ENDOCRINE CHANGES DURING LATE PREGNANCY AND PARTURITION IN BLACK BENGAL GOATS

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The objective of this study was to delineate the changes in plasma progesterone, estradiol, T3, T4, insulin and cortisol concentrations during late pregnancy and parturition in Black Bengal goats. Blood samples were collected on days 118, 125, 132, 139, 146 of pregnancy and on the day of kidding. Plasma progesterone concentration declined abruptly from day 146th of pregnancy to basal level on the day of kidding whereas plasma estradiol concentrations rose from day 139th of pregnancy to the day of kidding. Peripheral plasma insulin concentrations rose from day 118th of pregnancy to maximum concentrations on day 132th of pregnancy which deaeased ($P<0.05$) abruptly on the day of kidding. Plasma cortisol concentration declined from day 118th of pregnancy to day 146th of pregnancy which further increased on the day of kidding. Plasma T3 and T4 concentrations declined from day 139th of pregnancy to the lowest levels on the day of kidding. The results of this study indicate that plasma hormone levels change during late pregnancy and parturition in Black Bengal goat.

Goat, the poor man`s cow as a domestic animal with its predominant hometract in South East Asia have found great acceptance in the rural economy of Asia and is an indispensable source of employment to the marginal and landless farmers. Goat has evoked interest as an animal for meeting the growing demands of meat, milk, industrial raw products such as skin, fiber and manure. Studying the fundamental endocrine involvement during late pregnancy is essential for understanding of the regulatory mechanisms accompanying maintenance of pregnancy and fetal development. During early pregnancy, the growing embryo depends on uterine environment for survival and growth as the uterine environment undergoes continual modifications to cope with the needs of embryo. The survivality of embryo during early embryonic life is mostly dependent on the efficiency with which the maternal recognition of pregnancy (MRP) is established. Maternal recognition of pregnancy results from signaling between the trophoblast of conceptus and the maternal system. These signals ensure maintenance of structural and functional integrity of corpus luteum (CL). The CL produce progesterone which is required to stimulate and maintain endometerial function that are permissive for early embryonic development, implantation, placentation and successful fetal and placental development. Various hormones viz., T3, T4, and insulin play crucial roles in partitioning of nutrients during pregnancy and lactation. The endocrine changes during late pregnancy and parturition have been reported in various species (Soliman *et al*., 1963; Adams and Wagner, 1970; Wagner and Oxenrider, 1971; Thorburn *et al*., 1972; Bedford et

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al., 1972; Smith *et al*., 1973; Molokwu and Wagner, 1973; Chamley *et al.*, 1973; Molokwu and Wagner, 1973; Thompson and Wagner, 1974; Fairclough *et al.*, 1975; Hunter *et al.*, 1977; First and Bosc, 1979). Understanding the hormonal changes will furnish a background for ovarian and placental function during pregnancy and parturition. The objective of the study is to characterize the changes in plasma progesterone, estradiol, cortisol, triiodothyronine, thyroxin and insulin during late pregnancy and parturition in Black Bengal goats, in relation to its fertility, prolificacy, superior meat and skin quality.

MATERIAL AND METHODS

Experimental animals and blood sampling

Five cycling Black Bengal goats (aged between 3 and 5 years) were used in the present study. All the animals were maintained using standard farm practices at the goat herd of Physiology and Climatology division, Indian Veterinary Research Institute at Izatnagar. The animals selected for the study were free from any anatomical, physiological, or infectious disorders and were mated. The pregnant goats were housed in goat pen with a brick floor and fed on a diet of green fodder and concentrate mixture. Blood samples were collected once daily from all the goats in heparinised tubes through jugular venipuncture prior to feeding. The blood samples were collected at 7-day intervals during late pregnancy viz., between day 118 of pregnancy and day of parturition. Plasma was separated by centrifugation at 3000 rpm for 30 min at 4^0C and stored frozen at -20^0C until assay of hormones.

Hormonal assay

The levels of insulin, cortisol, T3, T4, progesterone and estradiol were quantified by the RIA kits procured from Immunetech, France. The sensitivity as well as inter- and intra-assay variations of the hormones are shown in the Table 1.

Hormones	Sensitivity	Inter-assay coefficient of variation (%)	Intra-assay coefficient of variation (%)
Insulin	0.5 IU/ml	3.4	4.3
Cortisol	10 nmol/L	9.2	5.8
T3	0.1 nmol/L	8.6	3.3
T4	9.5 nmol/L	8.6	6.2
Progesterone	0.08 ng/ml	9.0	5.8
Estradiol	4.5 pg/ml	11.2	12.1

Table 1. Sensitivity and coefficients of variation of various hormones

Statistical analysis

The data were expressed as the mean ±standard error of mean (S.E.M). Data were analyzed by repeated measures one way ANOVA using GraphPad Prism 5 (Graph Pad Software Inc., San Diego, CA, USA). Differences between mean values were considered significant when the probability values were < 0.05.

RESULTS

Plasma steroid hormone profiles

The concentrations of progesterone and estradiol from day 118th to 153th of pregnancy are presented in Figures 1-2. Plasma progesterone concentration was 4.68±0.16 ng/ml on 118th of pregnancy which then declined to 3.82±0.09 ng/ml on day 146th of pregnancy, failing abruptly ($P<0.05$) to 0.09±0.02 ng/ml on the day of kidding. Peripheral plasma estradiol concentrations decreased from 39.75±4.30 pg/ml on day 118th of pregnancy to 28.43±3.98 pg/ml on day 139th of pregnancy and then rose to 50.03±10.13 pg/ml on the day of kidding.

Plasma insulin and cortisol profiles

The concentrations of insulin and cortisol from day 118th of pregnancy to day of kidding are presented in Figures 3-4. Peripheral plasma insulin concentration rose from 33.76±7.34 μIU/ml from day 118th of pregnancy to a maximum concentrations of 51.21±5.45 ?IU/ml on μ132th of pregnancy which then fall ($P<0.05$) abruptly to 17.79±1.22 μIU/ml on the day of kidding. Plasma cortisol concentration was 57.39±9.87 nmol/L on day 118th of pregnancy which then declined ($P<0.05$) to a lowest level of 28.13±9.57 nmol/L on day 146th of pregnancy which further increased to 48.04±6.65 nmol/L on the day of kidding.

Plasma T_3 and T_4 profiles

Peripheral plasma concentrations of T3 ranged from 1.29±0.14 to 2.28±0.36 nmol/L and that of T_4 varied from 39.68±5.20 to 87.19±6.52 nmol/L throughout the experimental period (Figures 5-6). Plasma concentrations of T_3 decreased from 2.23±0.39 nmol/L on day 118th of pregnancy to 1.29±0.14 on day 132th which thereafter increased to 2.28±0.36 nmol/L on day 139th pregnancy. The concentrations declined to 1.49±0.20 nmol/L on the day of kidding. The concentrations of T_4 was 83.47±10.27 nmol/L on day 118th of pregnancy and declined to 72.59±1.84 nmol/L on day 132th pregnancy. The concentrations then suddenly increased to 87.19±6.52 nmol/L on day 139th of pregnancy and reached a lowest level of 39.68±5.20 nmol/L on the day of kidding.

DISCUSSION

Understanding the endocrine changes during late pregnancy and parturition serves a marker for ovarian and placental function during gestation. In this study, we have investigated the changes in plasma progesterone, estradiol, T_3, T_4, insulin and cortisol concentrations during late pregnancy and parturition in Black Bengal goats. Peripheral plasma progesterone concentrations decreased from day 146th of pregnancy to base level on the day of kidding. This agrees with earlier reports on cow (Fairclough *et al.,* 1975; Hunter *et al.,* 1977), ewe (Chamley *et al.*, 1973; Thompson and Wagner, 1974; Alwan *et al.,* 2010), goat (Khan and Ludri, 2002; Mondal *et al.,* 2007b) and pig (Molokwu and Wagner, 1973; Robertson and King, 1974) wherein plasma progesterone concentrations suddenly declined before kidding indicating its essential role in parturition in Black Bengal goat. Plasma estradiol concentrations have been found to increase from day 139th of pregnancy to the day of kidding which are in agreement with earlier reports in cow (Stabenfeldt *et al.,* 1970; Hoffman *et al.,* 1979), ewe (Bedford *et al.,* 1972; Thompson, 1973), goat (Kandiel *et al.,* 2010; Adam and Wagner, 1970;

Bloom and Lyngst, 1971; Emanuel *et al.,* 1986; Mondal *et al.,* 2006a) and pig (Wagner and Oxenrider, 1971; Guthrie *et al.,* 1972; Molokwu and Wagner, 1973). In the present study, circulating insulin concentrations rose from day 118th of pregnancy to day 132th of pregnancy and then fall abruptly on the day of kidding in order to mobilize nutrients from depot fat for milk synthesis (Khan and Ludri, 2002; Mondal *et al.,* 2007). The decrease in insulin levels during late pregnancy may be attributed to sharp increase in NEFA concentrations and decrease in glucose concentrations. Suganya and Gomathi (2009) observed that the insulin level was decreased by day 15 prepartum and reached a lowest concentration on the day of kidding. The level remained lower till day 10 of postpartum, which increased on day 15 postpartum. The fall in insulin level is associated with a concomitant decrease in the insulin receptors of the adipocytes which is responsible for fat mobilization during late pregnancy. During the postpartum period hypoinsulinemia is attributed to the continued mobilization during lactation as insulin is being removed by the mammary gland (Williamson, 1980).

In the present study, plasma cortisol levels declined from day 118th of pregnancy to day 146th of pregnancy which further increased on the day of kidding. Our results are also in agreement with earlier studies in cow (Adams and Wagner, 1970; Smith *et al.,* 1973), ewe (Thompson, 1973; Thompson and Wagner, 1974), goat (Suganya and Gomathi, 2009) and pig (Ash and Heap, 1975; First and Bosc, 1979). Suganya and Gomathi (2009) observed that the concentration of cortisol increased prior to kidding due to stress and reached the maximum concentration on the day of kidding. Thereafter the level was significantly decreased till day 15 postpartum. The secretion of ACTH from foetus increased during last stage of parturition which increased the concentrations of cortisol by stimulating the rapid growth of foetal adrenals. Plasma T_3 and T_4 concentrations have been found to decline from day 139th of pregnancy to the lowest levels on the day of kidding due to transfer of these hormones from placenta to the foetus. Our results agree with earlier reports in sheep (Eswari *et al.,* 1993; Okab *et al.,* 1993) and goat (Mondal *et al.,* 2006; Suganya and Gomathi, 2009). Plasma T3 and T4 concentrations decreased during late pregnancy due to inhibitory effect of glucocorticoid which rise before parturition whereas their increase during post-partum period indicates the enhancement of utilization of nutrients due to stress of parturition. Suganya and Gomathi (2009) also observed that serum T_4 and T_3 concentrations were declined from 30 days prior to kidding, and lowest on the day of kidding followed by an increase till day 15 postpartum. The findings were similar to that of Eswari *et al* (1993) in sheep. This could be attributed to the inhibitory effect of glucocorticoids on TSH (Mondal *et al,* 2006) whereas Blum *et al* (1983) related it to be a self defence mechanism to reduce metabolic demand when catabolic functions are high. The increase in the concentrations of thyroid hormones during the postpartum period could be due to the influence of estrogen on the development of mammary gland (Patel *et al.,* 1993). Novoselec *et al.* (2009) reported that a lower ($P<0.01$) concentrations of T_3 in the blood of lactating sheep as compared to non-pregnant and pregnant sheep. However, opposite trend ($P>0.05$) was observed for the concentration of T_4 in the above categories. Similar results of T_3 and T_4 levels in sheep were observed by Karapehlivan *et al.* (2007). Riis and Madsen (1985) reported that lower plasma T_3 and T_4 concentrations reduced the rate of oxidation and the rate of continuous breakdown and formation of protein and fat in mammary tissue. This will also tend to reduce the adverse

effects of nutrient deficiency at the onset of lactation. It is concluded that high concentrations of estradiol and cortisol as well as low concentrations of progesterone, insulin, T_3 and T_4 prior to kidding play a vital role in initiation of parturition in Black Bengal goat.

ACKNOWLEDGEMENT

The authors are thankful to the Director, IVRI, Bareilly for providing the necessary facilities for carrying out the research work. S. Mondal was supported by IVRI senior research fellowship.

REFERENCES

Adams WM and Wagner WC 1970 : The role of corticoids in parturition. Biological Reproduction, **3,** 223-228.

Alwan AF Amin FAM and NS Ibrahim 2010 : Blood progesterone and estrogen hormones level during pregnancy and after birth in Iraqi sheep and goat. Bangladesh Journal of Animal Sciences, **10,** 2-9.

Ash RW and RB Heap 1975 : Oestrogen, progesterone and corticosteroid concentrations in peripheral plasma of sows during pregnancy, parturition, lactation and after weaning. Journal of Endocrinology, **64,** 141-154.

Bedford CA GRG Challis FA Harrison and RB Heap 1972 : The role of oestrogens and progesterone in the onset of parturition in various species. Journal of Reproduction. Fertility, **16,** 1-23.

Bloom AK and O Lyngset 1971 : Plasma progesterone concentrations in goats during pregnancy measured by competitive protein binding. Acta Endocrinology, **66**, 471-477.

Blum JW P Kunz and H Leuenberger 1983 : Thyroid hormones, blood plasma metabolites and hematological parameters in relationship to milk yield in dairy cows. Animal Production, **36,** 93-104.

Chamley WA JM Buckmaster ME Cerini IA Cumming JR Coding JM Obst A Williams and C Winfield 1973 : Changes in the levels of progesterone, corticosteroids, estrone, estradiol-17ß, luteinizing hormone, and prolactin in the peripheral plasma of the ewe during late pregnancy and at parturition. Biology of Reproduction, **9,** 30-35.

Emanuel L P Krejci and D Pichova 1986 : Czech white breed goat milk production and hormonal during level parturition and lactation. In: Proc of 37th Annual Meeting of European Association for Annual Production, Hungry, pp174-175.

Eswari S S Viswanathan V Leela Md Nayeem and K Gajendran 1999 : Concentration of serum thyroid hormones during pregnancy, parturition, postpartum and lactation in Madras Red sheep. Indian Journal Animal Reproduction, **20**(2), 116-119.

Fairclough RJ JT Hunter RAS Welch and E Payne 1975 : Plasma corticosteroid concentrations in the bovine foetus near term. Journal of Endocrinology, **65**, 139-140.

First NL and MJ Bosc 1979 : Proposed mechanisms controlling parturition and the induction of parturition in swine. Journal of Animal Science, **48,** 1407-1421.

Guthrie HD, DM Henricks and DL Handlin 1972 : Plasma estrogen, progesterone and luteinizing hormone prior to estrus and during early pregnancy in pigs. Endocrinology, **91**, 675-679.

Hoffmann B, WC Wagner JE Hixon and J Bahr 1979 : Observations concerning the functional status of the corpus luteum and the placenta around parturition in the cow. Animal Reproduction Science, **2,** 253-261.

Hunter JT, RJ Fairclough AJ Peterson and RAS Welch 1977 : Foetal and maternal hormonal changes preceding normal bovine parturition. Acta Endocrology Copenh., **84**, 653-662.

Kandiel MM G Watanabe and K Taya 2010 : Ovarian expression of inhibin-subunits, 3ß-

hydroxysteroid dehydrogenase, and cytochrome P450 aromatase during the estrous cycle and pregnancy of Shiba goats (Capra hircus). Exp Animal, **59,** 605-614.

Karapehlivan M E Atakisi O Atakisi R Yucayurt and SM Pancarci 2007 : Blood biochemical parameters during the lactation and dry period in Tuj ewes. Small Ruminant Research, **73**(1-3), 267-271.

Khan JR and RS Ludri 2002 : Changes in blood glucose, plasma non-esterified fatty acids and insulin in pregnant and non-pregnant goats. Tropical Animal Health Production, **34,** 81-90.

Molokwu ECI and WC Wagner 1973 : Endocrine physiology of the puerperal sow. Journal of Animal Science, **36,** 1158-1163.

Mondal S VP Varshney and MC Pathak 2006a : Relationship between plasma estradiol and cortisol concentrations during periparturient period in Black Bengal goats. Reproduction Domestic Ruminants **41**(S2), 118.

Mondal S A Minj MC Pathak and VP Varshney 2006b : Peripheral plasma thyroid hormone concentrations during pregnancy in Black Bengal goats. Endocrine Abstracts, **12,** P100.

Mondal S MC Pathak and VP Varshney 2007a : Changes in peripheral plasma insulin levels during periparturient period in Black Bengal goats. In: Proc. of National symposium on Recent Trends in Policy Initiatives and Technological Interventions for Rural Prosperity in Small Holder Livestock Production Systems, Tirupati, India, pp 147.

Mondal S MC Pathak DN Singh and VP Varshney 2007b : Peripheral plasma progesterone concentration during periparturient period in Black Bengal goats. In Proc. of 40th Annual Meeting of Society for Study of Reproduction, USA, pp. 173.

Novoselec J Z Antunovic M Speranda Z Steiner and T Speranda 2009. Changes of thyroid hormones concentration in blood of sheep depending on age and reproductive status. Ital. Journal of Animal Sciences, 8 (Suppl. 3), 208-210.

Okab AB IM Elebenna MY Mekkawy GA Hassan FD El-Nouty MH Salem 1993 : Seasonal changes in plasma thyroid hormones, total lipid, cholesterol and serum transaminases during pregnancy and parturition in Barki and Rahmani ewes. Indian Journal Animal. Sciences, **63**(9), 946-951.

Robertson HA and GJ King 1974 : Plasma concentrations of progesterone, oestrone, oestradiol-17ß and of oestrone sulphate in the pig at implantation, during pregnancy and at parturition. Reproduction Fertility, **40**, 133-141.

Smith VG LA Edgerton HD Hafs and EM Convey 1973 : Bovine serum estrogens, progestins and glucocorticoids during late pregnancy, parturition and early lactation. Journal of Animal Sciences, **36,** 391-396.

Soliman FA H Nasir and H Zaki 1963 : Levels of thyroid and thyrotrophic hormones in the blood of Friesian cows at various reproductive stages. Journal of Reproduction Fertility, **6,** 335-340.

Stabenfeldt GH BJ Osburn and LL Ewing 1970 : Peripheral plasma progesterone levels in the cow during pregnancy and parturition. American Journal Physiology, **218**, 571-575.

Suganya G and VS Gomathy 2009 : Hormone profile of Tellicherry goats during periparturient period. Tamilnadu Journal of Veterinary and Animal Science **5** (5), 211-213.

Thompson FN 1973 : Felo-placental steroids andparturition in the ewe. Ph.D. thesis, Iowa State University, Ames.

Thompson FN and WC Wagner 1974 : Fetal-maternal corticosteroid relationships in sheep during late pregnancy. Journal of Reproduction Fertility, **41**, 49-56.

Wagner WC and SL Oxenreider 1971 : Endocrine physiology following parturition. Animal Sciences, **32**, 1-16.

Williamson DH 1980 : Integration of metabolism in tissues of the lactating rat. FEBS. Lett. Suppl, **117**, K93-K105.

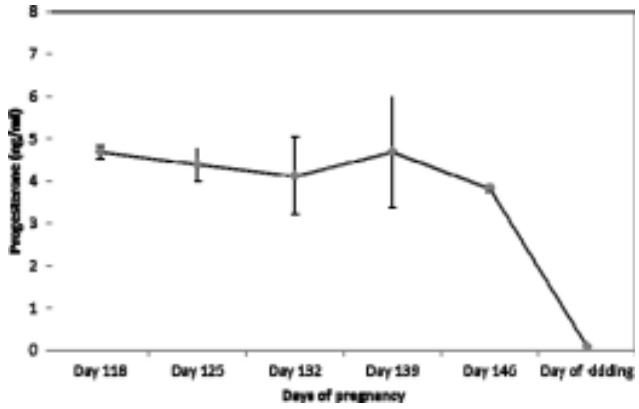

Figure 1: Plasma progesterone profiles during late pregnancy

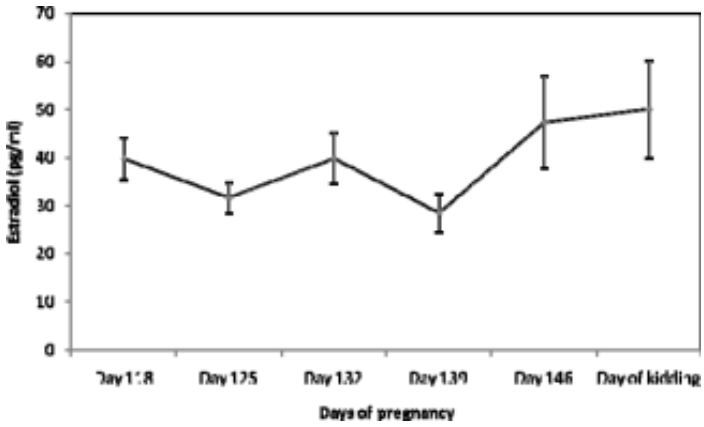

Figure 2: Plasma estradiol profiles during late pregnancy

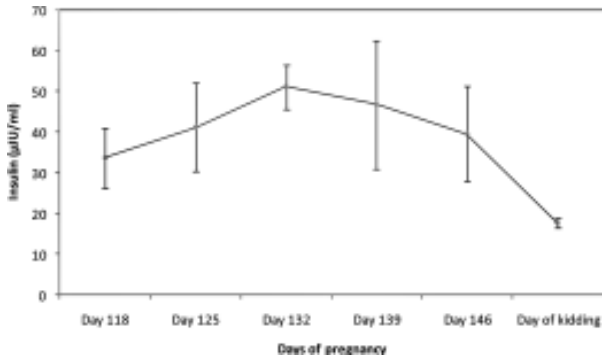

Figure 3: Plasma insulin profiles during late pregnancy

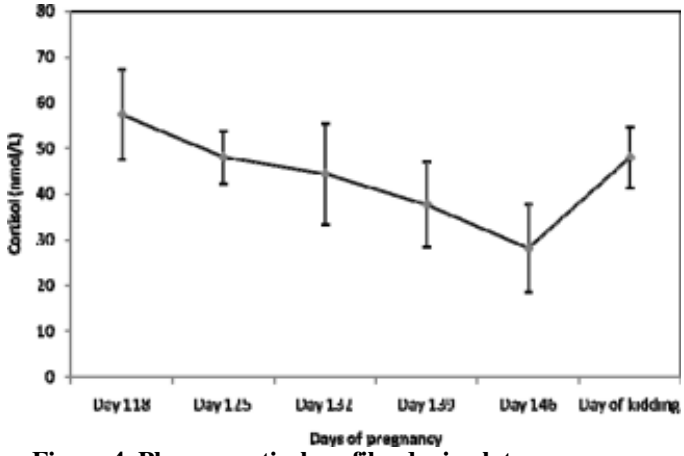

Figure 4: Plasma cortisol profiles during late pregnancy

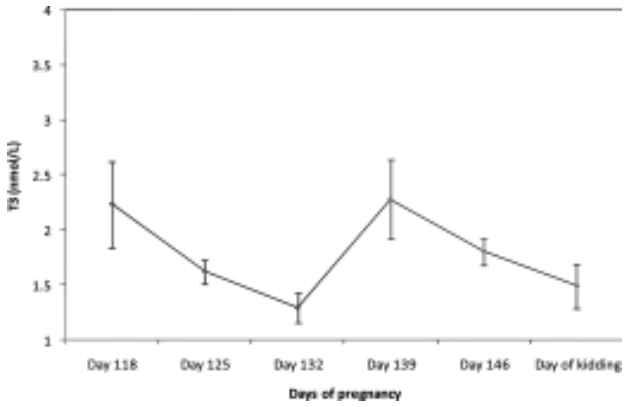

Figure 5: Plasma T3 profiles during late pregnancy

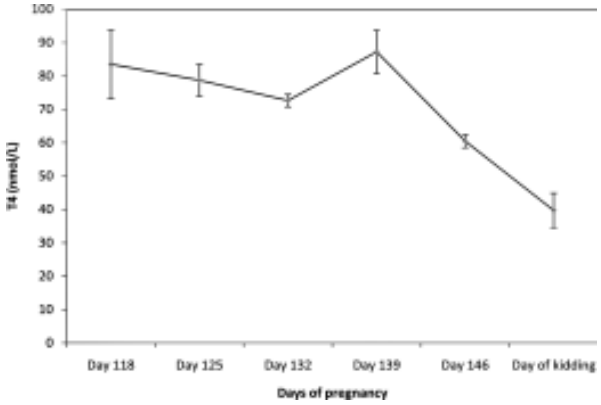

Figure 6: Plasma T4 profiles during late pregnancy