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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 559-562

www.thepharmajournal.com
Received: 02-03-2023
Accepted: 06-04-2023

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Estimation of serum calcium, phosphorus and triglycerides in postpartum Bidri goats supplemented with maize alone or with safflower oil and estrus synchronised using CIDR based protocol

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Abstract
This study was undertaken to evaluate the effect of supplementation of maize and safflower oil combined with CIDR estrus synchronization protocol on some biochemical parameters during major and minor breeding seasons. Seventy-five postpartum Bidri goats were selected from the day of kidding and divided into 5 groups (n=15). i. control, ii. maize, iii. maize and CIDR, iv. maize and safflower oil and v. maize, safflower oil and CIDR. The blood samples were collected on 0 (on the day of parturition), 15, 22, 30, estrus day and 30 days post mating. Samples were analysed for serum parameters *viz*., calcium, phosphorus and triglycerides. The serum calcium, phosphorus and triglycerides concentrations have an increasing trend following parturition and reaching high values on d-30 post mating. The supplementation of only maize or along with safflower oil with or without estrus induction using CIDR did not had any impact.

Keywords: Bidri goats, biochemical parameters, CIDR, estrus synchronization, postpartum period

1. Introduction
In a world where our future is increasingly dominated by adaptation to climate change, goat farming is emerging as a truly important husbandry, not only for maintaining production levels, but also due to its relatively minor impact on climate as goats emit less methane than other livestock (Darcan and Silanikove, 2018) [5]. There are about one billion goats worldwide, and the global goat population has more than doubled during the last four decades. Among the numerous breeds, Bidri goat is mostly reared in the Bidar and Kalaburagi districts of Northern Karnataka region of South India. It is one of the best dual-purpose breed with better milk yield and twinning ability making it as a breed of choice among the farmers. Reproduction is an important phenomenon that determines the income of the livestock farmers and is affected by various factors. Earlier studies have suggested that postpartum constituents of blood are important indicators of biochemical and physiological changes taking place during this critical period (Manat *et al*., 2016) [9]. The biochemical changes are related to the stress condition in animals and are related to the productivity and management practice of the animals (Manat *et al*., 2016; Soares *et al*., 2018; Zamunar *et al*., 2020) [9, 10, 13].
Estrus synchronization is among the most important reproductive management strategy to augment fertility (Stevenson and Britt, 2017) [11]. The controlled internal drug release (CIDR) devices containing 0.3 gm of progesterone are currently the preferred method of progesterone administration in goats (Wheaton *et al.*, 1993) [12]. The Bidri goats are reared mostly under traditional method and their commercialization is the need of the time. The reproductive performance and estrus synchronisation studies on this breed are scanty. The present study therefore aimed to evaluate biochemical parameters *viz*., serum calcium, phosphorus and triglycerides in postpartum does to improve fertility by energy supplementation and estrus synchronization.

2. Material and Method
2.1 Ethical approval
The study was conducted duly following approved guidelines from the Institutional Animal Ethics Committee (IAEC).

2.2 Location of the study
The study was conducted in and around Bidar city and lies between 17º35' and 18º29' North latitude and 76º41' to 77º39' East longitude. The coldest months are December and January, the temperature begins to rise towards the end of February till May which is the hottest month of the year. The temperature varies in between 20 ºC and 42 ºC. The year may be divided into summer season from March to May, southwest monsoon season from June to September, post-monsoon season from October to November and winter season from December to February (CGWB, 2008). The complete study was carried out from October 2021 to November 2022. The phase one of the study was conducted between October 2021 to April 2022 and phase two was between May-2022 to November-2022.

2.3 Selection of animals
The experimental animals were selected from the flocks of Bidri goats maintained by local farmers (private farms), in and around Bidar district. For the study, seventy-five healthy, post-partum Bidri goats between 1-4 parity were selected and randomly divided into 5 groups of 15 goats each. The goats were reared under a semi-intensive housing system with free grazing for 4-6 hrs daily with *ad libitum* drinking water and routine deworming and vaccinations on regular basis.

2.4 Estrus synchronization protocols
The following treatment protocols were repeated for two sequential kidding`s on the same goats.

2.4.1 Group 1 (T_0) - Control
This group was considered as control, the goats in this group were not provided with any additional feed other than grazing.

2.4.2 Group 2 (T_1) – Maize Feeding
Each animal in this group along with grazing, additionally fed with 250 g of maize grains daily (morning) for 30 days from the day of parturition.

2.4.3 Group 3 (T_2) – Maize + CIDR
Each animal in this group along with grazing, additionally fed with 250 g of maize grains daily (morning) for 30 days from the day of parturition. On 16th day postpartum, Controlled Internal Drug Release (CIDR= 0.3gm of progesterone) devices were inserted into the vagina aseptically with the help of an applicator and left in-situ for 14 days. Then, implants were withdrawn and an intramuscular injection of a synthetic prostaglandin, PGF2α (Cloprostenol Sodium) @ 125 µg/doe was administered.

2.4.4 Group 4 (T3) – Maize + Safflower Oil Feeding
Each animal in this group were fed 250 g of maize grains daily (morning) along with 50 g of Safflower oil for 30 days from the day of parturition.

2.4.5 Group 5 (T_4) – Maize + Safflower Oil Feeding + CIDR
Each animal in this group were fed 250 g of maize grains daily (morning) along with 50 g of Safflower oil for 30 days from the day of parturition. On the 16th day Controlled Internal Drug Release (CIDR= 0.3gm of progesterone) devices were inserted into the vagina aseptically with the help of an applicator and left inside the vagina for 14 days. Then, implants were withdrawn and an intramuscular injection of a synthetic prostaglandin, PGF2α (Cloprostenol Sodium) @ 125 µg/doe was given.

2.5. Estrus detection and Mating
The does were observed for estrus signs twice daily at 12-hour interval. The does in estrus were allowed to mate with bucks for naturally.

2.6 Blood Collection
Blood samples, collected by jugular vein puncture in the morning hour before feeding, from all the groups on day 0 (day of kidding), 15, 22, 30, on the day of estrus and 30 days post mating. The serum samples were harvested by centrifugation at 3000 rpm for 10 minutes and samples were made into two aliquot and stored at -20˚C until analysis.

2.7 Serum biochemical analysis
Serum biochemical analysis for calcium (mg/dL), phosphorus (mg/dL) and triglycerides (mg/dL) were performed as per assay procedures mentioned in the kits of Transasia Bio-Medicals Ltd. duly following the procedures as directed by the supplier with semi-automatic biochemical analyser (Microlab-300, Elite Tech Ltd.).

2.8 Statistical Analysis
The data obtained was analysed and compared using SAS 9.3 software.

3. Results and Discussion
The mean±SE values of serum biochemical parameters for different groups at different reproductive stages in Bidri goats are presented in Tables 1 to 6.

3.1 Serum Calcium
In the first kidding (Phase-I), the serum calcium showed varying levels and was significantly high on all postpartum collection days and 30 days post-mating compared to parturition day in all the groups, but not in the second kidding.
The serum calcium (mg/dL) were in range of 6-11 mg/dL for phase 1 and 6-13 mg/dL in phase 2. These values were nearer to Cenk and Mahmut (2020) [4] who recorded 7.77±1.89 mg/dL of serum calcium in female hair goats and were within the range of 8.9 to 11.7 mg/dL. The total calcium behavior throughout the study period was higher than results of Azab and Abdel-Maksoud (1999) [1] and Iriadam (2007) [8]. According to these authors, total calcium decreases in late pregnancy and reaches its lowest values at delivery, remaining low during the first 3 weeks after parturition. This can be attributed to the high demand for calcium by the developing fetal skeleton and early milk production.

3.2 Serum Phosphorus
In both the sequential kidding's (phase I & phase II), the serum phosphorus did not vary significantly ($p>0.05$) either between the groups or between the days except for between the days in phase I on 30 days post mating for group T_1 and T_4.
The serum phosphorus (mg/dL) values were in the range of 4-6 mg/dL in phase 1 and 8-10 mg/dL in phase 2. Though there were elevated levels of phosphorus in phase 2, they are within the normal reference range. The findings of present study

were similar to reports of Devi *et al.* (2005) [6] and Cenk and Mahmut (2020) [4] who recorded 4.71±0.70 mg/dl and 4.63±1.52 mg/dL of serum phosphorus in adult female Kagani goat of Jammu region and female hair goats respectively. The phosphorus results agree with those obtained by Azab and Abdel-Maksoud (1999) [1], who found no difference in serum concentrations of this mineral in goats during the transitional period. The uniformity of the values for this mineral in the bloodstream suggests an adequate supply of this element in the diet and an especially efficient phosphorus metabolism (Iriadam, 2007) [8].

3.3 Serum Triglycerides

In the first kidding (phase I), the triglycerides levels followed non-significant increasing trend but not in second kidding (phase II) where they showed significant increase in triglycerides values on d-15, d-22, d-30 and estrus day in treatment group T_3 and T_4.

The serum triglycerides (mg/dL) were in the range of 10 to 25 mg/dL in both the phases. The values were closer to reports made by Cajueiro *et al.* (2021) [2] for serum triglycerides (mg/dL) concentration in dairy goats during transitional period as 12.13, 10.45, 10.94, 15.21, 16.47, 16.18 and 15.10 during parturition day, 10, 20, 30, 40, 50 and 60 days after parturition, respectively and Cenk and Mahmut (2020) [4] who reported 27.08±14.21 mg/dL of triglycerides in female hair goats.

The significantly higher triglyceride values in the prepartum period relative to parturition and postpartum are due to intense body fat mobilization. Because the liver is unable to partially (forming ketone bodies) or fully oxidize all NEFA, this product mobilizes, resulting in the transformation of excess NEFA into triglycerides. The lower concentration of this element in the postpartum period may be related to an increase in insulin and better hormone response by the target tissues, which increases the triglyceride uptake by circulating cells (Caldeira & Portugal, 1991; Grummer, 1995) [3, 7].

Table 1: Mean±SE values of serum calcium (mg/dL) in different groups at different intervals (Phase 1)

Groups \ Days	0th Day	15th Day	22nd Day	30th Day	Estrus Day	P.D. Day
Control (T_0)	6.50^{aA}±0.58	10.51^{bA}±0.78	9.72^{bA}±0.72	10.02^{bA}±0.57	8.79^{abA}±0.63	10.82^{bA}±0.69
Maize (T_1)	6.74^{aA}±0.63	10.28^{bA}±0.53	9.08^{abA}±0.28	9.61^{abA}±0.39	10.22^{bA}±0.91	10.98^{bA}±0.57
Maize+CIDR (T_2)	7.95^{aA}±0.92	10.04^{aA}±0.73	8.73^{aA}±0.51	9.82^{aA}±0.33	9.03^{aA}±0.65	10.64^{aA}±0.50
Maize+SFO (T_3)	7.08^{aA}±0.41	10.49^{bA}±0.56	8.86^{abA}±0.31	9.37^{abA}±0.53	8.52^{abA}±0.48	10.97^{bA}±0.53
Maize+SFO+CIDR (T_4)	7.03^{aA}±0.51	10.62^{bA}±0.43	9.17^{abA}±0.57	9.53^{abA}±0.63	9.35^{abA}±0.76	10.52^{bA}±0.67

Table 2: Mean±SE values of serum calcium (mg/dL) in different groups at different intervals (Phase 2)

Groups \ Days	0th Day	15th Day	22nd Day	30th Day	Estrus Day	P.D. Day
Control (T_0)	13.13^{aA}±0.43	11.87^{aA}±0.35	7.93^{bA}±0.50	10.74^{abA}±0.45	7.82^{bcA}±0.54	10.86^{abA}±0.74
Maize (T_1)	13.17^{aA}±0.56	12.00^{adA}±0.77	7.41^{bA}±0.47	11.03^{acA}±0.61	8.60^{bcA}±0.50	9.92^{bcdA}±0.62
Maize+CIDR (T_2)	12.82^{aA}±0.56	10.82^{aeA}±0.60	6.67^{bcA}±0.34	11.28^{afA}±0.63	7.96^{ceA}±0.62	9.00^{cdefA}±0.43
Maize+SFO (T_3)	12.69^{aA}±0.64	9.75^{abA}±0.69	6.97^{bA}±0.68	10.47^{acA}±0.34	7.81^{bcA}±0.74	9.81^{abA}±0.91
Maize+SFO+CIDR (T_4)	13.48^{aA}±0.42	10.86^{abA}±0.56	8.06^{bA}±0.69	10.76^{abA}±0.59	9.67^{bcA}±0.83	10.60^{abA}±0.71

Means with different superscripts differ significantly at P<0.05

^{abcdefg} Superscripts indicate the statistical difference in serum glucose values on different time interval within groups.

^{ABC} Superscripts indicate the statistical difference in serum glucose values between groups on different time interval

Table 3: Mean±SE values of serum phosphorus (mg/dL) in different groups at different intervals (Phase 1)

Groups \ Days	0th Day	15th Day	22nd Day	30th Day	Estrus Day	P.D. Day
Control (T_0)	4.13^{aA}±0.55	4.50^{aA}±0.49	4.13^{aA}±0.35	4.20^{aA}±0.51	4.00^{aA}±0.36	5.26^{aA}±0.54
Maize (T_1)	4.19^{abA}±0.45	4.08^{aA}±0.43	4.09^{acA}±0.32	4.49^{abA}±0.56	4.02^{adA}±0.29	6.67^{bA}±0.71
Maize+CIDR (T_2)	4.14^{aA}±0.35	4.68^{aA}±0.34	4.60^{aA}±0.59	4.14^{aA}±0.33	4.38^{aA}±0.49	4.84^{aA}±0.30
Maize+SFO (T_3)	4.17^{abA}±0.53	4.20^{abA}±0.34	4.18^{abA}±0.59	4.05^{aA}±0.66	4.60^{abA}±0.66	6.63^{bA}±0.58
Maize+SFO+CIDR (T_4)	4.04^{aA}±0.34	4.49^{aA}±0.43	4.14^{aA}±0.41	4.16^{aA}±0.55	4.26^{aA}±0.42	6.23^{aA}±0.43

Table 4: Mean±SE values of serum phosphorus (mg/dL) in different groups at different intervals (Phase 2)

Groups \ Days	0th Day	15th Day	22nd Day	30th Day	Estrus Day	P.D. Day
Control (T_0)	8.60^{aA}±0.51	10.29^{aA}±0.79	8.73^{aA}±0.58	9.22^{aA}±0.67	8.68^{aA}±0.33	10.07^{aA}±0.58
Maize (T_1)	8.08^{aA}±0.50	10.65^{aA}±1.10	9.41^{aA}±0.49	9.01^{aA}±0.64	8.38^{aA}±0.42	10.17^{aA}±0.42
Maize+CIDR (T_2)	8.25^{aA}±0.36	9.90^{aA}±0.52	8.81^{aA}±0.45	8.46^{aA}±0.54	9.10^{aA}±0.51	10.30^{aA}±0.42
Maize+SFO (T_3)	8.15^{aA}±0.46	9.33^{aA}±0.69	8.45^{aA}±0.46	8.23^{aA}±0.54	8.83^{aA}±0.41	10.48^{aA}±0.51
Maize+SFO+CIDR (T_4)	8.80^{aA}±0.55	9.58^{aA}±0.69	9.63^{aA}±0.43	8.84^{aA}±0.44	8.28^{aA}±0.32	10.13^{aA}±0.43

Means with different superscripts differ significantly at P<0.05

^{abcdefg} Superscripts indicate the statistical difference in serum cholesterol values on different time interval within groups.

^{ABC} Superscripts indicate the statistical difference in serum cholesterol values between groups on different time interval

Table 5: Mean±SE values of serum triglycerides (mg/dL) in different groups at different intervals (Phase 1).

Groups \ Days	0th Day	15th Day	22nd Day	30th Day	Estrus Day	P.D. Day
Control (T_0)	9.75 ^{aA}±1.19	12.35 ^{aA}±1.21	15.87 ^{aA}±0.97	17.67 ^{aA}±1.07	15.35 ^{aA}±1.13	16.56 ^{aA}±0.77
Maize (T_1)	10.04 ^{aA}±0.99	12.92 ^{aA}±1.23	14.91 ^{aA}±1.48	17.29 ^{aA}±1.21	16.19 ^{aA}±1.08	18.15 ^{aA}±1.10
Maize+CIDR (T_2)	9.49 ^{aA}±1.02	14.77 ^{aA}±1.17	15.36 ^{aA}±1.19	17.40 ^{aA}±1.40	16.39 ^{aA}±1.17	16.98 ^{aA}±0.98
Maize+SFO (T_3)	9.11 ^{aA}±1.00	14.19 ^{abA}±1.02	21.71 ^{bA}±7.09	17.78 ^{abA}±1.06	15.42 ^{abA}±0.99	16.81 ^{abA}±1.03
Maize+SFO+CIDR (T_4)	11.03 ^{aA}±1.25	14.80 ^{aA}±0.97	14.99 ^{aA}±1.25	17.46 ^{aA}±1.62	14.90 ^{aA}±1.40	16.38 ^{aA}±1.14

Table 6: Mean±SE values of serum triglycerides (mg/dL) in different groups at different intervals (Phase 2).

Groups \ Days	0th Day	15th Day	22nd Day	30th Day	Estrus Day	P.D. Day
Control (T_0)	12.58 ^{aA}±0.91	12.26 ^{aA}±0.88	15.93 ^{aA}±1.28	16.02 ^{aA}±1.13	17.13 ^{aA}±1.70	16.53 ^{aA}±0.95
Maize (T_1)	12.03 ^{aA}±0.67	13.07 ^{aA}±0.94	15.69 ^{aA}±1.64	16.87 ^{aA}±0.92	18.40 ^{aAB}±2.13	17.00 ^{aA}±0.69
Maize+CIDR (T_2)	12.22 ^{aA}±0.62	16.67 ^{abA}±1.50	17.37 ^{abAB}±0.74	19.18 ^{abA}±0.99	20.27 ^{bcAB}±1.52	16.23 ^{acA}±0.86
Maize+SFO (T_3)	11.33 ^{aA}±0.90	24.62 ^{bcdeB}±2.97	23.79 ^{cdefB}±1.45	20.32 ^{defA}±0.81	24.15 ^{efB}±2.33	16.94 ^{afA}±1.55
Maize+SFO+CIDR (T_4)	11.42 ^{aA}±0.67	25.65 ^{bcdeB}±1.72	21.11 ^{cdefB}±1.19	22.34 ^{defA}±1.33	24.82 ^{eB}±2.14	17.24 ^{afA}±1.69

Means with different superscripts differ significantly at P<0.05

^{abcdefg} Superscripts indicate the statistical difference in serum total protein values on different time interval within groups.

^{ABC} Superscripts indicate the statistical difference in serum total protein between groups on different time interval

4. Conclusion

In conclusion, the serum calcium, phosphorus and triglycerides concentrations have an increasing trend following parturition and reaching high values on d-30 post mating. The supplementation of only maize or along with safflower oil with or without estrus induction using CIDR did not had any impact.

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