms that maintain body temperature during the cold-dry season. The fluctuations in serum glucose concentrations with peak values occurring at certain periods of the cycle agrees with the concept of a regulated rather than steady state glucose homeostasis that displays a circadian rhythm (Hoffman, 2003; La Fleur, 2003; Pocai et al., 2005). This explanation may also hold true for the similar fluctuations observed in the serum cholesterol profiles. Higher serum cholesterol concentrations during the early rainy season than cold-dry season are consistent with a recent observation of lower blood cholesterol during summer than winter in dairy cattle (Shehab-El-Deen *et al.*, 2010). This variation could be attributed to diurnal changes in the rate of cholesterol synthesis and 3-hydroxy-3-methylglutaryl CoA reductase activity (HMG-CoA reductase), which is the rate limiting enzyme in endogenous cholesterol biosynthesis (Mayes and Bothman, 2003). Furthermore, the lower serum cholesterol levels observed in the cold-dry as compared to early rainy season cycles in this study may be attributed to a higher rate of cellular uptake and utilisation of cholesterol for the synthesis of sex steroids and adrenocortical hormones during the cold-dry season. Net increase in cellular uptake and utilisation of cholesterol from the blood for the synthesis of steroid and adrenocortical hormones could be responsible for the relative hypocholesterolaemia observed during cold-dry season cycles of this study. The relatively lower but insignificant total protein levels in the cold-dry as compared to the early rainy season may be attributed to increased plasma lipoprotein, tissue protein catabolism and utilization of the component amino acids for gluconeogenesis to generate heat for the maintenance of body temperature during the cold-dry season.

It is concluded that season but not oestrous cycle phase affects serum concentrations of some nutritional metabolites during the oestrous cycle in SB goats. It is therefore recommended that producers and clinicians should take into

cognizance the seasonal variation in serum profiles of some energy substrates in feed formulation and reproductive herd health management in SB goats in the Northern Guinea Savannah zone of Nigeria.

REFERENCES

- Armstrong, D.G., Gong, J.G. and Webb, R. (2003). Interactions between nutrition and ovarian activity in cattle: physiological, cellular and molecular mechanisms. *Reproduc* (supplement), 61: 403 - 414.
- Hoffman, R.M. (2003). Carbohydrate metabolism in horses. In: Ralson, S.L. and Hintz, H.F. (Eds). *Recent Advances in Equine Nutrition*. International Veterinary Information Service. (www.iviis.org) Ithaca, New York, USA.
- La fleur, S.E., Kalsbeek, A., Wortel, J., Fekkes, M.L. and Buijs, R.M. (2001). A dairy rhythm in glucose tolerance: a role for the suprachiasmatic nucleus. *Diabetes*, 50: 1237-1243.
- Mayes, P.A. and Bender, D.A. (2003). Overview of metabolism. In: *Harper's illustrated Biochemistry*. Ed. by Murray, R.K., Granner, D.K., Mayes, P.A., and Rodwell, V.W. Pub by Lange Medical Books. McGraw Hill Medical Publishing Division. New York. London. Pp. 122 - 129.
- Muller, M.J and Seitz, H.J. (1984). Thyroid hormone action on intermediary metabolism. *J Molec Med*, 62: 0946 - 2716.
- Pocai, A., Lam, T.K.T., Gutierrez-Juarez, R., Obici, S., Schwartz, G.J., Bryan, J., Aguilar-Bryan, L. and Rossetti, L. (2005). Hypothalamic K_{ATP} channels control hepatic glucose production. *Nat*, 434: 1026-1031.
- Scherzer, J., Ghuman, S.P.S., Pope, M., Routly, J.E., Walter, L., Smith, R.F. and Dobson, H. (2009). Follicle and oocyte morphology in ewes after treatment with insulin in the late follicular phase. *Theriogenol*, 71: 817 - 828.
- Shehab-El-Deen M.A.M.M., Leroy, J.L.M.R., Fadel, M.S., Saleh, S.Y.A., Maes, D and Van Soom, A. (2010). Biochemical changes in the follicular fluid of the dominant follicle of high producing dairy cows exposed to heat stress early post-partum. *Anim Reproduc Sci*, 117: 189 - 200.
- Waterman, R.C., Grings, E.E., Geary, T.W., Roberts, A.J., Alexander, L.J. and MacNeil, M.D. (2007). Influence of seasonal forage quality on glucose kinetics of young beef cows. *J Anim Sci*, 85: 2585 - 2595.

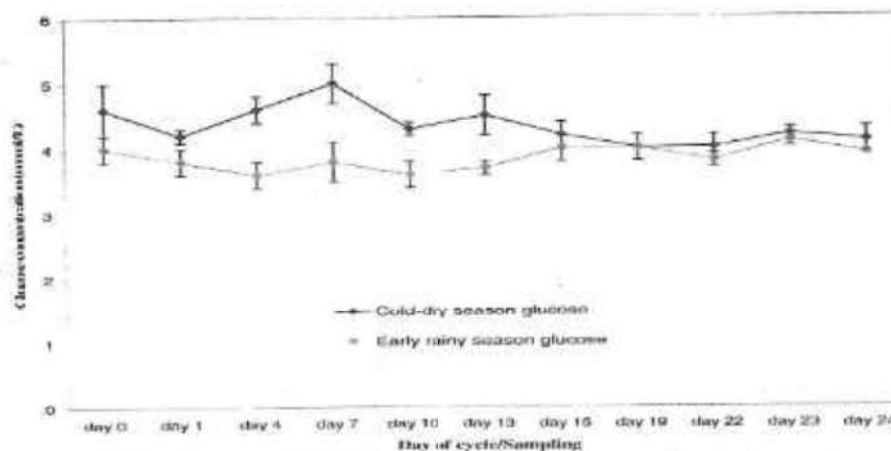


Figure 1: Seasonal changes in serum glucose profiles during oestrous cycle in Savannah Brown goats in the cold-dry and early rainy seasons

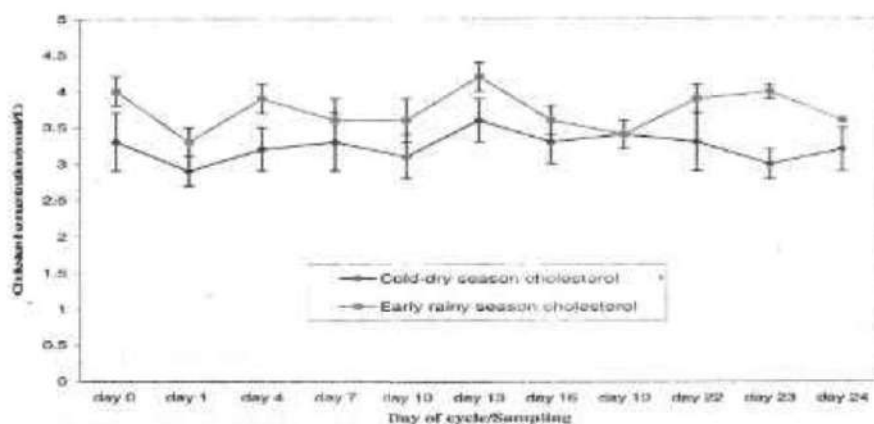


Figure 2: Seasonal changes in serum cholesterol profiles during oestrous cycle in Savannah Brown goats in the cold-dry and early rainy seasons

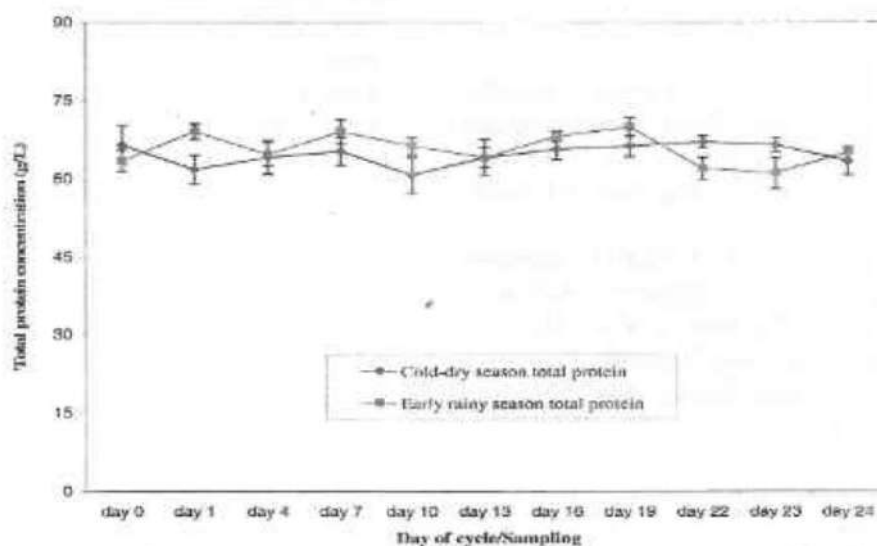


Figure 3: Seasonal changes in serum total protein profiles during oestrous cycle in Savannah Brown goats in the cold-dry and early rainy seasons