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Effect of High Energy Diet Supplementation during Periparturient Period on Ovarian Steroids and Reproductive Performance in Vrindavani Cows

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

The objective of the study was to assess the effect of high energy diet supplementation during periparturient period on ovarian steroids and reproductive performance in vrindavani cows. Postpartum vrindavani cows (n= 20) of second to fourth parity with lactation yield of > 10 L/day were divided in to two groups (n=10 cow/group). Group I (CON) cows were fed with basal diet to serve as control. Group II (TRT) cows were provided with 20% extra concentrates in the form of energy. 20% additional concentrate diet was supplemented from second week to eight week after calving. Blood samples were collected at weekly interval from 4 week before calving to8weeks after calving. Blood samples were collected to determine estradiol (E2) and progesterone (P4) in the serum using RIA. Postpartum reproductive performance was assessed in terms occurrence of first postpartum estrus, calving to conception interval, conception rate and number of service per conception. Serum estradiol and progesterone concentration increased significantly($P<0.05$) from 2 to 8 week postpartum in Group II as compared to Group I. Marked significant($P<0.05$)improvement in the postpartum reproductive performance in terms of early occurrence of first postpartum estrus(67.0Vs 53.0), reduced calving to conception interval(85.87 Vs74.4), service per conception (1.62 Vs 1.2), days from calving to first AI(88.5 Vs 65.73), higher first AI conception rate(40 Vs 80%) and cumulative conception rate(88.52 Vs 65.73%) in group II as compared to group I. In conclusion, additional high energy diet supplemented group showed significant increased ovarian steroid hormonal concentrations and marked improvement in the reproductive performance in Vrindavani cows.

Keywords: Ovarian steroids; high energy diet; reproductive performance; Vrindavani cows.

1. INTRODUCTION

The livestock sector plays a vital role in nutritional security, socio-economic development, and the national economy, and it has emerged as one of the key components of agricultural growth in developing countries, including India. Profitable dairy farming relies on two main objectives, to produce a calf every year and to get optimum milk production thereafter from each cow. “Lactating dairy cows undergo important changes in energy and mineral metabolism during the periparturient period” [1]. “These changes are a consequence of the increased nutritional demand associated with the later stage of foetal development, followed by the onset of milk production [2]. Furthermore, the gradual decrease in dry matter intake results in considerable mobilization of body reserves and deterioration of body condition [3]. The nutritional status of high-producing dairy cattle during the transition period has important implications for fertility performance and reproductive status in crossbred dairy cows” [4] [5]. Transition period is defined as the period, extending from the last 3 to 4 weeks to the first 3 to 4 weeks after calving [6] where transition from pregnancy to parturition and lactation occurs. During this period, there are drastic changes in the loss of appetite, negative energy balance, changes in reproductive endocrine changes, and a decrease in reproductive performance [7]. Energy intake is one of the most important nutritional factors deficiencies of which adversely affect the various reproductive processes, including the ovarian steroid hormone profiles in postpartum high-yielding dairy cows [8]. During the postpartum period in high-yielding dairy cows, because of increased metabolic demand, the requirement for oxygen levels gets increased, which acts as a source of reactive oxygen species [9], which negatively affects the various reproductive events [1], including the synthesis of ovarian steroids, because ovarian steroidogenic tissues are much more sensitive to free radical damage. Endocrine balances are essential to support normal cyclicity and the gradual restoration of fertility postpartum [10], so impaired fertility is associated with an alteration in reproductive steroids in dairy cows [11]. The energy status of dairy cows has a variable effect on the profile of ovarian steroids [12]. A profile of ovarian steroids helps to evaluate the reproductive status of a cow [5]. Hence, the present study was conducted to assess the effect of high-energy diet supplementation during the periparturient period on ovarian steroids and reproductive performance in high yielding Vrindavani cows.

2. MATERIALS AND METHODS

Twenty Vrindavani cows that appeared to be in good health after giving birth were used for the study. They were kept in the Livestock Production and Management Section of the Indian Veterinary Research Institute, Izatnagar, cattle and buffalo farm. These animals were kept in isomanagerial circumstances after being chosen based on their milk output (>10L/day) and parity (second to fourth). Ten animals were split into two groups: group I (control) and group II (treatment). Water, concentrate, and green forage were available to every cow at all times. Group II cows received a high energy diet in the form of 20% more concentrate, while Group I cows received only the basic feed without any supplements. This was supplemented from 2 to 8 week after calving on daily basis to individual animal. The concentrate mixture was fed in the range of 1-2.5 kg per cow based on the milk yield and the cost of concentrate mixture was ₹ 22.50 INR per kg. Blood samples from experimental animals were collected by jugular venipuncture aseptically using 18-G needle in sterilized vacutainers (heparinized or clot activators) at weekly interval from 4 week before calving to 8 weeks of calving. "Serum was separated by centrifugation at 800×g for 10 min and stored at -80°C until analysis. Progesterone and estradiol-17β concentrations in the serum were estimated by Radioimmunoassay (RIA) using standard diagnostic kits (Immunotech, France). All the cows were observed till day 150 postpartum to record the occurrence of first postpartum estrus, calving to conception interval, conception rate and number of service per conception. Data were first checked by Shapiro-Wilk test for adherence to a normal distribution. Time series or longitudinal data for estradiol and progesterone were analyzed using GLM two repeated measure ANOVA". [8] Data were presented as Mean ± SE. occurrence of first postpartum estrus, calving to conception interval, conception rate and Service per conception by independent't' test and pregnancy rate (%) was analyzed by Fisher's exactxact Chi-square test was set at 95%. GLM was done with SPSS software (IBM® SPSS® statistics, version 20.0) while Chi-square test was done with Graph Pad prism version 6.

3. RESULTS AND DISCUSSION

3.1 Serum Estradiol

The serum estradiol concentration does not differ significantly from the 4th week before calving to the 1st week before calving, the day of calving, and the 1st week after calving, but overall, the estradiol concentration showed an increasing trend for the 1st week before and on the day of calving in all the experimental animals. From week 2nd to 8th week postpartum, group II had a significantly higher concentration of serum estradiol as compared to group I (Fig 1), which could be due to follicular activity during the early postpartum period. The trend of serum estradiol in both groups is consistent with the report of Balamurugan et al [8], who reported "increased serum estradiol from 4 weeks before calving and peak at calving to 8 weeks post-calving following supplementation of a high-energy diet with additional supplementation of Cu, Zn, Se, and vitamin E". A further similar finding was also reported by Balamurugan et al [12], supplemented with Cu and Zn along with an additional energy diet in cows. Smith et al. [13] reported that "estradiol levels increased linearly from one month before calving and showed peak concentration on the day of calving, thereafter decreased at one day postpartum, and remained at basal level until the first postpartum estrus". Corah et al. (1974) reported "a non-significant effect of energy level on plasma oestrogen at the transition period in cows". A similar result was obtained by [5] supplemented Vit. E and Se along with a high-energy diet in crossbred cows.

3.2 Serum Progesterone

Serum progesterone was significantly ($P<0.05$) differ during the first week of postpartum to 8 weeks of postpartum in group II as compared to group I. During the antepartum period, the level of serum progesterone does not differ significantly ($P > 0.05$) in all the experimental animals (Fig. 2). The pattern of serum progesterone in both groups concurred with the reports of Balamurugan et al. [8] and Balamurugan et al. [3] "the progesterone concentration showed non-significant difference in the antepartum period and a significantly ($P<0.05$) high concentration during the first six weeks of the postpartum in High Energy Diet with Additional Supplementation of Copper, Zinc, Selenium, and Vit. E in crossbred cows". Smith et al. [13] reported "a steady decrease in progesterone till day 2 antepartum with a sharp decline on the day of calving (0.6 ng/mL) and basal level during the early postpartum period in the cow", however, Khatti et al. [5] observed "no marked effect of a high-energy diet

supplemented with Vitamin E and Se on serum progesterone concentration during the periparturient period. The effect of high energy status on reproductive steroids showed inconsistent findings in previous studies, and it might be because of multifactorial influences such as body condition, inheritance, nutrition, and endocrine factors".

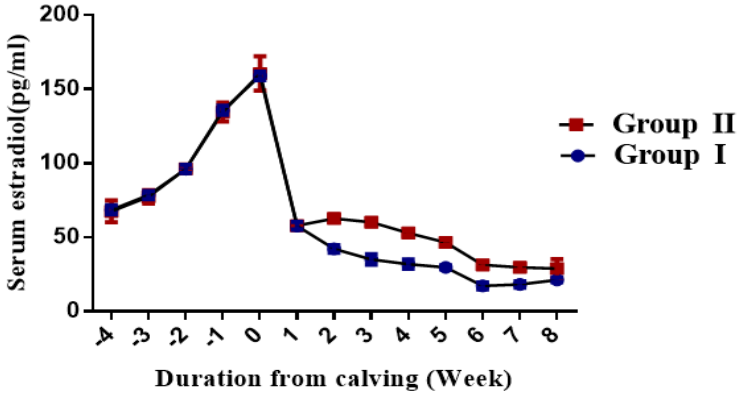

Fig.1. Effect of additional supplementation of high energy diet on serum estradiol concentration

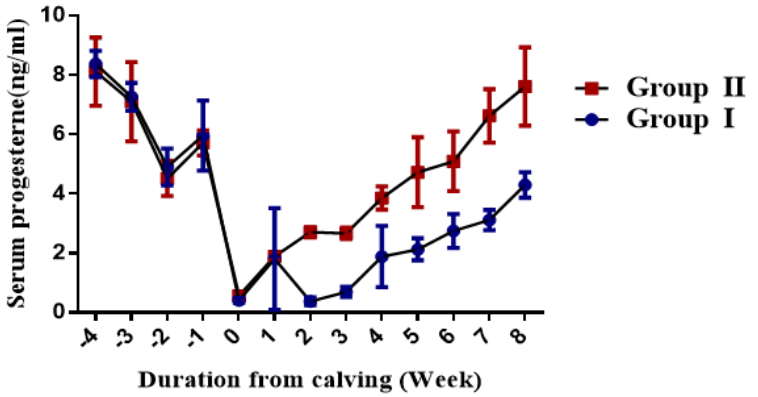

Fig. 2. Effect of additional supplementation of high energy diet on serum progesterone concentration

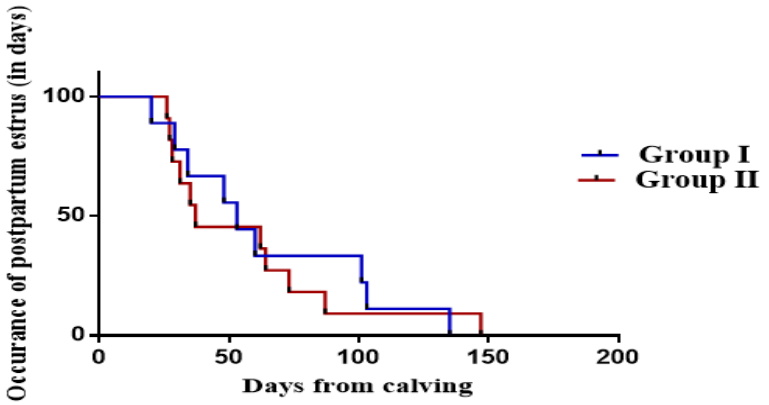

Fig. 3. Kaplan-Meier survival analysis showing the occurrence of first postpartum oestrus (%) over a period of 150 days from calving in the vrindavani cow

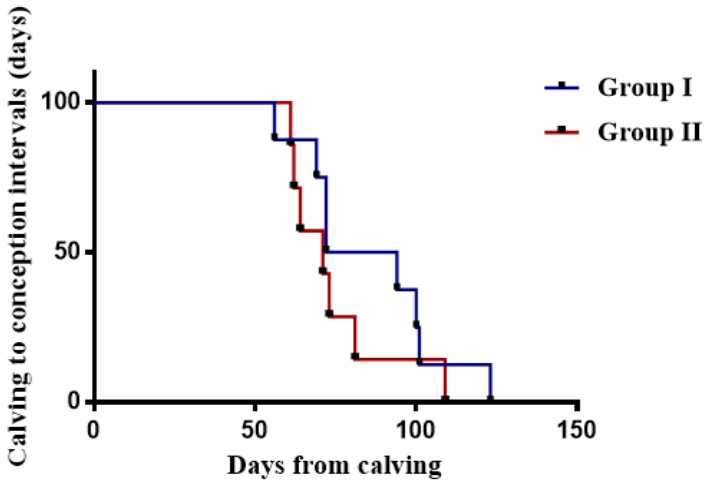

Fig. 4. Calving to conception intervals in experimental animals in days

Table 1. Effect of additional supplementation of high energy diet on the postpartum reproductive variables in the Vrindavani cows

Reproductive variable	Group I	Group II
Occurrence of first postpartum estrus (days)	67.0±10.83[b]	53.0±9.12[a]
Calving to conception interval (days)	85.87±12.01[b]	74.4±10.34[a]
Service per conception	1.62±1.21[b]	1.2±0.03[a]
Overall Conception rate (%)	61.53±8.43[a]	79.7±6.45[b]
First AI Conception rate (%)	40±1.12[a]	80±5.43[b]
Days calving to first AI (days)	88.52±6.53[b]	65.73±4.21[a]

(The mean bearing different superscripts (a and b) a row differs significantly P< 0.05)

3.3 Reproductive Performance

Postpartum reproductive performance data for both groups is depicted in Table 1. The occurrence of postpartum estrus was noticed significantly (P<0.05) earlier as compared to control animals (53.0 days vs. 67.0 days). From the K-M survival curve, it is apparent that 48.25% cows in the treatment group resumed the estrus by 35 days as compared the control group. similarly, the calving to conception interval in group I cows was significantly (P<0.05) shorter than that of the control (74.4 days vs. 85.87 days). The conception rate was 77.7% in treated animals as compared to 61.53% in control, which also differed significantly (P<0.05). Accordingly, service per conception was also significantly (P<0.05) low in group I animals. Days from calving to first AI recorded in group II are fewer than those in group I, along with a higher first AI conception rate (Table 1). It is evident from the results that high-energy diet-supplemented cows significantly improved postpartum reproductive performance in the treated group as compared to the control group. High-yielding dairy cows had a negative energy balance that affected their postpartum reproductive performance by predisposing them to anestrus [14] and reproductive failure [15]. “Energy limitation decreases the LH pulse frequency; as a consequence, the dominant follicle fails to ovulate” [15]. “Increasing the glucogenic nutrient availability improves the energy balance, resulting in better reproductive performance in dairy cows” [16]. “Supplementation of a high-energy diet along with Se, Cu, Zn, and Vit. E during the periparturient period improved the reproductive performance of high-yielding crossbred dairy cows” [5] [12]. In the present study, a significant improvement in postpartum reproductive performance could be attributed predominantly to the supplementation of an additional high-energy diet in the diet of Vrindavani cows, which has implications for optimal transition cow management practices.

4. CONCLUSION

It can be concluded that supplementation with an additional high-energy diet during the periparturient period increased the ovarian steroid hormonal concentrations and improved reproductive performance in Vrindavani cows.

ETHICAL APPROVAL

The experiment was approved by the Institute Animal Ethics Committee.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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