The Haryana Veterinarian (June, 2025) **64(1),** 10-14 ISSN 0033-4359 (P) **Research Article**

SERUM MACRO AND MICROMINERAL PROFILE OF SURTI GOATS UNDER DIFFERENT SYNCHRONIZATION PROTOCOLS

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Received: 05.04.2024; Accepted: 22.06.2024

ABSTRACT

Present study was conducted to study serum macro and micro mineral profile in Surti goats under different estrus synchronization protocols. Thirty Surti goats were divided into five groups (n=6 each) as G1, G2 and G3 were implanted with intra-vaginal progestagen sponges for 11 days, without and with exposure to buck in G1 and G2, and with injection of 125 µg cloprostenol at sponge removal in G3 group. G4 was exposed to buck only for 11 days, while G5 acted as control with no treatment. Blood was collected on day 0, 5, 11, at estrus and 45th day post-service to analyse serum calcium, phosphorus, copper, iron and zinc. Significant ($p<0.05$) differences between groups were observed for calcium at 11th day, phosphorus at 0-day and 11th day, copper at 11th day as well as on the day of estrus, iron at 0-day as well as 5th day and zinc at all days. Within the groups i.e. between days differences in levels were either significant ($p<0.01$) or non-significant ($p>0.01$). However, all the values were in normal physiological range. Thus, the present study was successful in establishing the important serum macro and mineral profile in Surti goats under different oestrus synchronization protocols. Minimum variation in serum levels of calcium, phosphorus and zinc under synchronization protocol of IVPS for 11 days followed by 125 µg cloprostenol Intra muscular injection may further be explored in future such studies.

Keywords: Macrominerals, Microminerals, Oestrus synchronization, Surti goats

How to cite: Sharma, H.C., Khasatiya, C.T., Patel, V.R., Patel, S.B. and Singh, V.K. (2025). Serum macro and micromineral profile of Surti goats under different synchronization protocols. *The Haryana Veterinarian* **64(1)**: 10-14.

Goats (*Capra hircus*) referred as "poor man's cow" are commonly reared in Indian sub-continent for meat, milk, fibre and skin. Their suboptimal reproduction performance hinders to cater surge in demand for its production. The indidance of infertility in goats has been reported as 11.5% with anoestrous as major cause (Dutt *et al.*, 2010). Non-efficient reproductive management can be overcome by synchronization of oestrous cycle. Macrominerals such as Calcium and Phosphorus are indispensable for structural integrity of bones, muscle function, hormonal regulation, cellular processes and overall reproductive health during oestrus cycle. Microminerals such as Iron, Zinc and Copper contribute to proper functioning of oestrus cycle by supporting processes such as oxygen transport, energy metabolism, enzyme activity, hormonal regulation, and reproductive tissue development. Reduction in reproductive efficiency due to mineral deficiency (Ahuja and Parmar, 2017) has been stated as one of the causes highlighting the critical role of minerals in maintaining reproductive performance. Thus, based on importance of knowing the variation of serum mineral profile especially under different synchronization and lack of such studies as well as considering the fact that Surti breed is native to south Gujarat, present study was planned with the objective to study serum macro and micro mineral profile of Surti goats under different synchronization protocol.

MATERIALS AND METHODS

Present study was done at AICRP (Surti Goat) at LRS, Navsari (KU, Gujarat) between June, 2018 and May, 2019.

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Thirty healthy Surti goats were randomly selected irrespective of parity and were equally divided in five groups *viz*. G1, G2, G3, G4 and G5 with 6 goats in each group, separated from bucks and maintained under farm's standard housing and managemental conditions. They were allowed to graze 4-5 hours during day, offered concentrate mixture (250 g/animal/day) along with ad-lib green fodder (Hybrid Napier /Jowar and tree leaves) and water. Oestrus synchronization of G1 group was done using intra-vaginal sponges (IVPS) impregnated with 60mg Medroxyprog esterone acetate (MAP) for only 11 days. G2 and G3 groups were similar to G1 but there was simultaneous exposure to sexually active apronized buck in G2 group whereas 125µg cloprostenol was administered intramuscularly at the time of sponge removal in G3 group. G4 group was only teased with sexually active aproned buck during 11 days and G5 acted as control without any treatment.

Whole blood was collected from jugular vein in vacutainers without anticoagulant on day 0 (before treatment), day 5 (during treatment), day 11 (at the end of treatment), on day of observed estrus and day 45 of post service. Serum was separated and used for determining concentrations of Calcium (kit by Randox Laboratories India Pvt. Ltd.) and Phosphorus (kit by Diatek Healthcare India Pvt. Ltd.). Copper, Iron and Zinc were estimated by atomic absorption spectrophotometer after digesting the serum sample with triple acid according to the method of Krishna and Ranjhan (1980).

Results obtained were analysed statistically at 5% and 1% using One-way Anova and post-hoc test DMRT. Box and

whisker plot was generated to observe distribution of data. Percent coefficient of variation (CV%) of different groups for different minerals was calculated from coefficient of variation for different days within each group using the formula as CV% = (standard deviation/mean) × 100.

RESULTS AND DISCUSSION

Table 1 represents comparison of serum levels (Mean ± SE) as well as Fig. 1 depicts the box and whisker plots for serum calcium, phosphorus, copper, iron and zinc, respectively. Box and whisker plots have been shown to visualize the individual data point spread and five-number summary i.e. minimum, first quartile, median, third quartile, and maximum. It also displays the outliers.

Serum Calcium concentration: As compared to levels of calcium in present study, various studies have also reported similar, higher or lower levels. Arya (2008) in Black Bengal goats at Ranchi (Jharkhand) with 10mg progesterone (i/m injection) for 12 days reported levels of calcium at 0-day as 6.98±0.70 mg/dl, at estrus, as 9.07±0.68 mg/dl in treatment as well as 7.34±0.33 mg/dl - in control and 8.11±0.30 mg/dl at 21st day post-service. Saribay *et al.* (2020) at Hatay (Turkey) in Damascus goats treated by IVPS (30 mg FGA) for 12 days along with I/m injection of 0.075 µg cloprostenol reported 9.60±0.10 mg/dl at 0-day, 9.20±0.10 mg/dl at sponge removal and 9.40±0.10 mg/dl at 15th day post-estrus. Calcium has been reported as 9.58±0.01 mg/dl by Kumar (2017) in local goats at Telangana (Hyderabad) at 0 day. During post-estrus calcium valued as 8.98±0.13 mg/dl in Arbia goats (Allaoua and Mahdi, 2018) and 9.23±0.69 mg/dlin Surtigoats (Pandya, 2009)wereereported. Chaudhary (2017) in Surti does at Navsari (Gujarat) found calcium as 9.77±0.25 mg/dl before treatment and 9.77±0.25 mg/dl at 40th day post-service.

Non-significant fluctuation have been reported by Arya (2008), Gangaram (2013) in Osmanabadi goats with IVPS (350 mg natural progesterone) for 14 days at Bidar (Karnataka), Kumar (2017) in local goats with IVPS (350 mg natural progesterone) for 12 days at Telangana (Hyderabad), Chaudhary (2017) in Surti does using teaser buck for 11 days and at Navsari (Gujarat) by Saribay *et al.* (2020).

Serum Phosphorus concentration: Similar to the present research, various studies have reported higher or lower levels of serum phosphorous. Saribay *et al.* (2020) reported serum phosphorus concentration before treatment as 4.40±0.30 mg/dl, 5.30±0.30 mg/dl on the day of estrus and 5.10±0.30 mg/dl at 15th day post-estrus. Arya (2008) reported phosphorus as 7.02±0.22 mg/dl before treatment, 4.39±0.40 mg/dl and 6.80±0.59 mg/dl in treatment and its control group on the day of estrus and 4.45±0.45 mg/dl at 21st day post-service in treatment group. Chaudhary (2017) reported phosphorus as 5.73±0.44 mg/dl before treatment and 5.14±0.60 mg/dl as well as 8.19±0.92 mg/dl at 40th day post-service in treatment and control groups.

Mean serum phosphorus level of Surti does differ significantly ($p<0.05$) between different groups at 0-day and 11th day whereas within the groups was observed to vary either significantly ($p<0.01$) or non-significantly ($p>0.01$) between different days. Non-significant fluctuation in the mean serum phosphorus level at 0-day, on the day of estrus and 21st day post-estrus was reported by Arya (2008); at 0-day, 6th day and 14th day by Gangaram (2013); at 0-day, 6th day and 12th day by Kumar (2017); at 0-day, 3rd day, 11th day and 40th day post-service by Chaudhary (2017) in Surti does synchronized by teasing with sexually active buck for 11 days and its control group at Navsari (Gujarat) as well as 0-day, on the day of estrus and 15th day post-estrus by Saribay *et al.* (2020).

Serum Copper concentration: As compared to levels of copper in present study, various studies have also reported similar, higher or lower levels. Arya (2008) reported copper levels as 0.650±0.019 µg/ml before treatment, on the day of estrus as 0.673±0.020 µg/ml in treatment and 0.664±0.018 µg/ml in control group and at 21st day post-estrus as 0.744 ± 0.016 µg/ml in treatment and 0.656±0.018 µg/ml in control group. Chaudhary (2017) reported copper levels as 0.082± 0.012 µg/ml at 0-day and 0.076±0.015 µg/ml and 0.087± 0.014 µg/ml at 40th day post-service in treatment and its control group.

Mean serum copper level of Surti does was observed to have significant ($p<0.05$) different between different groups at 11th day as well as on the day of estrus whereas within groups there was either significant ($p<0.01$) or non-significant ($p>0.01$) variationsbetweendifferentdays.Trendof fluctuation in the mean serum copper level similar to present study has been reported at 0-day, on the day of estrus and 21st day post-estrus was reported by Arya (2008). While, non-significant difference in the mean serum copper level at 0-day, 3rd day, 11th day, on the day of estrus and 40th day post-service was observed by Chaudhary (2017) in Surti does synchronize by teasing with sexually active buck for 11 days and its control group at Navsari (Gujarat).

Serum Iron concentration: As compared to levels of iron in present study, various studies have also reported similar, higher or lower levels. Arya (2008) reported serum iron levels as 1.821±0.012 µg/ml and on the day of estrus as 2.054±0.019 µg/ml in treatment and 1.821±0.038 µg/ml in control group and at 21st day post-estrus as 1.851±0.016 µg/ml in treatment and 1.801±0.041 µg/ml in control group. Chaudhary (2017) in Surti does at Navsari (Gujarat) reported serum iron levels as 0.108±0.014 µg/ml at 0-day, 0.116±0.027 µg/ml and 0.100±0.016 µg/ml in treatment and control groups, respectively at 40th day post-service.

Mean serum iron level of Surti does was significantly ($p<0.05$) different between groups at 0-day as well as 5th day and found to vary within the groups either significantly ($p<0.01$) or non-significantly ($p>0.01$) between different

Table 1. Serum macro and microminerals (Mean±SE) at different time intervals/ days in treatment and control groups of Surti does under different synchronization protocols

Days	G1	G2	G3	G4	G5	Overall	F value	P value
Serum Calcium concentration (mg/dl)								
0 day	9.41±0.42^{aW}	9.87±0.79^{aW}	10.20±0.31^{aX}	9.78±0.36^{aW}	9.23±0.22^{aY}	9.70±0.20^{X}	0.69	0.61
5th day	10.17±0.62^{aW}	10.30±0.67^{aW}	10.96±0.47^{aX}	10.41±0.38^{aW}	10.34±0.34^{aWX}	10.44±0.22^{W}	0.35	0.84
11th day	11.02±0.66^{bW}	10.32±0.59^{bW}	12.86±0.57^{aW}	9.70±0.58^{bW}	10.06±0.16^{bXY}	10.79±0.31^{W}	5.35**	0.00
Estrus	10.32±0.54^{aW}	10.88±0.40^{aW}	11.12±0.52^{aX}	10.96±0.66^{aW}	10.92±0.43^{aWX}	10.84±0.22^{W}	0.34	0.85
45th day	10.23±0.21^{aW}	10.02±0.78^{aW}	10.82±0.43^{aX}	9.80±0.50^{aW}	11.26±0.32^{aW}	10.43±0.22^{W}	1.52	0.23
Overall	10.23±0.23^{b}	10.28±0.28^{b}	11.19±0.25^{a}	10.13±0.23^{b}	10.36±0.18^{b}	10.44±0.11	3.22*	0.01
F value	1.21	0.34	4.52**	1.14	6.46**	3.70**	-	-
P value	0.33	0.85	0.00	0.36	0.00	0.00	-	-
Serum Phosphorus concentration (mg/dl)								
0 day	9.42±0.61^{aW}	6.15±0.35^{bcW}	5.31±0.38^{cY}	6.28±0.94^{bcWX}	7.36±0.46^{bW}	6.90±0.36^{W}	7.20**	0.00
5th day	7.08±0.61^{aX}	6.53±0.80^{aW}	6.64±0.40^{aX}	7.57±0.76^{aW}	7.59±0.39^{aW}	7.08±0.27^{W}	0.66	0.63
11th day	6.26±0.98^{abX}	6.38±0.51^{abW}	7.73±0.38^{aW}	5.35±0.53^{bX}	7.70±0.57^{aW}	6.69±0.31^{W}	2.66*	0.05
Estrus	7.17±0.30^{aX}	6.43±0.15^{aW}	6.35±0.29^{aXY}	6.58±0.51^{aWX}	7.52±0.49^{aW}	6.81±0.18^{W}	1.86	0.15
45th day	7.84±0.61^{aWX}	6.62±0.48^{aW}	7.88±0.37^{aW}	6.97±0.41^{aWX}	8.55±0.98^{aW}	7.57±0.28^{W}	1.61	0.20
Overall	7.55±0.34^{a}	6.42±0.21^{b}	6.78±0.23^{b}	6.55±0.30^{b}	7.75±0.27^{a}	7.01±0.13	4.80**	0.00
F value	3.22*	0.12	8.46**	1.58	0.58	1.46	-	-
P value	0.03	0.97	0.00	0.21	0.68	0.22	-	-
Serum Copper concentration (µg/ml)								
0 day	0.092±0.007^{aW}	0.089±0.009^{aX}	0.097±0.004^{aW}	0.083±0.005^{aX}	0.072±0.015^{aY}	0.086±0.004^{Y}	1.20	0.33
5th day	0.109±0.010^{aW}	0.117±0.012^{aW}	0.109±0.007^{aW}	0.110±0.006^{aW}	0.128±0.007^{aW}	0.115±0.004^{W}	0.87	0.50
11th day	0.115±0.008^{aW}	0.098±0.008^{abWX}	0.103±0.005^{abW}	0.092±0.008^{bWX}	0.090±0.005^{bXY}	0.100±0.003^{X}	2.16*	0.05
Estrus	0.117±0.005^{aW}	0.090±0.006^{bWX}	0.096±0.003^{bW}	0.097±0.011^{bWX}	0.105±0.003^{abWX}	0.101±0.003^{X}	2.59*	0.05
45th day	0.108±0.013^{aW}	0.103±0.008^{aWX}	0.102±0.007^{aW}	0.103±0.009^{aWX}	0.087±0.003^{aXY}	0.100±0.004^{X}	0.82	0.52
Overall	0.108±0.004^{a}	0.100±0.004^{a}	0.101±0.002^{a}	0.100±0.004^{a}	0.100±0.005^{a}	0.100±0.002	1.48	0.21
F value	1.16	1.72*	0.91	1.65*	6.87**	7.39**	-	-
P value	0.35	0.05	0.47	0.05	0.00	0.00	-	-
Serum Iron concentration (µg/ml)								
0 day	1.323±0.141^{bW}	1.430±0.079^{bW}	1.475±0.024^{abW}	1.613±0.116^{abW}	1.751±0.097^{aW}	1.518±0.050^{W}	2.79*	0.05
5th day	1.629±0.107^{aW}	1.649±0.106^{aW}	1.501±0.050^{abW}	1.267±0.069^{bX}	1.735±0.085^{aW}	1.556±0.047^{W}	4.48**	0.00
11th day	1.560±0.072^{aW}	1.429±0.121^{aW}	1.582±0.077^{aW}	1.379±0.049^{aX}	1.568±0.059^{aW}	1.504±0.036^{W}	1.36	0.27
Estrus	1.423±0.177^{aW}	1.510±0.090^{aW}	1.455±0.109^{aW}	1.408±0.027^{aWX}	1.626±0.100^{aW}	1.484±0.048^{W}	0.62	0.65
45th day	1.544±0.127^{aW}	1.500±0.068^{aW}	1.679±0.184^{aW}	1.607±0.048^{aW}	1.584±0.059^{aW}	1.583±0.047^{W}	0.38	0.82
Overall	1.496±0.057^{b}	1.503±0.042^{b}	1.538±0.046^{ab}	1.455±0.038^{b}	1.653±0.037^{a}	1.529±0.020	2.83*	0.03
F value	0.88	0.90	0.78	4.85**	1.08	0.76	-	-
P value	0.49	0.48	0.55	0.00	0.39	0.55	-	-
Serum Zinc concentration (µg/ml)								
0 day	0.878±0.03^{aWX}	0.793±0.02^{bW}	0.682±0.02^{cX}	0.553±0.04^{dW}	0.654±0.03^{cX}	0.712±0.02^{XY}	19.23**	0.00
5th day	0.730±0.02^{aY}	0.740±0.03^{aW}	0.645±0.02^{bX}	0.629±0.03^{bW}	0.603±0.03^{bX}	0.669±0.02^{Y}	6.00**	0.00
11th day	0.830±0.05^{bXY}	0.583±0.03^{dX}	0.975±0.03^{aW}	0.691±0.04^{cW}	0.702±0.02^{cWX}	0.756±0.03^{X}	17.82**	0.00
Estrus	0.985±0.02^{aW}	0.603±0.02^{bX}	1.032±0.03^{aW}	0.632±0.09^{bW}	0.713±0.02^{bWX}	0.793±0.04^{WX}	22.37**	0.00
45th day	0.969±0.08^{abWX}	0.799±0.05^{abcW}	0.995±0.05^{aW}	0.731±0.08^{cW}	0.766±0.06^{bcW}	0.852±0.04^{W}	3.18*	0.03
Overall	0.878±0.03^{a}	0.704±0.02^{b}	0.866±0.03^{a}	0.647±0.03^{b}	0.688±0.02^{b}	0.757±0.01	17.16**	0.00
F value	5.13**	10.28**	32.64**	1.26	3.09*	5.86**	-	-
P value	0.00	0.00	0.00	0.31	0.03	0.00	-	-

Means bearing different superscripts (W,X,Y) within a column (between time intervals/days) differ significantly (**p<0.01 & *p<0.05) and means bearing different subscripts (a, b, c, d) within a row (between the group) differed significantly (*p<0.05 & **p<0.01) G1 = Intra-vaginal sponge, G2 = Intra-vaginal sponge + Buck effect, G3 = Intra-vaginal sponge + PGF2α, G4 = Buck effect, G5 = Control

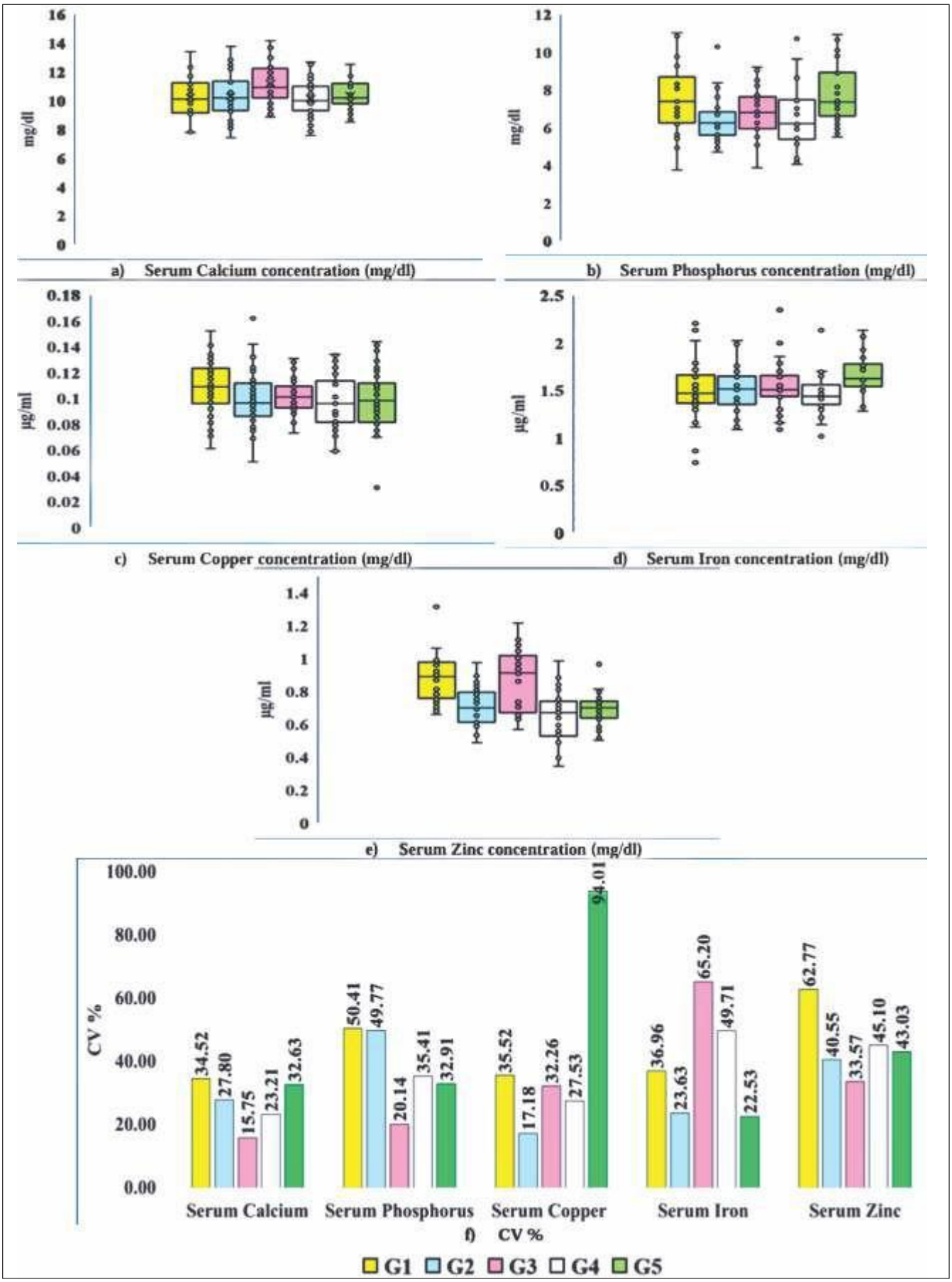

Fig. 1. (a-e) Box and Whisker plots (f): Coefficient of variation (CV) % of Serum macro and microminerals

days. Similar to present study, trend of fluctuation in the mean serum iron level at 0-day, on the day of estrus and 21st day post-estrus was reported by Arya (2008). While, non-significant difference in the mean serum iron level at 0-day, 3rd day, 11th day, on the day of estrus and 40th day post-service was observed by Chaudhary (2017) in Surti does synchronize by teasing with a sexually active buck for 11 days and its control group at Navsari (Gujarat).

Serum Zinc concentration: As compared to levels of zinc in present study, various studies have also reported similar, higher or lower levels. Arya (2008) reported serum zinc levels as 0.883±0.020 µg/ml at day 0 and 0.954±0.014 µg/ml in treatment and 0.854±0.037 µg/ml in control group on the day of estrus. Chaudhary (2017) in Surti does at Navsari (Gujarat) reported serum zinc levels as 0.190±0.012 µg/ml on the day of estrus and 0.167±0.011 µg/ml and 0.189± 0.007 µg/ml in treatment and control groups, respectively at 40th day post-service. Mean serum zinc level of Surti does was observed to be significantly ($p<0.05$) different between different groups whereas within the groups fluctuations were either significant ($p<0.01$) or non-significant ($p>0.01$) between different days.

Similar to present study, trend of fluctuation in mean serum zinc level at 0-day, on the day of estrus and 21st day post-estrus was reported by Arya (2008). While, non-significant difference in the mean serum zinc level at 0-day, 3rd day, 11th day, on the day of estrus and 40th day post-service was observed by Chaudhary (2017) in Surti does synchronized by teasing with a sexually active buck for 11 days and its control group at Navsari (Gujarat).

Normal ranges for serum calcium, phosphorus, copper, iron and zinc are 8.9 to 11.7 mg/dl, 4.2 to 9.1 mg/dl, 0.070 to 0.155 µg/ml, 0.60 to 1.60 µg/ml and 0.66 to 1.10 µg/ml, respectively (Fielder, 2022). Differences in their level reported by different researchers might be due to variation in geographical, nutritional, reproductive and health status of animals, breed difference and parity apart from seasonal and analytical differences.

Variation in mineral levels: Coefficient of variation % of coefficient of variation of serum minerals at different days in different treatment and control groups in Surti does (Fig. 6). Even though Sharma *et al.* (2022) have shown the synchronization protocols used in the present study to be equally efficient in oestrus synchronization and advantageous for improving conception rate in Surti does, there still exists some differences in coefficient of variation in mineral levels. Coefficient of variation % in Fig. 6 shows that minimum values were observed in G3 group as compared to other groups for serum calcium, serum phosphorus and serum zinc. This shows that oestrus synchronization using intra-vaginal sponges (IVPS) impregnated with 60 mg Medroxyprogesterone acetate (MAP) for 11 days followed by administration of 125 µg cloprostenol intramuscularly at the time of sponge removal was most effective in synchronizing and minimizing the variation of serum levels of Calcium, Phosphorus and Zinc in a narrow range at different days within the group. Such analysis has not been done in similar studies so the present results could not compare and reviewed due to lack of related scientific literature. However, the synchronization protocol (IVPS for 11 days +125 µg cloprostenol i/m) seems to have potential for minimize variation in Calcium, Phosphorus and Zinc levels in serum.

CONCLUSION

The present study was successful in establishing the important serum macro and mineral profile in Surti goats under different oestrus synchronization protocols. This study may serve as an addition to reference literature for study of serum mineral profile during different stages of oestrus cycle in Surti goats. Minimum variation in serum levels of Calcium, Phosphorus and Zinc under synchronization protocol of IVPS for 11 days followed by 125 µg cloprostenol i/m injection may further be explored in future such studies.

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