

RESEARCH ARTICLE

Effect of Rumen Mega Mineral Bolus Insertion at Calving on Blood Biochemical and Minerals Profile and Postpartum Fertility in Kankrej Cows

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ABSTRACT

A study was conducted on 12 pluriparous parturient Kankrej cows of the University Farm, in Anand, randomly divided into two equal groups (n = 6 each). Group-I cows were administered on the day of calving with a sustained release 80 g mega mineral rumen bolus (Prepavel[®] 1 bolus/animal, Neolait, France) intra-ruminal through a specially designed applicator, while group-II animals served as untreated control. The animals were monitored periodically from the day of calving till 140 days postpartum along with other herd mates. Blood samples were obtained at 10 days interval in heparinized vacutainers for plasma progesterone, biochemical, and macro-micro mineral profiling. Among the six Kankrej cows of group-I, only one animal exhibited prominent estrus signs on day 96 postpartum and conceived at first service (AI) giving CR of 16.66%, while in group-II three cows exhibited estrus between day 73 and 86 postpartum, and conceived with one or two AI giving CR of 50% by 150 days postpartum. In both the groups, all other cows remained subestrus for more than 150 days postpartum and conceived very late, though mostly with single service at spontaneous estrus. The mean values of plasma progesterone (0.74 ± 0.32 to 5.57 ± 0.78 ng/mL), total cholesterol (103.88 ± 3.20 to 237.17 ± 24.66 mg/dL) and triglycerides (17.07 ± 1.16 to 28.29 ± 1.75 mg/dL) differed significantly ($p < 0.01$) between postpartum intervals in both the groups, but not between groups at any of the intervals. The values of plasma total protein, calcium, inorganic phosphorus, and magnesium as well as trace elements, viz., zinc, iron, copper, cobalt, and manganese, however varied insignificantly and inconsistently between intervals and also between groups from day 0 to day 140 postpartum. Thus, the insertion of Mega mineral ruminal bolus on the day of calving did not influence the plasma profile of biochemical/ metabolic constituents and macro-micro minerals profile in lactating postpartum Kankrej cows and was not beneficial in improving postpartum fertility. However, further study on a larger sample size is required to draw a valid conclusion.

Keywords: Blood profile, Intra ruminal placement at calving, Kankrej cow, Mega mineral bolus, Postpartum fertility.

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INTRODUCTION

Mineral supplementation is an important factor influencing reproduction in ruminants (Underwood and Suttle, 1999). Mineral deficiencies in the diet or in the uptake may indirectly decline ovulation rate, by its primary influence on basic health status (Upadhyay *et al.*, 2006; Sprinkle *et al.*, 2006). Adequate trace mineral intake and absorption are needed for growth physiology and reproduction. In ruminants, maternal copper deficiency may cause infertility, delayed or suppressed estrus, and decreased conception rate (Underwood and Suttle, 1999). Manganese deficiency increases infertility, abortion, silent estrus, and anestrus in cattle. Selenium deficiency leads to silent estrus, early embryonic death, stillbirth or weak offspring, and abortions (Upadhyay *et al.*, 2006). Cobalt/vitamin B₁₂ status during pregnancy has also been shown to affect the calf viability at birth (Mitchell *et al.*, 2007).

A long-acting reticulorumen trace mineral bolus 'Cosecure' (Telsol Ltd., Leeds, UK) and 'Ferrobloc' (Laprovat, Town, France) containing Ca, Mg, Na, Cu, Mn, I, Fe, Co, Zn, and Se has been developed and has shown promise for helping alleviate trace mineral deficiencies (Hidiroglou *et al.*, 1987;

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Abdollahi *et al.*, 2014; Abdollahi *et al.*, 2015). A long-acting means of trace mineral delivery could be advantageous for production and reproduction in extensively managed systems. Nevertheless, no experiments have been performed

on Kankrej, a zebu cattle, to investigate the effect of multi-mineral rumen bolus on the postpartum fertility and its plasma profile. Hence, this study was designed to investigate the effect of mega mineral rumen bolus (Prepavel[®], Neolait, France) insertion at calving on blood biochemical and minerals profile and postpartum fertility in Kankrej cows.

MATERIALS AND METHODS

The study was conducted on 12 pluriparous parturient Kankrej cows of the University Farm, in Anand after approval of the Institutional Animal Ethics Committee. The animals were randomly divided into two equal groups. In group I six pluriparous cows were administered on the day of calving with a sustained release 80 g rumen mega mineral bolus (Prepavel[®] 1 bolus per animal, Neolait, France; bolus size 85 × 25 mm) intraruminal through the oral cavity with a specially designed applicator, while group-II (n=6) animals served as untreated control. The animals were monitored from the day of calving till 140 days postpartum along with other herd mates. All the animals were maintained identically under loose housing system and received green fodder (20 kg/day), hay (5–6 kg/day), compounded concentrate mixture (40% of milk) mixed with mineral mixture (50 g/day - Amul brand), and had free access to pure wholesome drinking water. Hand milking and suckling by the young ones was followed till dry off of cows. The reproductive/ovarian status of the cows was assessed by palpation per rectum of the genitalia periodically. The animals were inseminated only after 60 days of calving, if found in estrus with good quality frozen-thawed bull semen upon detected estrus. The occurrence of the first estrus postpartum and service period for each animal were recorded.

Jugular blood samples were collected from all animals at an interval of 10 days from the day of calving till day 140 postpartum. The samples were immediately centrifuged at 3000 rpm for 15 minutes, and the plasma samples were stored at –20°C by adding a drop of 0.01% sodium merthiolate until analyzed. Plasma progesterone was determined by Radio-Immuno-Assay technique of Kubasic *et al.* (1984) using kits procured from Immunotech-SA, France. Plasma total protein, total cholesterol, triglycerides, and macro-minerals (Ca, P, Mg)

were determined as per standard procedures using kits procured from Crest Biosystems, Goa, on Chemistry Analyzer (Mindray, BS 120). The trace elements, *viz.*, iron, zinc, copper, cobalt, and manganese were determined on wet digested plasma samples on an Atomic Absorption Spectrophotometer (Model-3110, Perkin Elmer) (Oser, 1979). The data was analysed statistically using CRD and DMRT, and paired 't' test to see the differences between periods and between groups at significance level of $p < 0.05$ (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Effect of Mineral Bolus on Reproductive Performance

The effects of rumen mega mineral bolus insertion intraruminal at calving on various reproductive traits in Kankrej cows are shown in Table 1. Among the six cows of group-I (mega mineral bolus), only one cow (An-33) exhibited estrus signs on day 96 postpartum and conceived at first service (AI) giving conception rate of 16.6%. In group-II (control), however, three cows exhibited estrus between day 73 and 86, and conceived with one or two AIs, giving CR of 50.0%. All other cows in both the groups remained subestrus till more than 140 days postpartum and conceived very late between 150–180 days postpartum at spontaneous estrus mostly with one AI only. The estrus signs as and when expressed were prominent in all the cows. There was no statistical difference between the two groups in any of the reproductive parameters studied. However, in a recent study on Iranian Afshari ewes during the breeding season, the sustained release multi-trace element ruminal bolus administration showed superiority on reproductive performance in terms of lambing rate (150%) and litter size (150%) (Abdollahi *et al.*, 2015). Srivastava, (2008), supplemented 30–40 g commercial mineral mixture in concentrate for 20 days, which induced ovulatory estrus in 93.33% (28/30) of anestrus crossbred heifers with first AI conception rate of 32.14%. Joshi *et al.*, 2020, recorded significant ($p < 0.05$) improvement in conception rates after supplementation of chelated mineral mixture @ 50/d/h for 60 days in lactating anoestrus buffaloes as compared to control group.

Table 1. Postpartum reproductive performance of Kankrej cows with and without rumen mega mineral bolus insertion at calving (mean ± SE)

Reproductive traits	Group-I (n = 6) Mega min bolus	Group-II (n = 6) Normal control
Uterine involution (days)	37.50 ± 1.53	36.66 ± 1.73
FOPP by plasma P4 (days)	51.66 ± 4.00	53.33 ± 4.83
FOPP clinically (days)	96.00 ± 0.00 (1)	78.50 ± 3.24 (3)
Service period (days)	96.00 ± 0.00 (1)	97.33 ± 4.17 (3)
No. of AI/conception	1.00 ± 0.00	1.33 ± 0.75
First service conception rate (%)	16.66 (1/6)	33.33 (2/6)
Overall CR by 150 days PP	16.66 (1/6)	50.00 (3/6)

FOPP - first oestrus postpartum; PP – postpartum.



Effect of Mineral Bolus on Plasma Profile

The findings on plasma progesterone, biochemical/metabolic, and macro-micro minerals profile of Kankrej cows treated with rumen mega mineral bolus at calving and of control group are presented in Tables 2 and 3, and Figs. 1–3.

The mean values of plasma progesterone concentrations varied significantly between different intervals postpartum in both the groups from day 0 (day of calving/ bolus insertion) till day 140 postpartum, however, there was no significant difference between groups at any of the intervals (Table 2). The progesterone profile of individual animals in each group presented in Figs. 1 and 2 reveal that most of the animals were cyclic with silent ovulation at varying postpartum intervals from day 30-40 onwards, but the behavioral signs were not expressed as long as they were suckled by the calves. Similar were the observations of Patel and Dhama (2005a) on ovarian status in weaned postpartum HF cows.

Among the biochemical constituents, the mean values of total cholesterol (103.88 ± 3.20 to 237.17 ± 24.66 mg/dL) and triglycerides (17.07 ± 1.16 to 28.29 ± 1.75 mg/dL) varied significantly between postpartum intervals in both the groups, but not between groups at any of the intervals. There was no influence of the postpartum period or rumen bolus on the plasma total protein profile (Table 2). Comparable findings on plasma cholesterol and triglycerides were also reported by Patel and Dhama (2005^b) in routinely managed parturient HF cows. Further, the mean values of calcium, inorganic phosphorus, magnesium and all trace elements, viz, zinc, iron, copper, cobalt and manganese varied insignificantly and inconsistently between different intervals as well as between two groups from day 0 to day 140 postpartum (Fig. 3 and Table 3), suggesting that there was no any beneficial effect of sustained release rumen mega mineral bolus inserted intraruminally on the day of calving. Patel and Dhama (2005b) noted comparable

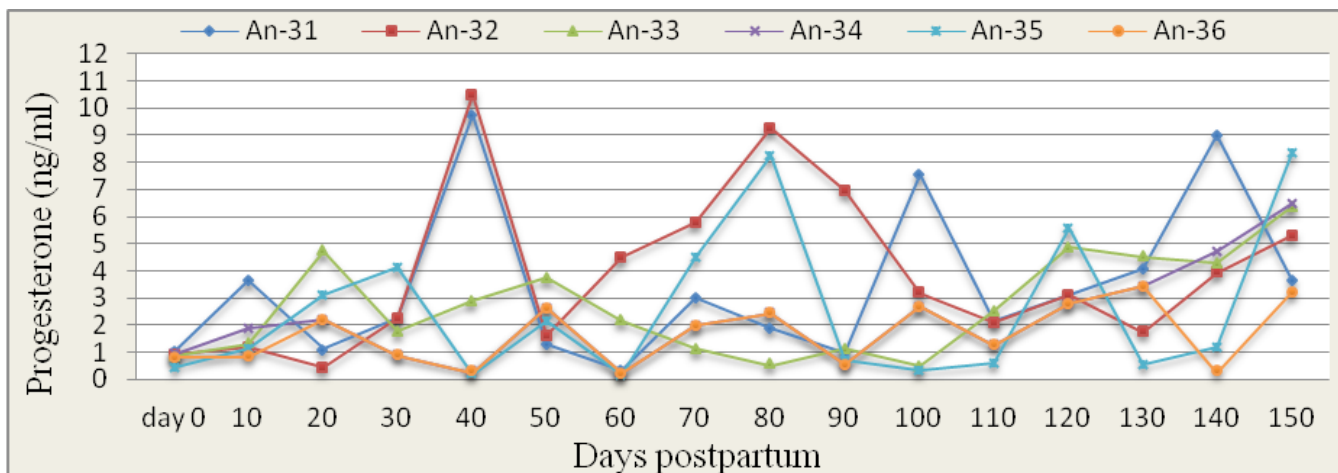


Fig. 1: Plasma progesterone (ng/mL) profile of individual cows of rumen mega mineral bolus group during 0 to 150 days postpartum

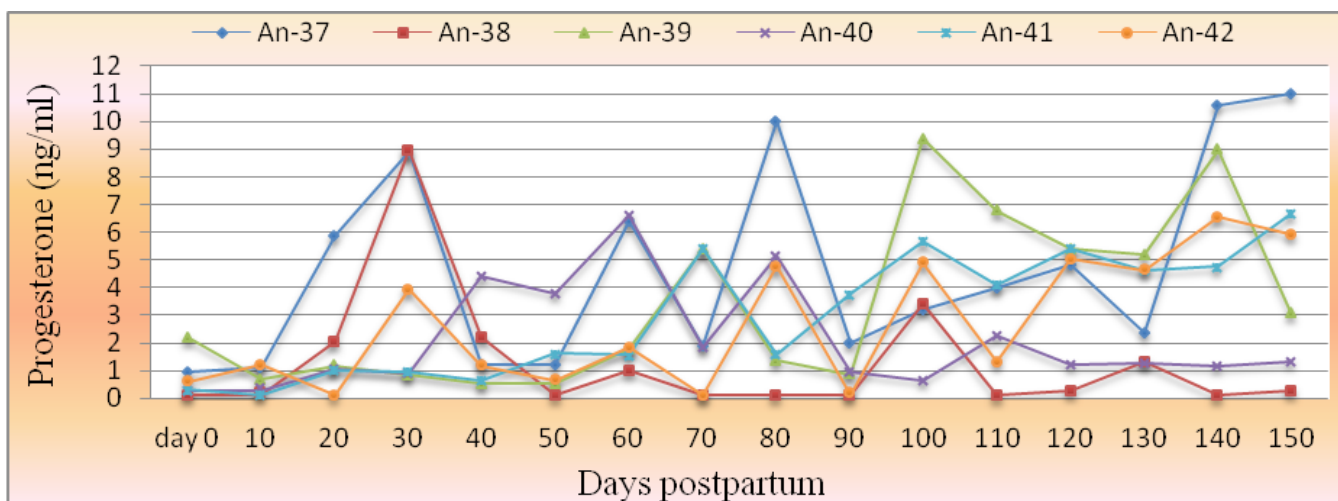


Fig. 2: Plasma progesterone (ng/mL) profile of individual cows of control group during 0 to 150 days postpartum

Table 2: Postpartum plasma progesterone and biochemical profile in postpartum Kankrej cows of control group and those given intra-ruminal Mega mineral bolus at calving (mean ± SE)

Postpartum days	Plasma progesterone (ng/mL)		Plasma total protein (g/dL)		Plasma total cholesterol (mg/dL)		Plasma triglyceride (mg/dL)	
	Mega bolus	Normal control	Mega bolus	Normal control	Mega bolus	Normal control	Mega bolus	Normal control
00	0.84 ± 0.08 ^c	0.74 ± 0.32 ^c	6.38 ± 0.24	6.19 ± 0.20	116.73 ± 4.71 ^d	103.88 ± 3.20 ^d	23.23 ± 0.74 ^{bc}	17.07 ± 1.16 ^c
10	1.67 ± 0.41 ^{bc}	0.62 ± 0.19 ^c	6.34 ± 0.26	6.76 ± 0.53	118.49 ± 2.33 ^{cd}	135.70 ± 15.26 ^{cd}	23.05 ± 0.51 ^c	17.61 ± 1.15 ^c
20	2.30 ± 0.62 ^{bc}	1.87 ± 0.83 ^{abc}	6.83 ± 0.42	6.35 ± 0.13	141.02 ± 10.49 ^{bcd}	155.32 ± 14.07 ^{abcd}	24.72 ± 1.59 ^{abc}	18.14 ± 1.46 ^{bc}
30	2.04 ± 0.49 ^{bc}	4.09 ± 1.60 ^{ab}	5.88 ± 0.36	6.65 ± 0.34	154.31 ± 6.11 ^{abcd}	175.50 ± 19.11 ^{abc}	26.29 ± 1.84 ^{abc}	21.25 ± 1.96 ^{abc}
40	4.01 ± 1.98 ^{ab}	1.70 ± 0.59 ^{bc}	6.70 ± 0.24	6.17 ± 0.42	175.61 ± 9.65 ^{abcd}	194.80 ± 25.15 ^{abc}	27.23 ± 0.61 ^{abc}	21.38 ± 1.84 ^{abc}
50	2.36 ± 0.36 ^{bc}	1.32 ± 0.54 ^{bc}	6.58 ± 0.22	5.81 ± 0.35	180.56 ± 18.43 ^{abc}	189.46 ± 22.44 ^{abc}	28.01 ± 1.60 ^{abc}	20.73 ± 1.96 ^{abc}
60	1.27 ± 0.72 ^{abc}	3.20 ± 1.05 ^{abc}	6.72 ± 0.36	6.73 ± 0.16	196.64 ± 14.93 ^{ab}	204.04 ± 16.09 ^{ab}	28.43 ± 1.05 ^a	22.23 ± 1.54 ^{abc}
70	3.07 ± 0.72 ^{abc}	2.46 ± 0.98 ^{abc}	6.66 ± 0.26	6.29 ± 0.31	207.50 ± 15.56 ^a	206.56 ± 20.10 ^{ab}	29.67 ± 1.40 ^a	21.40 ± 1.15 ^{abc}
80	4.15 ± 1.49 ^{ab}	3.84 ± 1.48 ^{abc}	6.40 ± 0.08	6.65 ± 0.26	196.18 ± 18.75 ^{ab}	237.17 ± 24.66 ^a	27.86 ± 1.23 ^{abc}	23.93 ± 1.21 ^a
90	1.83 ± 1.03 ^{bc}	1.31 ± 0.56 ^{bc}	7.03 ± 0.20	6.20 ± 0.25	196.43 ± 22.83 ^{ab}	205.15 ± 25.00 ^{ab}	28.38 ± 1.33 ^a	23.97 ± 2.00 ^a
100	2.83 ± 1.65 ^{abc}	4.54 ± 1.20 ^{ab}	6.60 ± 0.12	6.52 ± 0.36	181.45 ± 28.18 ^{abc}	198.81 ± 22.13 ^{abc}	26.13 ± 1.34 ^{abc}	21.92 ± 1.16 ^{abc}
110	3.71 ± 0.49 ^{abc}	3.69 ± 0.94 ^{abc}	6.81 ± 0.28	6.06 ± 0.37	179.55 ± 25.38 ^{abc}	184.64 ± 17.60 ^{abc}	25.96 ± 1.57 ^{abc}	22.32 ± 1.30 ^{abc}
120	2.98 ± 0.62 ^{abc}	3.22 ± 0.74 ^{abc}	6.83 ± 0.13	6.48 ± 0.29	181.20 ± 23.52 ^{abc}	207.97 ± 17.04 ^{ab}	26.52 ± 1.55 ^{abc}	25.85 ± 1.78 ^a
130	3.91 ± 1.25 ^{abc}	5.36 ± 0.71 ^a	6.26 ± 0.15	6.16 ± 0.29	169.02 ± 22.96 ^{abcd}	198.77 ± 22.75 ^{abc}	27.39 ± 2.59 ^{abc}	25.18 ± 2.30 ^a
140	5.57 ± 0.78 ^a	4.71 ± 1.62 ^{ab}	6.19 ± 0.20	6.68 ± 0.19	171.56 ± 22.78 ^{abcd}	203.95 ± 24.40 ^{ab}	28.29 ± 1.75 ^{ab}	23.52 ± 1.50 ^a
Significance	P = 0.03	P = 0.03	P = 0.34	P = 0.66	P = 0.02	P = 0.003	P = 0.012	P = 0.004

Means bearing uncommon superscripts within the column differ significantly (p < 0.05).

Table 3: Postpartum plasma micro-minerals concentrations in postpartum Kankrej cows of control group and those given intra-ruminal Mega mineral bolus at calving (mean ± SE)

Postpartum days	Plasma zinc (ppm)		Plasma iron (ppm)		Plasma copper (ppm)		Plasma cobalt (ppm)	
	Mega bolus	Normal control	Mega bolus	Normal control	Mega bolus	Normal control	Mega bolus	Normal control
00	0.82 ± 0.03	0.76 ± 0.11	3.80 ± 0.15	3.96 ± 0.44	0.73 ± 0.03	0.81 ± 0.07	0.27 ± 0.04	0.38 ± 0.05
10	0.78 ± 0.04	0.79 ± 0.06	3.37 ± 0.22	3.52 ± 0.32	0.72 ± 0.03	0.78 ± 0.07	0.22 ± 0.01	0.33 ± 0.05
20	0.73 ± 0.05	0.71 ± 0.07	3.30 ± 0.12	3.05 ± 0.25	0.76 ± 0.07	0.82 ± 0.07	0.29 ± 0.04	0.31 ± 0.01
30	0.75 ± 0.03	0.82 ± 0.06	3.51 ± 0.27	3.32 ± 0.25	0.74 ± 0.05	0.73 ± 0.08	0.36 ± 0.03	0.32 ± 0.05
40	0.74 ± 0.06	0.64 ± 0.06	3.25 ± 0.13	3.15 ± 0.18	0.62 ± 0.04	0.72 ± 0.09	0.27 ± 0.03	0.34 ± 0.06
50	0.78 ± 0.04	0.66 ± 0.03	3.21 ± 0.21	3.13 ± 0.47	0.72 ± 0.05	0.77 ± 0.08	0.32 ± 0.02	0.40 ± 0.04
60	0.71 ± 0.03	0.68 ± 0.06	3.14 ± 0.28	3.42 ± 0.19	0.62 ± 0.07	0.73 ± 0.07	0.35 ± 0.03	0.35 ± 0.03
70	0.76 ± 0.06	0.71 ± 0.08	3.54 ± 0.27	3.53 ± 0.21	0.75 ± 0.05	0.67 ± 0.04	0.29 ± 0.03	0.35 ± 0.01
80	0.77 ± 0.03	0.67 ± 0.06	3.32 ± 0.31	3.13 ± 0.20	0.62 ± 0.03	0.64 ± 0.06	0.32 ± 0.02	0.37 ± 0.03
90	0.71 ± 0.04	0.76 ± 0.70	3.19 ± 0.34	3.32 ± 0.33	0.61 ± 0.05	0.63 ± 0.08	0.34 ± 0.04	0.38 ± 0.04
100	0.68 ± 0.04	0.68 ± 0.09	3.23 ± 0.13	3.18 ± 0.14	0.67 ± 0.02	0.67 ± 0.03	0.29 ± 0.03	0.35 ± 0.05
110	0.69 ± 0.06	0.80 ± 0.05	3.61 ± 0.35	3.34 ± 0.33	0.68 ± 0.07	0.70 ± 0.05	0.32 ± 0.03	0.34 ± 0.01
120	0.62 ± 0.06	0.76 ± 0.09	3.44 ± 0.33	3.41 ± 0.29	0.62 ± 0.03	0.58 ± 0.07	0.37 ± 0.02	0.36 ± 0.02
130	0.70 ± 0.06	0.80 ± 0.07	3.05 ± 0.22	3.31 ± 0.25	0.61 ± 0.02	0.68 ± 0.05	0.29 ± 0.04	0.37 ± 0.02
140	0.77 ± 0.05	0.83 ± 0.05	3.15 ± 0.29	3.27 ± 0.26	0.71 ± 0.04	0.75 ± 0.03	0.30 ± 0.02	0.35 ± 0.02
Significance	P = 0.37	P = 0.70	P = 0.79	P = 0.77	P = 0.18	P = 0.43	P = 0.16	P = 0.82

The column means in none of the parameters differ significantly (p > 0.05).



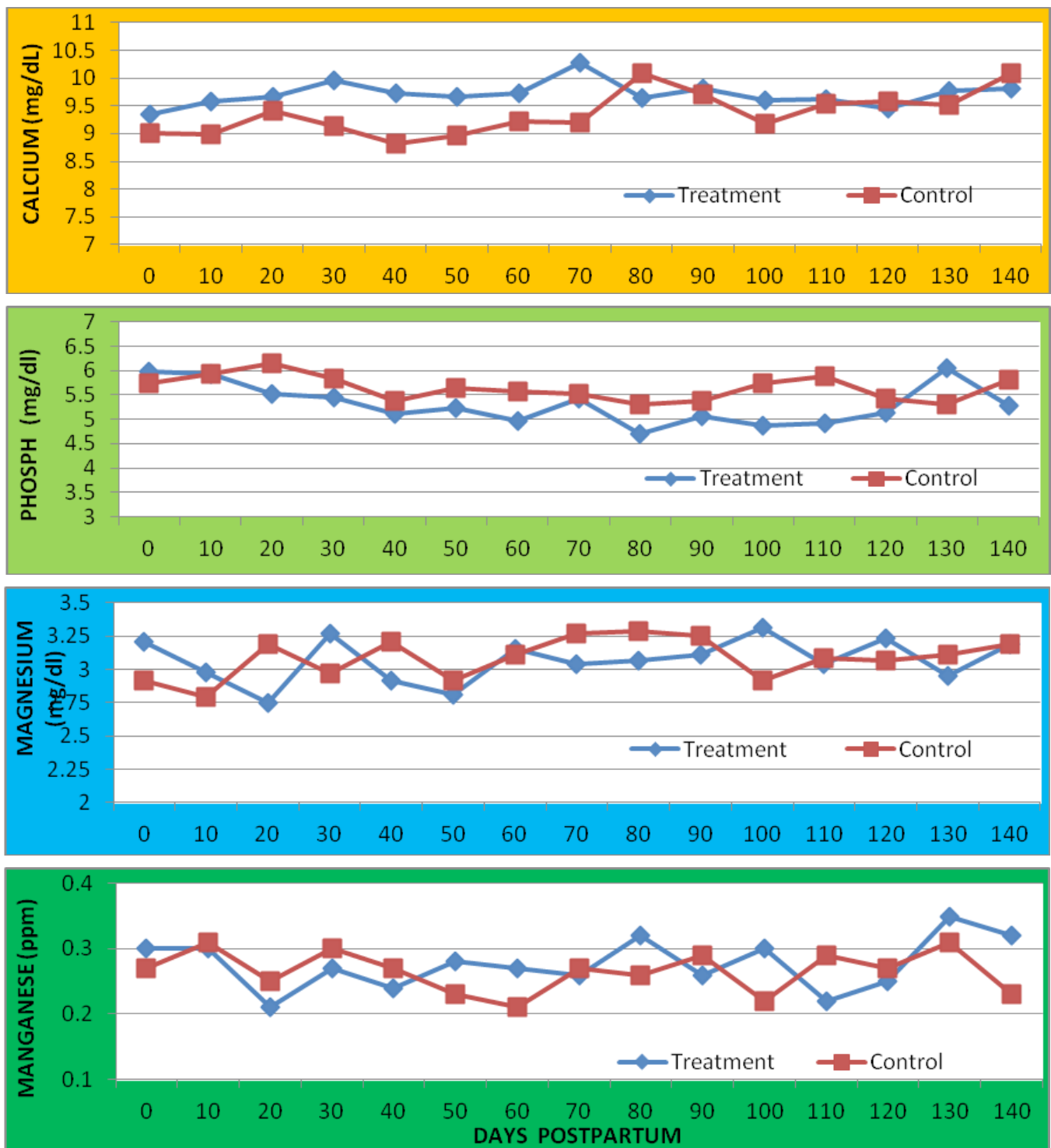


Fig. 3: Plasma levels of macro-minerals and manganese in Kankrej cows of control and Mega mineral bolus treatment groups during 0 to 140 days postpartum

inconsistent trends of plasma macro-micro minerals status of postpartum fertile and infertile HF cows with routine feeding management though values were higher in the fertile group.

The published evidence on fertility and blood profiling following feeding single rumen multi-mineral bolus is scanty in literature. Abdollahi *et al.* (2014) fed Afshari cycling ewes

a single multi-mineral rumen bolus (Ferrobloc bolus) four weeks prior to synchronization and found that boluses increased the status of copper, selenium, and iodine on mating day and days 90 to 100 of gestation, but ruminal bolus did not significantly increase the number of different classes of ovarian follicles. The cows supplemented via a

long-acting trace mineral rumen bolus had successfully increased liver copper content in cows and blood selenium in cows and calves, but the response varied between years (Sprinkle *et al.*, 2006). Similarly, Joshi *et al.* (2020) recorded significant ($p < 0.05$) improvement in serum total protein, cholesterol, progesterone, and macro (Ca, P) – micro (Zn, Fe, Cu, Co, Mn) mineral status at day 45 and 90 after supplementing chelated mineral mixture @ 50 g/d/h for 60 days in postpartum anoestrus buffaloes compared to control group. However, we did not find any positive results of rumen mineral bolus supplementation. Following use of single rumen mega mineral bolus (Prepavel®) improvement in reproductive efficiency of infertile cattle and buffaloes was experienced by a district cooperative dairy in Gujarat (personal communication), but they did not study the serum/plasma profile of minerals contained in the bolus.

Few scientists have reported significant improvement in postpartum reproductive health, with early onset of postpartum first estrus, shorter service period and enhanced pregnancy rate with some improvement in plasma mineral and biochemical status of cattle and buffaloes following peripartum oral and injectable minerals and other nutrients supplementation (Kalasariya *et al.*, 2017; Crowe *et al.*, 2018; Vala *et al.*, 2019). But, we could not find any improvement in postpartum fertility or blood biochemical/ mineral profile in Kankrej cows following feeding long-acting single multi-mineral rumen bolus. This may be due to difference in feed composition, rumen microbial population, and the rumen/blood pH affecting the solubility and bioavailability of minerals from rumen mineral bolus and chelated free mineral mixtures. Based on the findings of our experiment, it is concluded that the insertion of rumen mega mineral bolus orally on the day of calving did not influence the plasma profile of biochemical/ metabolic constituents and macro-micro minerals profile and in fact suppressed the postpartum estrus and fertility in lactating postpartum Kankrej cows. There is a need to investigate further the effect of rumen multi-mineral bolus on nutritional and reproductive status using more number of animals of different breeds and with different feeding regimens.

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