Changes in Maternal Blood Glucose and Plasma Non-Esterified Fatty Acid during Pregnancy and around Parturition in Twin and Single Fetus Bearing Crossbred Goats

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ABSTRACT : The effects of fetal number (single or twin) on blood glucose and plasma NEFA during pregnancy and around parturition were studied on ten Alpine × Beetal crossbred goats in their first to third lactation. The animals were divided in-groups 1(carrying single fetus, n=4) and 2(twin fetus, n=6). The samples were drawn on day1 after estrus and then at 14 days interval (fortnight) for 10 fortnights. Around parturition the samples were taken on days -20, -15, -10, -5, -4, -3, -2, -1 prior to kidding and on day 0 and +1, +2, +3, +4, +5, +10, +15, +20 days post kidding. In twin bearing goats the blood glucose concentration continued to increase from 1st until 4th fortnight and thereafter gradually decline from 5th upto 8th fortnight. In single bearing goats there was increase in levels from 2nd upto 4th fortnight and thereafter it declined from 5th uptill 9th fortnight. The difference in sampling interval was highly significant ($p<0.01$) in both the groups. However the values were higher in single than in twin bearing goats. The plasma NEFA concentration was low in both the groups' upto 4th fortnight and thereafter it is continuously increased upto 9th fortnight. During prepartum period the blood glucose was higher in single than in twin bearing goats. The values were minimum on the day of kidding in both the groups. During postpartum period the values were significantly ($p<0.01$) higher in twin than in single fetus bearing goats. The plasma NEFA was significantly ($p<0.05$) higher in twin than in single fetus bearing goats. The blood glucose and plasma NEFA concentration can be used as index of nutritional status during pregnancy and around parturition in goats. ***(Asian-Aust. J. Anim. Sci. 2002. Vol 15, No. 4 : 504-508)***

Key Words : Blood Glucose, Goats, NEFA, Pregnancy

INTRODUCTION

The maintenance of pregnancy in farm animals calls for specific metabolic and functional changes between conception to termination of gestation. The carbohydrate need of pregnancy and lactation are of particular interest in ruminants because the adult ruminants obtain very little glucose from its diet and its metabolic requirements for glucose are supplied by gluconeogenesis in the liver and kidney (Bergman, 1983). Normal gestation is characterized by several physiological events. The developing mammalian fetus completely depends on the maternal organism to meet its metabolic needs for growth and development. The glucose is the source of energy for fetus which is derived from maternal circulation viz. The placenta is the important source of energy for fetus. The blood glucose level is used as an index of nutritional status (Morant-Fehr et al., 1977). The blood metabolites that have been used to assess energy status of ruminants are glucose and non-esterified fatty acids (NEFA). The NEFA is released in blood when adipose tissue is mobilized to supply metabolic need of animal i.e. increase energy demand during pregnancy and lactation produces an increase in NEFA levels (Bowden, 1971). Although the quantity of NEFA in the blood of ruminant is small, it is an important factor in caloric homeostasis of the body. The deposition and mobilization of fat during pregnancy is a biphasic process, in early and mid pregnancy it is accumulated and during late pregnancy and early lactation these resources were found to be mobilize (Faulkner, 1983). The increase in energy requirement of pregnancy and lactation usually produces an increase in plasma NEFA level. In ewes Reid and Hinks (1962) found that levels of plasma NEFA in late pregnancy were highly correlated with the total fetal weight per unit of maternal weight. Radloff et al. (1966) found that levels of blood NEFA increased at parturition in cows. The growing fetus draws nutrients and other materials from the dam circulation either as ready made or as raw materials. Prior to the termination of pregnancy some nutrients and metabolites are diverted for udder development and milk synthesis. The developing fetus and placenta places an increasing demands upon the maternal vascular system and caused marked reversible changes to occur in pregnant goats. It was hypothesized that the number of fetus will effect the blood glucose and plasma NEFA concentration.

Perusal of the literature indicate that no comprehensive study has been conducted on the level of these metabolites during complete pregnancy and periparturient period in goats carrying single and twin fetuses. The objective of the

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Received July 9, 2001; Accepted October 24, 2001

present experiment was to study the changes in blood metabolites viz. blood glucose and plasma NEFA levels in does bearing different fetal number during pregnancy and around parturition. This is to understand clearly the effect of number of fetus on circulatory levels of these metabolites during complete gestation period and around parturition in crossbred goats.

MATERIALS AND METHODS

Environmental conditions and animal management.

This experiment was conducted at the institutes goat herd from Nov. 1996 and continued up to April 1997. Average daily minimum ambient temperature ranges from 4.08 to 15.19°C and maximum temperature ranges from 17.94 to 35.50°C. The experimental does were kept in goat pen with brick flooring as practice in the goat herd. The fresh fodder consisting of berseem (*Trifolium Alexandrium)* and mustard (*Brassica Compestris*) were feed ad libitum. The requisite amount of concentrate mixture having 19.50% crude protein and 70.00% total digestible nutrients was divided into two parts and was fed in the morning and evening. The concentrate mixture consisted of maize-18%, barelly-15%, mustard cake oil-12%, GNC-15%, cotton seed cake (undecorated) 6%, rice bran (deoiled)-11%, wheat bran 20%, mineral mixture-2%, common salt 1-% DM basis. The animals were provided drinking water *ad libitum*. This feeding regiment was given to all the goats during the experiment period.

Experimental design and protocol

Ten pluriparous cycling non pregnant, non-lactation Alpine × Beetal cross bred goats in their first to third lactation were selected from the institute goat herd. During the mating period the experimental does were mixed with vasectomised buck for detection of heat and then mated with the fertile buck. At the end of experiment period, only four gave birth to single fetus and six gave birth to twin fetuses. Experimental does were grouped into groups 1 (does carrying a single fetus) and 2 (does carrying twin fetuses) with n=4, 6 respectively. Blood samples were drawn on day 1 after estrus and then at 14 days interval (fortnight) for 10 fortnight from the goats of both the groups. During periparturient period the samples were taken on day -1, -2, -3, -4, -5, -10, -15, -20 before expected kidding and on day 0 (day of kidding) thereafter, +1, +2, +3, +4, +5, +10, +15, +20 days postpartum.

Blood sampling and processing

A 10 ml blood was drawn in heparinized vacutainer tubes from the jugular vein in the morning between 08:00 to 09:00 h. The bleeding time was conducted prior to feeding. For glucose estimation samples were collected in tubes containing sodium fluoride. The samples were centrifuged immediately after collection at 3,000 rpm for 20 minutes. Days prior to kidding were counted back from the last blood samples prior to the kidding date and postpartum after kidding.

Analytical methods

Blood glucose was estimated by Nelson Somogyi method as described by Oser (1965). Non esterified fatty acids (NEFA) in plasma were estimated by extraction method (Chloroform: Heptane: Methanol, 49:49:2) as described by Shipe et al. (1980).

Statistical analyses

Data collected during the 10 fortnight were analyzed for effect of fetuses (single and twin) according to Snedecor and Cochran (1989). The least square analysis using two way ANOVA was carried out for both the groups. The randomized block designed was used to find out the significant difference during periparturient period.

RESULTS

The mean concentration of blood glucose and plasma NEFA in twin and single fetus bearing goats during 10 fortnight after day 1 of onset of estrus have been presented in table 1, and changes during periparturient period have been presented in table 2. The levels of blood glucose were low on the day 1 after estrus in twin compared to single fetus bearing goats (53.29% vs 58.29 mg %). In twin bearing goats the blood glucose level continued to increase from 1st (54.86 mg %) until 4th fortnight (64.43 mg %) and thereafter, gradually decline from 5th (57.43 mg %) upto 8th fortnight (45.00 mg %). In single bearing goats also there was increase in blood glucose level from 2nd fortnight (52.00 mg %) to 4th fortnights (62.33 mg %) and thereafter the values declined from 5th fortnight (58.33 mg %) until 9th fortnights. The difference in the sampling interval in both the groups was highly significantly ($p<0.01$). However the overall mean values in single fetus bearing goats were higher as compared to twin fetus bearing goats but the difference was not statistically significant. The plasma NEFA levels were low in both the groups up to 4th fortnight and thereafter it is continuously increased up to 9th fortnight from (0.19-0.26 mM/L) and (0.21 to 0.27 mM/L) in twin and single fetus bearing goats. During prepartum period the blood glucose level was higher in single compared to twin bearing goats. The values were minimum on the day of kidding in both the groups 47.85 and 44.33 mg % in twin and single fetus bearing goats. During postpartum period the levels were significantly ($p<0.01$) higher in twin compared to single fetus bearing goats.

Table 1. Mean concentration (±SE) of blood glucose and plasma NEFA in twin and single fetus bearing pregnant goats

Attributes	Day 1 after estrus	Fornights 1	2	3	4	5	6	7	8	9	10	Mean
					Blood glucose (mg %)							
Twins	53.29	54.86	55.85	63.71	64.43	57.86	53.43	46.14	45.00	46.57	51.00	53.83
	±1.95	±1.83	±2.84	±1.75	±1.87	±1.35	±2.01	±1.40	±2.94	±1.49	±1.57	±0.90
Single	58.67	53.67	52.00	61.00	62.33	58.33	58.67	55.33	50.33	46.00	46.33	54.79
	±0.88	±3.84	±3.05	±0.58	±1.20	±0.88	±3.28	±4.67	±3.71	±4.58	±1.45	±1.20
					NEFA (mM/I)							
Twins	0.27	0.28	0.22	0.16	0.19	0.21	0.22	0.25	0.25	0.26	0.21	0.23
	±0.03	±0.05	±0.03	±0.01	±0.02	±0.02	±0.03	±0.04	±0.04	±0.02	±0.01	±0.01
Single	0.22	0.28	0.27	0.20	0.21	0.23	0.22	0.24	0.25	0.27	0.24	0.24
	±0.01	±0.07	±0.01	±0.01	±0.02	±0.02	±0.01	±0.01	±0.03	±0.04	±0.04	±0.01

Table 2. Mean concentrations (±SE) of blood glucose and plasma NEFA in twin and single fetus bearing pregnant goats during periparturient period

Attributes	Day of sampling in relation to parturition																
	-20	-15	-10	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+10	+15	+20
								Blood glucose (mg %)									
Twin	51.43	50.71	51.86	47.14	45.71	46.43	48.43	52.29	47.85	57.57	58.71	58.57	58.57	60.71	63.43	65.43	63.57
	±1.13	±2.29	±0.91	±1.45	±2.33	±2.74	±2.78	±2.47	±2.24	±2.09	±2.85	±1.75	±1.27	±3.13	±2.20	±2.58	±2.22
Single	50.33	51.67	48.00	52.00	51.33	51.67	54.33	52.00	44.33	55.67	48.67	55.33	58.67	56.00	53.67	60.67	59.33
	±1.20	±2.18	±4.04	±6.11	±5.24	±4.33	±4.63	±2.88	±2.18	±1.20	±4.91	±3.18	±0.66	±3.21	±7.53	±8.35	±6.06
								NEFA (mM/I)									
Twin	0.25	0.23	0.22	0.22	0.23	0.22	0.23	0.23	0.28	0.20	0.18	0.16	0.18	0.19	0.20	0.17	0.16
	±0.03	±0.03	±0.02	±0.01	±0.01	±0.02	±0.02	±0.02	±0.02	±0.01	±0.02	±0.01	±0.02	±0.01	±0.02	±0.01	±0.01
Single	0.14	0.23	0.19	0.21	0.26	0.20	0.20	0.23	0.26	0.21	0.21	0.20	0.22	0.21	0.19	0.19	0.24
	±0.01	±0.04	±0.01	±0.03	±0.04	±0.02	±0.03	±0.03	±0.02	±0.01	±0.01	±0.02	±0.33	±0.03	±0.01	±0.01	±0.03

Plasma NEFA levels during prepartum period were significantly ($p<0.05$) higher in twin compared to single fetus bearing ones. However the levels increased on the day of kidding in both the groups (0.28 vs 0.26 mM/L). Thereafter the level declined up to day 3 postpartum. During postpartum period the levels were higher in single compared to twin fetus bearing goats. The difference between days of sampling during postpartum period varied significantly ($p<0.01$).

DISCUSSION

The fetus has been found to receive a continuous supply of glucose from the mother. Glucose is the major energy substrate for the developing fetus and is also utilized by the uteroplacenta (Wilson, 1984). Glucose entry in to gravid uterus and its component tissues are determined by maternal arterial glucose concentration (Hay and Meznarich, 1988; Leury et al., 1990). The concepts (fetuses), placenta, associated membranes and supporting uterine tissue make extensive, direct demands upon maternal supplies of glucose especially during late pregnancy (Bell and Ehrhards, 2000). In well-fed monotocous ewes during late pregnancy, uterine uptake of glucose consumes 30-50% of maternal glucose supply (Prior and Christenson, 1978; Hay et al., 1983; Oddy et al., 1985; Leury et al., 1990). Glucose uptake and its requirement increase with stage of gestation and multiple fetuses in ewes (Prior and Christenson, 1978). The increase in the levels of blood glucose upto 4th fortnight may be due to the less utilization of it as during this period the demand of development of fetus is minimal resulting in little glucose utilization. As the pregnancy advances the requirement of glucose increases hence in the present study from 5th fortnight onward up to 9th fortnight in both the groups the blood glucose level decreases. The decrease in glucose concentration can be attributed to its utilization by the growing fetus (Lindsay, 1973). Bergman (1983) observed that the fetal glucose metabolism account for 40% to 70% of fetal glucose metabolized by the whole body in sheep during late pregnancy, suggesting that pregnancy

imposes a greater demand upon the animal, then the blood glucose showed a decline similar to present observations. During early and mid pregnancy the demand of the fetus in minimum resulting in less utilization of glucose hence the levels during this period increased in the present study in both groups. The rate of glucose turnover increases during the late pregnancy. This increase in glucose production may be inadequate for growing fetus as well as the normal demand of the extrauterine tissue which lead to mobilization of lipid reservoir and increasing free fatty acids (Chaiyabutr et al., 1982). The overall mean blood glucose in twin and single bearing goats was not statistically significant and our observations are in agreement with Hussain et al. (1996) reported that glucose levels were not affected by number of fetuses. However, Prior and Christenson (1978) reported that glucose uptake and requirement increases with stage of gestation and multiple fetuses in ewes. The levels of blood glucose during prepartum period remained almost similar however on the day of kidding in both the groups the level decline. This decline may be due to the stress of kidding on this day, which result in decreased food intake by the goat. Mohy El-Deen et al. (1985) reported that plasma glucose levels was low during early pregnancy then decreased to lowest at 10 week of pregnancy followed by a sharp increased and then significant ($p<0.05$) decreased further before parturition and finding are also similar in crossbred goats. Mbassa and Poulsen (1991) reported lower glucose in pregnant.

The lower level of plasma NEFA concentration upto 4th fortnight may be due to less requirement of energy during early pregnancy, hence there may be deposition of fat during this period. After 4th fortnight onwards the glucose utilization by the developing fetus increased, the requirement was apparently met by the release of NEFA from the depot fat, hence the concentration increases. The present findings are in agreement with Faulkner (1983) that the deposition and mobilization of fat during pregnancy are biphasic processes. On the day of kidding in both the groups a sharp increase in NEFA concentration are coincided with sharp declines in glucose and insulin concentration (Khan, 1998). This type of adjustment was necessary to meet the energy demand of mammary gland for lactogenesis and increased milk secretion. Veron (1980) reported that the release of NEFA in to the blood plasma from the adipose tissue during late pregnancy was associated with decreased activity of acetyl Co-A carboxylase, glucose phosphatase and NADP malate dehydrogenase and also observed that the decrease in plasma insulin in sheep contributed to mobilization of fat at this time. During late pregnancy the high requirement of glucose for fetus lowered the glucose and insulin concentration, and body reserves were used up, so increasing the NEFA concentrations (Lindsay, 1974).

Thus during twin and single pregnancy the blood glucose concentrations increases and then decrease due to increased demands of growing fetus in late pregnancy. The decreased plasma NEFA concentrations during early pregnancy and increased during mid and late pregnancy and on the day of kidding may be due to supply the energy demand for the maintenance of twin and single pregnancy and initiation of lactation. The plasma NEFA concentration and blood glucose can be used as index of nutritional status during pregnancy and peripartureint period in crossbred goats.

ACKNOWLEDGEMENT

The authors are thankful to the Director, National Dairy Research Institute for providing the necessary facilities during the research work and Indian Council of Agricultural Research, New Delhi, for an award of a Senior Research fellowship for a Ph.D. program to the first author.

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