The Pharma Innovation Journal 2022; SP-11(6): 1958-1965

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(6): 1958-1965

www.thepharmajournal.com
Received: 01-03-2022
Accepted: 05-04-2022

Arvind K Nandanwar
Department of Livestock Production Management, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Dhirendra Bhonsle
Department of Livestock farm Complex, C.V.Sc., Anjora, Durg, Chhattisgarh, India

VN Khune
Department of Livestock Production Management, C.V.Sc., Anjora, Durg, Chhattisgarh, India

K Mukherjee
Department of Animal Genetics and Breeding, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Sonali Prusty
Department of Animal Nutrition, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Nutan Ramteke
Department of Livestock Production Management, C.V.Sc., Anjora, Durg (C.G.)

Vandana Bhagat
Department of Livestock Production Management, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Gaurav Kankarwal
Department of Livestock Production Management, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Ankita Thakre
Department of Veterinary Physiology and Biochemistry, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Corresponding Author
Arvind K Nandanwar
Department of Livestock Production Management, C.V.Sc., Anjora, Durg, Chhattisgarh, India

Effect of nano zinc supplementation on milk production, udder health and protein profile during transition period in Sahiwal cows

Arvind K Nandanwar, Dhirendra Bhonsle, VN Khune, K Mukherjee, Sonali Prusty, Nutan Ramteke, Vandana Bhagat, Gaurav Kankarwal and Ankita Thakre

Abstract
The objective of the present study was to investigate the effect of nano zinc oxide in comparison to inorganic Zn on milk yield, udder health and protein profile in Sahiwal cows during transition period. A total of 24 Sahiwal cows were randomly divided into four groups (T_0 (control), T_1, T_2 and T_3) with 6 animals in each, based on parity (2-5 parity). Basal diet was followed in all the groups whereas in groups T_1, T_2 and T_3 additional 40 ppm Zn from ZnO, and 20 and 40 ppm Zn from nano ZnO was supplemented, respectively. Results indicated that significant ($P \leq 0.05$) difference was observed in milk yield at fifth fortnight; although T_2 and T_3 group does not have significantly differed. The mean value of milk yield was significantly ($P \leq 0.01$) higher in T_3 group compared to other groups; however, there was no significant difference between T_1, T_2 and T_3 groups. Milk SCC was significantly ($P \leq 0.01$) lower in T_3 group compared to other groups; however, there was no significant difference between T_1 and T_2 group. Overall mean of milk pH of 75 days of lactation period in all groups differ significantly ($P \leq 0.01$) and was significantly ($P \leq 0.01$) lower in T_3 group compared to other groups; however, there was no significant difference between T_1 and T_2 group. The total protein and globulin concentration during prepartum period was lower compared to postpartum period among all the groups. The postpartum mean concentration of total protein and albumin in T_3 group were found highly significant ($P \leq 0.01$) compared to other groups. Mean concentration of serum total protein was significantly ($P < 0.05$) higher in both T_3 and T_2 groups; however, T_2 and T_3 group does not have significantly differed. Mean albumin conc. was significantly ($P < 0.05$) higher in T_3 group; however, T_0 and T_2 group does not have significantly differed. The prepartum mean of globulin conc. in treatment groups was found highly significant ($P \leq 0.01$). However, treatment groups do not have significantly differed. Significantly ($P < 0.01$) higher in mean concentration of serum globulin was found in T_2 group compared to other groups. The result revealed that animals supplemented with 40 ppm of nano Zn has shown better performance compared to animals of other groups.

Keywords: Nano zinc, Sahiwal cow, transition period, SCC, pH, milk yield

Introduction
A transition period (parturition before 3 weeks to after 3 weeks) is a vital period in the life of a dairy cow when they face tremendous metabolic and physiological changes (Yadav *et al.*, 2019) [20]. During this period cows have more chances against diseases like mastitis due to onset of lactation. The milk production, udder health and protein profile are important parameters in evaluating the health status of animals during this period. Milk production and udder health of dairy animals to assessing the profitability of herd and thus it needs time-dependent management. Protein profiling during this period has been provide a steady approach to guide health of animal during this critical period with the major goal to conclude a herd's susceptibility to production diseases (Kevin and Ellen, 2012) [8]. Provision of sufficient amount of supplementation of minerals especially trace minerals during this period can be used as a strategy to improve the milk quality and quantity as well as maintaining udder health of dairy animals (Cortinhas *et al*., 2010) [2]. Zinc deficiency has frequently observed during the peri-parturient period (Maurya *et al*., 2014) [10]. However, low level of zinc in animal's body leads to high somatic cell count with low milk quality and increased incidence of mastitis (Gaafar *et al*., 2010) [5].
Zinc is the second most abundant trace element in the animal's body, which cannot be stored (Swain *et al.*, 2021) [19] and thus requires regular dietary intake.

Zinc had associated with controlling various biochemical and physiological functions that influence the health and production in different ways. NRC (2001) [12] recommended 40- 60 mg of Zn/kg should be included in the diet of dairy cow. The soil in several parts of India is zinc deficient due to which zinc deficiency is also found in fodder. To overcome the deficiency the common practice is to add inorganic form of Zn (oxides, sulphates and carbonates) to basal diet. Inorganic sources with low bioavailability resulted in higher levels of Zn excreted from the supplemented animals raising concern over the issue of environmental pollution (Feng *et al.*, 2009) [4]. Hence, highly bioavailable sources of zinc requirement are recognized, that will additionally reduce the supplemental dose of zinc to the animals.

Recently concept of nano technology come in to picture in which trace minerals is in a chemically inert form, more stable, stronger absorbing ability, greater specific surface area, higher surface activity and high catalytic efficiency, so absorbed and circulated to target tissue very efficiently. The use of nanotechnology to produce nano zinc oxide was proven to have better effects in comparison inorganic and organic zinc sources and to improve livestock performance. The main advantage with this property of nano zinc is that it could lower the rate of inclusion in animal diet. Therefore, the present study was taken up to evaluate the effect of nano zinc oxide in comparison to inorganic Zn on milk production, udder health and protein profile in Sahiwal cows during transition period.

Material and Method

Experimental design:

Twenty-four pregnant pure bred Sahiwal cows were randomly selected on the basis of well-maintained farm records from Bull Mother Experimental Farm, College of Veterinary Science and A.H., Anjora, Durg. The basal diet represented the routine feeding practice followed in the farm as per feeding standard. In T_0 (control) group no additional Zn was supplemented whereas in T_1 40 ppm Zn was supplemented from ZnO and in T_2 and T_3 20 and 40 ppm Zn was supplemented from nano ZnO, respectively. The experimental supplementation was done during transition phase starting 30 days prepartum to 30 days postpartum.

Production parameter

After calving, fortnightly milk samples were collected from all experimental cows up to 75 days of lactation for the estimation of milk yield (kg).

Udder health indices

After calving, fortnightly milk samples were collected from all experimental cows up to 75 days of lactation for the estimation of Somatic cell count (SSC) ($x10^5$/ml) in milk was performed as per method described by Schalm *et al.* (1971) [15] and milk pH was done by digital pH meter MK Vl.

Protein profile

In the morning before feeding and watering, blood samples were collected from jugular vein in non EDTA vacutainer tubes. The sampling was done on -21, -14, -7, -5, -3, -1 days prepartum and on the day of calving (day 0) as well as on +1, +3, +5, +7, +14, +21 postpartum from individual animals. Analysis of protein profile (total protein, albumin and globulin concentration) was done by semi auto analyzer using diagnostic kit (Biolab Diagnostics Pvt. Ltd.).

Statistical analysis

To see the difference between different treatment groups one way analysis of variance was applied as per procedure given by Snedecor and Cochran (1994) [17]. If there was any significant difference existed in any group then DMRT was applied as per procedure given by Steel and Torrie (1984) [18].

Result and Discussion

Production parameter

Milk yield

Table 1: Mean values (±SE) of fortnightly changes of milk yield (kg) in Sahiwal cows

Fortnightly milk production (kg)	Experimental Group				Sig. level
	T_0	T_1	T_2	T_3	
First	51.88±4.14	68.06±7.72	64.64±5.26	66.50±6.82	NS
Second	54.87±3.18	71.26±4.96	76.68±6.00	78.63±10.46	NS
Third	56.32±2.73	74.06±6.87	77.16±5.90	81.88±13.56	NS
Fourth	57.65±4.70	76.70±6.92	78.38±11.57	84.33±11.54	NS
Fifth	$50.42±2.98^b$	$65.00±5.70^{ab}$	$68.84±5.13^a$	$79.18±7.87^a$	*
Mean	$54.22±1.35^b$	$71.01±2.08^a$	$73.14±2.71^a$	$78.10±3.07^a$	**

^{a,b}- Mean with different superscript in a row differ significantly *($P\leq0.05$), **($P\leq0.01$)

Fortnightly changes in milk yield during early lactation stage in Sahiwal cows under different dietary supplementation of zinc have been shown in Table 1 and the changes in milk yield depicted in Fig. 1. The mean values of milk yield of Sahiwal cows in T_0, T_1, T_2 and T_3 groups were 54.22±1.35, 71.01±2.08, 73.14±2.71 and 78.10±3.07 kg, respectively.

Milk yield was gradually increased with the progress of lactation from second to fourth fortnight; although higher milk yield was found in T_3 group towards second fortnight compared with other groups which are accordance with findings of Rajendran *et al*. (2013) [13], where they observed that milk yield was increased significantly ($P<0.01$) towards second fortnight in Holstein Friesian crossbred cows supplemented with nano zinc oxide due to increased bioavailability and biocide action of ZnO killed pathogenic bacteria and performed a protective action on mammary epithelium which influences the milk production. The level of improvement from first to fourth fortnight in milk yield was 8.55, 12.69, 18.62 and 26.81 % in T_0, T_1, T_2 and T_3 groups. Significant ($P\leq0.05$) difference was observed at fifth fortnight; although T_2 and T_3 group does not have significantly differed. There were significant ($P\leq0.01$) variation in mean value of milk yield of Sahiwal cows across the treatments and was significantly ($P\leq0.01$) higher in T_3 group followed by T_2, T_1 compared to control group; however, there was no significant difference between T_1, T_2 and T_3 groups due to good udder health, higher DMI and higher BCS in the treatment groups. These results were in

agreement with the findings of Bakhshizadeh *et al*. (2019), where they observed significantly (P<0.01) increased in milk yield being observed from third to eight week of lactation in Holstein dairy cows.

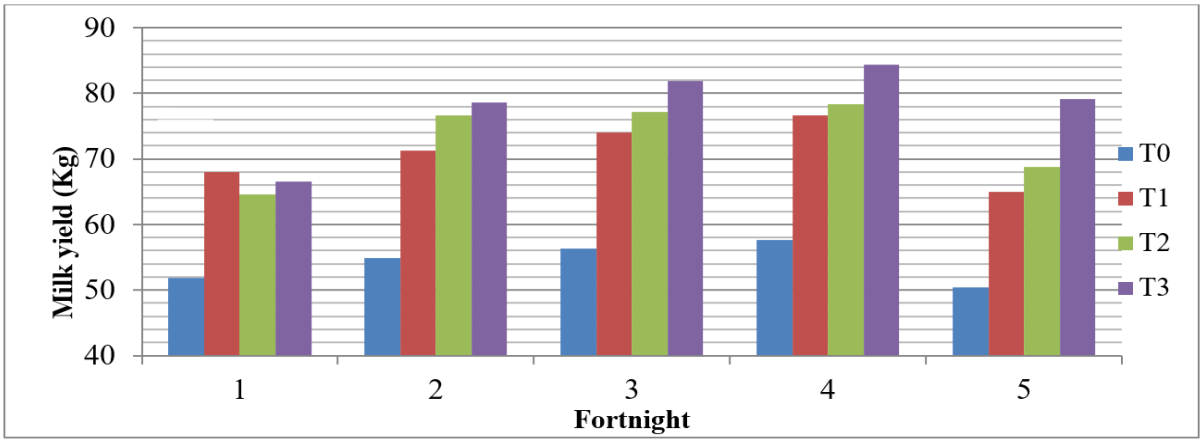

Fig 1: Fortnightly changes of milk yield (kg) in Sahiwal cows

Udder health indices

Somatic cell count

Table 2: Mean values (±SE) of SCC (x10^{5}cell/ml) in Sahiwal cows

Fortnightly milk SCC (x10^{5}cell/ml)	Experimental Group				Sig. level
	T_0	T_1	T_2	T_3	
First	1.93±0.44	1.75±0.32	1.80±0.23	1.64±0.27	NS
Second	1.72±0.26	1.58±0.22	1.63±0.17	1.38±0.31	NS
Third	1.80±0.41	1.53±0.39	1.53±0.21	1.44±0.35	NS
Fourth	1.70±0.37	1.47±0.19	1.49±0.31	1.22±0.28	NS
Fifth	1.65±0.18	1.51±0.28	1.36±0.29	1.24±0.34	NS
Mean	1.76±0.04^a	1.56±0.04^{ab}	1.56±0.07^{ab}	1.38±0.07^b	**

^{a,b}- Mean with different superscript in a row differ significantly **(P≤0.01)

Fortnightly changes in milk SCC during early lactation stage in Sahiwal cows under different dietary supplementation of zinc have been shown in Table 2 and the change in milk SCC is depicted in Fig. 2. The mean values of milk SCC of Sahiwal cows in T_0, T_1, T_2 and T_3 groups were 1.76±0.04, 1.56±0.04, 1.56±0.07 and 1.38±0.07 x10^{5}cell/ml, respectively. Lowest milk SCC was found at fifth fortnight of lactation in T_0 and T_2 group, whereas, fourth fortnight of lactation in T_1 and T_3 group. The level of SCC in milk from first to fifth fortnight was lower in T_3 group compared to other groups; although values were statistically non significant might be due to property of zinc which decreases a bacterial infection as well as improving the udder health during transition period in dairy cows.

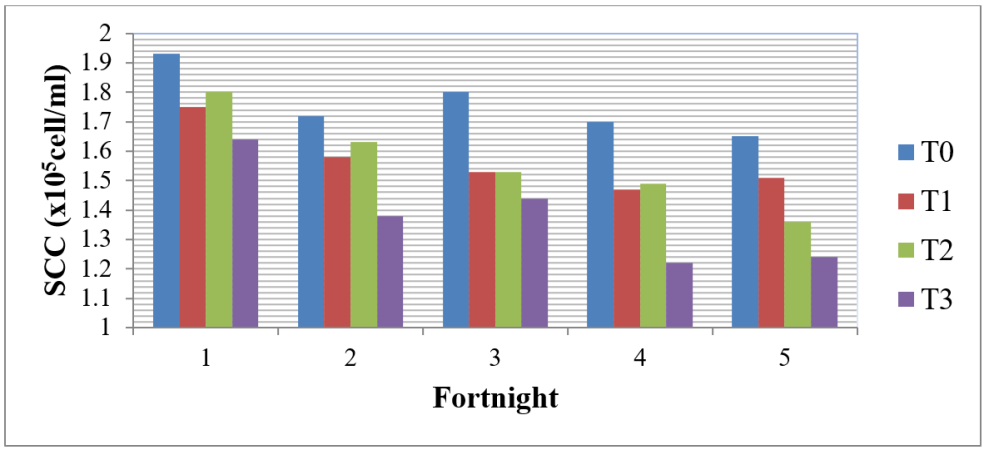

Fig 2: Fortnightly changes in SCC (x10^{5}cell/ml) in Sahiwal cows

There were significant (P≤0.01) variation in mean value of milk SCC of Sahiwal cows across the treatments and was significantly (P≤0.01) lower in T_3 group compared to other groups; however, there was no significant difference between T_1 and T_2 group. These results were in agreement with the findings of Bakhshizadeh *et al*. (2019) [1], where they reported that cows received nano zinc had significantly (P<0.05) reduced SCC in milk as lactation progressed in Holstein dairy cows may be attributed to a increase in leukocyte function, which can lead to decrease in the susceptibility of mammary gland to bacterial infection.

Milk pH

Table 3: Mean values (±SE) of milk pH in Sahiwal cows

Fortnightly milk pH	Experimental Group				Sig. level
	T_0	T_1	T_2	T_3	
First	7.06±0.04	6.94±0.03	7.01±0.06	6.78±0.16	NS
Second	6.90±0.04	6.72±0.14	6.74±0.18	6.55±0.10	NS
Third	7.01±0.07	6.68±0.20	6.66±0.19	6.58±0.07	NS
Fourth	6.85±0.10	6.63±0.11	6.63±0.15	6.51±0.18	NS
Fifth	6.82±0.10	6.65±0.13	6.53±0.13	6.53±0.17	NS
Mean	6.92±0.04^a	6.72±0.05^b	6.71±0.08^b	6.59±0.04^b	**

^{a,b}- Mean with different superscript in a row differ significantly **(P≤0.01)

Fortnightly pH of milk during early lactation stage in Sahiwal cows under different dietary supplementation of zinc have been shown in Table 3 and illustrated in Fig. 3. The mean of pH of milk of Sahiwal cows in T_0, T_1, T_2 and T_3 groups were 6.92±0.04, 6.72±0.05, 6.71±0.08 and 6.59±0.04, respectively. pH of milk was found to be decrease as lactation proceeded from first to fifth fortnight in all the groups during the period of study. The values of pH of milk from first to fifth fortnight was lower in T_3 group compared to other groups; although values were statistically non significant. Overall mean of pH of milk of 75 days of lactation period in all groups differ significantly (P≤0.01) and was significantly (P≤0.01) lower in T_3 group compared to other groups; however, there was no significant difference between T_1 and T_2 group. Overall milk pH was higher in control group which are accordance with findings of Singh *et al*. (2020) [16], where they observed pH of milk was significantly (P<0.01) higher in control group in Jersey crossbred cows. Similar findings were observed by Ianni *et al*. (2020) [7] who reported that milk pH was statistically non significant with zinc supplementation of lactating dairy cows.

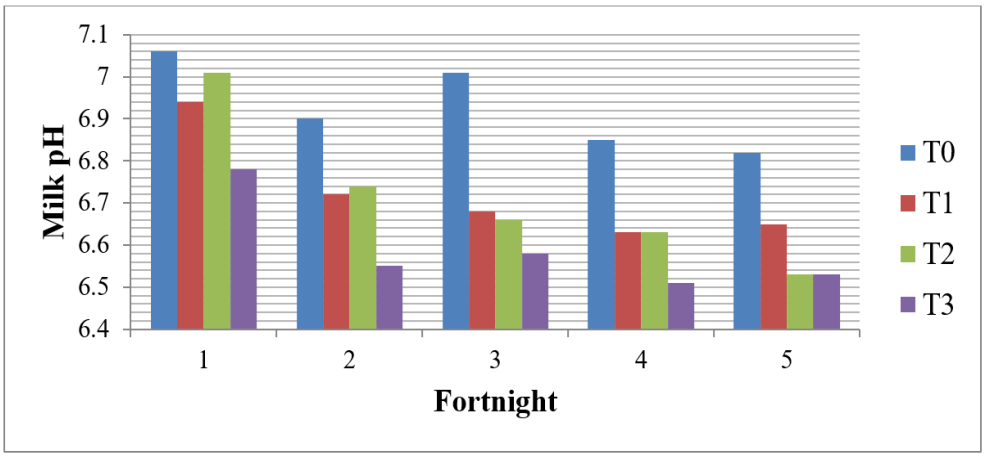

Fig 3: Fortnightly changes in pH of milk in Sahiwal cows

Protein Profile

Total Protein

Table 4: Mean values (±SE) of Total protein (g/dl) in Sahiwal cows

Periods of observations	Total protein (g/dl) in Sahiwal cows				Sig. level
Days relative to calving	T_0	T_1	T_2	T_3	
-21	6.65±0.25	6.68±0.24	6.64±0.27	6.51±0.26	NS
-14	7.35±0.33	7.42±0.15	7.77±0.20	7.56±0.24	NS
-7	7.03±0.32	7.11±0.33	7.16±0.23	7.30±0.17	NS
-5	7.15±0.42	6.92±0.26	7.20±0.27	7.21±0.31	NS
-3	7.21±0.36	7.26±0.18	7.01±0.30	7.29±0.14	NS
-1	6.86±0.39	7.04±0.15	7.31±0.41	7.55±0.26	NS
At Calving	6.52±0.24	6.74±0.12	6.85±0.38	7.00±0.28	NS
+1	7.11±0.46	7.43±0.47	7.81±0.28	7.68±0.43	NS
+3	7.37±0.36	7.51±0.37	7.72±0.20	7.99±0.38	NS
+5	7.28±0.40	7.46±0.42	7.54±0.24	7.78±0.26	NS
+7	7.31±0.33	7.32±0.45	8.13±0.30	8.38±0.25	NS
+14	7.22±0.28^b	8.16±0.22^a	8.00±0.19^a	8.19±0.29^a	*
+21	7.35±0.22	7.84±0.37	8.28±0.23	8.52±0.32	NS
Mean	7.10±0.07^b	7.29±0.11^{ab}	7.49±0.14^a	7.61±0.15^a	*
Prepartum Mean	7.04±0.10	7.07±0.10	7.18±0.15	7.23±0.15	NS
Postpartum Mean	7.27±0.03^c	7.62±0.12^b	7.91±0.11^{ab}	8.09±0.13^a	**

^{a,b,c}- Mean with different superscript in a row differ significantly *(P≤0.05), **(P≤0.01)

The mean serum concentration of total protein during the transition period in Sahiwal cows under different dietary supplementation of zinc have been shown in Table 4. The pattern of total protein concentration from pre to postpartum is shown in Fig. 4. The mean concentration of total protein of Sahiwal cows in T_0, T_1, T_2 and T_3 groups were 7.10±0.07, 7.29±0.11, 7.49±0.14 and 7.61±0.15 g/dl, respectively. The total protein concentration during prepartum period was lower compared to postpartum period among all the groups might be due to protein catabolism increased around parturition to support milk protein synthesis and hepato gluconeogenesis. These results were in agreement with the findings of Yadav *et al.* (2019) [20], where they observed higher levels of total protein was reported at postpartum compared to prepartum period in Sahiwal cows but values were found to be statistically non significant.

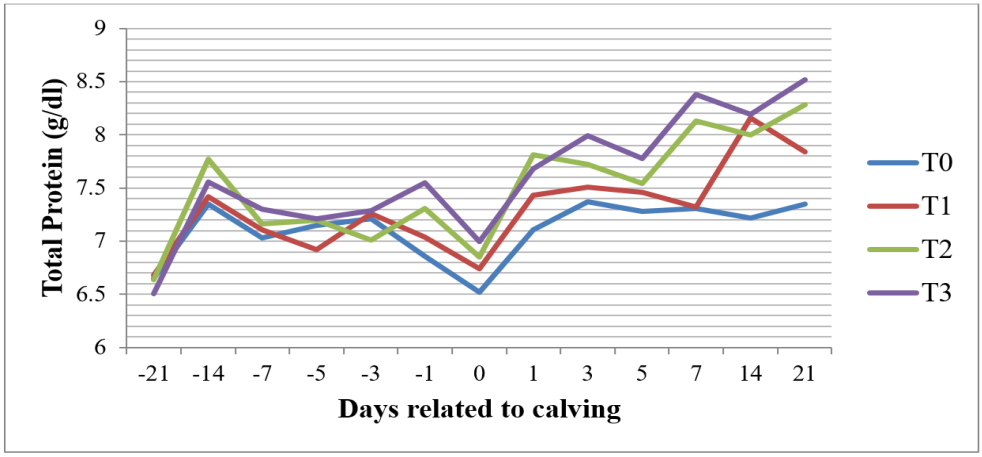

Fig 4: Trend in total protein conc. (g/dl) in Sahiwal cows

The significant (P<0.05) higher level of total protein concentration was found at 14 days after calving in treatment groups compared to control group; however, treatment groups does not have significantly differed. The postpartum mean concentration of total protein in T_3 group was found to be highly significant (P≤0.01) followed by T_2, T_1 with respect to control group. There were significant (P<0.05) variation in mean concentration of serum total protein of Sahiwal cows across the treatments and was significantly (P<0.05) higher in both T_3 and T_2 groups compared to T_1 and control; however, T_2 and T_3 group does not have significantly differed. In corroboration with present findings, Elshahawy and Abdullaziz (2017) [3] observed plasma total protein concentration was significantly increased with diets including supplementary chelated zinc in Friesian cows. In contrary to present findings, Bakhshizadeh *et al.* (2019) [1], who found that Holstein dairy cows whose diets were supplemented with different sources of zinc had no significant effects on plasma concentration of total protein.

Albumin concentration

The mean serum concentration of albumin during the transition period in Sahiwal cows under different dietary supplementation of zinc have been shown in Table 5 and Fig. 5. The mean concentration of albumin of Sahiwal cows in T_0, T_1, T_2 and T_3 groups were 3.11±0.06, 2.91±0.08, 3.04±0.08 and 3.27±0.09 g/dl, respectively. The albumin concentration during postpartum was higher compared to prepartum period among all the treatment groups compared to control group. The postpartum mean concentration of albumin in T_3 group was found highly significant (P≤0.01) followed by T_2, T_0 with respect to T_1 group. There were significant (P<0.05) variation in mean concentration of serum albumin of Sahiwal cows across the groups and was significantly (P<0.05) higher in T_3 group compared to other treatment and control group; however, T_0 and T_2 group does not have significantly differed. In corroboration with present findings, Mandal and Dass (2010) [9] observed plasma albumin concentration was significantly increased with diets including supplementary zinc in crossbred calves. In contrary to present findings, Shakweer *et al.* (2010) [14], where they reported that concentration of albumin was decreased with supplementation of different sources of Zn in Friesian cows.

Table 5: Mean values (±SE) of Albumin (g/dl) in Sahiwal cows

Periods of observations	Albumin (g/dl) in Sahiwal cows				Sig. level
Days relative to calving	T_0	T_1	T_2	T_3	
-21	2.91±0.19	2.62±0.27	2.54±0.23	2.49±0.21	NS
-14	3.64±023	3.43±0.29	3.17±0.28	3.46±0.27	NS
-7	3.03±0.25	2.88±0.34	2.88±0.40	3.00±0.25	NS
-5	3.07±0.27	2.39±0.19	2.75±0.32	3.09±0.33	NS
-3	3.25±0.34	2.77±0.26	2.76±0.30	3.07±0.23	NS
-1	3.24±0.40	2.79±0.35	2.90±0.19	3.20±0.42	NS
At Calving	2.80±0.34	2.70±0.26	3.00±0.35	3.03±0.25	NS
+1	3.20±0.42	3.37±0.27	3.41±0.29	3.48±0.28	NS
+3	3.27±0.39	2.99±0.17	3.08±0.24	3.57±0.21	NS
+5	3.08±0.37	3.09±0.26	3.19±0.42	3.65±0.23	NS
+7	3.02±0.35	2.96±0.36	3.74±0.21	3.89±0.19	NS
+14	2.86±0.33	3.18±0.42	3.00±0.23	3.32±0.37	NS

+21	3.16±0.26	2.67±0.25	3.16±0.27	3.29±0.34	NS
Mean	3.11±0.06^{ab}	2.91±0.08^{b}	3.04±0.08^{ab}	3.27±0.09^{a}	*
Prepartum Mean	3.19±0.10	2.81±0.14	2.83±0.08	3.05±0.13	NS
Postpartum Mean	3.09±0.05^{b}	3.04±0.09^{b}	3.26±0.11^{b}	3.53±0.09^{a}	**

^{a,b}- Mean with different superscript in a row differ significantly *(P≤0.05), **(P≤0.01)

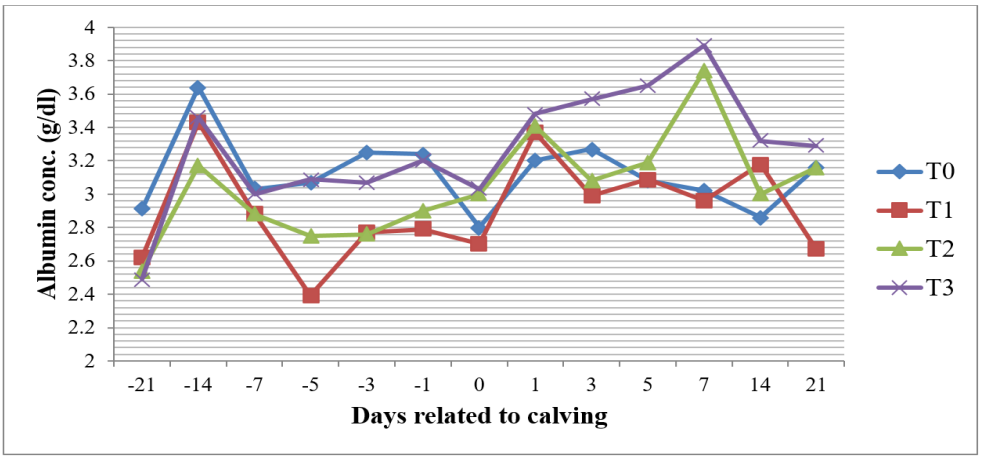

Fig 5: Trend in albumin conc. (g/dl) in Sahiwal cows

Globulin concentration

Table 6: Mean values (±SE) of Globulin (g/dl) in Sahiwal cows

Periods of observations	Globulin (g/dl) in Sahiwal cows				Sig. level
Days relative to calving	T_0	T_1	T_2	T_3	
-21	3.74±0.21	4.06±0.19	4.10±0.22	4.02±0.24	NS
-14	3.71±0.24	3.99±0.23	4.60±0.29	4.10±0.28	NS
-7	4.00±0.27	4.22±0.20	4.28±0.33	4.30±0.17	NS
-5	4.08±0.19	4.53±0.29	4.45±0.27	4.12±0.23	NS
-3	3.96±0.13	4.49±0.22	4.25±0.34	4.30±0.30	NS
-1	3.62±0.21	4.25±0.30	4.41±0.24	4.12±0.28	NS
At Calving	3.73±0.27	4.00±0.12	3.85±0.18	3.97±0.0.25	NS
+1	3.96±0.18	4.06±0.23	4.40±0.24	4.20±0.13	NS
+3	4.10±0.25	4.52±0.33	4.64±0.26	4.42±0.23	NS
+5	4.20±0.25	4.37±0.25	4.35±0.30	4.12±0.24	NS
+7	4.29±0.30	4.36±0.29	4.39±0.33	4.47±0.30	NS
+14	4.36±0.25	4.98±0.12	5.00±0.23	4.87±0.19	NS
+21	4.19±0.22^{b}	5.17±0.16^{a}	5.12±0.21^{a}	5.23±0.14^{a}	**
Mean	3.99±0.06^{b}	4.38±0.10^{a}	4.45±0.09^{a}	4.33±0.09^{a}	**
Prepartum Mean	3.85±0.07^{b}	4.25±0.09^{a}	4.35±0.07^{a}	4.1±0.04^{a}	**
Postpartum Mean	4.18±0.05	4.57±0.17	4.65±0.13	4.55±0.17	NS

^{a,b}- Mean with different superscript in a row differ significantly **(P≤0.01)

The mean serum concentration of globulin during the transition period in Sahiwal cows under different dietary supplementation of zinc have been shown in Table 6. The pattern of globulin concentration from prepartum to postpartum is shown in Fig. 6. The mean concentration of globulin of Sahiwal cows in T_0, T_1, T_2 and T_3 groups were 3.99±0.06, 4.38±0.10, 4.45±0.09 and 4.33±0.09 g/dl, respectively. The globulin concentration during prepartum period was lower compared to postpartum period among all the groups because globulins playing a role in immune response (antibodies and immunoglobulins), provide an early line of defense in immunologically naive animals against pathogens and also influence the development of antibodies. The significant (P<0.01) higher level of globulin concentration was found at 21 days after calving in treatment groups compared to control group; however, treatment groups does not have significantly differed. The prepartum mean concentration of globulin in treatment groups was found highly significant (P≤0.01) with respect to control group. However, treatment groups do not have significantly differed. There were significant (P<0.01) variation in mean concentration of serum globulin of Sahiwal cows across the treatments and was significantly (P<0.01) higher in T_2 group compared to other groups. In corroboration with present findings, Gaafar *et al.* (2011) [6] reported that cows fed higher level of Zn at 10 gm/head/day of Zn methionine had the significantly higher plasma globulin. In contrary to present findings, Nagalakshmi *et al.* (2016) [11] reported that increasing levels of organic zinc did not influenced the concentration of globulin in rats.

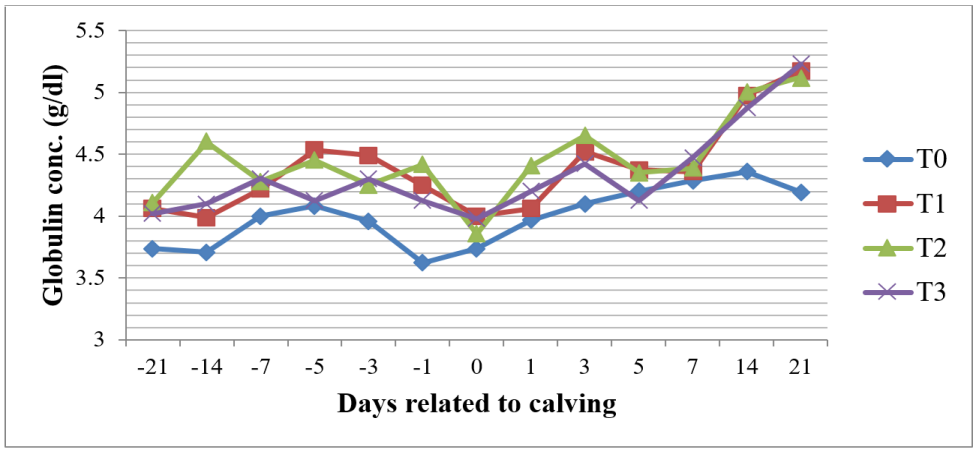

Fig 6: Trend in globulin conc. (g/dl) in Sahiwal cows

Conclusion

Overall, it can be concluded that cows supplemented with 40 ppm of nano Zn showed better performance compared to cows of other groups. T_3 group had significantly higher in milk yield, total protein concentration, and albumin concentration; however, significantly lower in somatic cell count and milk pH. As a result increase in milk production and reduction in SCC values ie. better milk quality by 40 ppm of nano Zn supplementation to Sahiwal cows could be useful feeding strategies.

Acknowledgment

Authors are thankful to Dean, College of Veterinary Science and A.H., DSVCKV, Anjora, Durg providing the facilities for conducting this research work and are also sincerely acknowledge to cattle keepers in BMEF, Anjora for their kind participation in the study.

References

1. Bakhshizadeh S, Aghjehgheshlagh FM, Taghizadeh A, Seifdavati J, Navidshad B. Effect of zinc sources on milk yield, milk composition and plasma concentration of metabolites in dairy cows. South African Journal of Animal Science, 2019, 49(No. 5).
2. Cortinhasa CS, Botarob BG, Sucupirac MCA, Rennoa FP, Santo MV. Antioxidant enzymes and somatic cell count in dairy cows fed with organic source of zinc, copper and selenium. Livestock Science. 2010;127:84-87.
3. Elshahawy II, Abdullaziz IA. Haemato-Biochemical Profiling in Relation to Metabolic Disorders in Transition Dairy Cows. Alex. J Vet. Sci. 2017;55(2):25-33.
4. Feng M, Wang ZS, Zhou AG, Ai DW. The effects of different sizes of nanometer zinc oxide on the proliferartion and cell integrity of mice duodenum-epithelial cells in primary culture. Pak. J Nutr. 2009;8:1164-1166.
5. Gaafar HMA, Basiuoni MI, Ali MFE, Shitta AA, Shamas ASE. Effect of zinc methionine supplementation on somatic cell count in milk and mastitis in Friesian cows. Archiva Zootechnica, 2010;13:36-46.
6. Gaafar HMA, Basiuoni MI, Ali MFE, Shitta AA, Shamas ASE. Effect of zinc methionine supplementation on productive performance of lactating Friesian Cows. J. Anim. Sci. Biotech. 2011;2(2):94-101.
7. Ianni A, Martino C, Innosa D, Bennato F, Grotta L, Martino G. Zinc supplementation of lactating dairy cows: effects on chemical- nutritional quality and volatile profile of Caciocavallo cheese. AJAS. 2020;33(5):825-835.
8. Kevin L, Ellen J. The metabolic profile for the modern transition dairy cow. Mid-South Ruminant Nutrition Conference, Grapevine, Texas, 2012.
9. Mandal GP, Dass RS. Haemato-biochemical profile of crossbred calves supplemented with inorganic and organic source of zinc. Indian J Anim. Res. 2010;44:197-200.
10. Maurya PK, Aggarwal A, Singh SV, Chandra G, Singh AK, Chaudhari BK. Effect of vitamin E and zinc on cellular antioxidant enzymes in Karan Fries cows during transition period. Indian J Anim. Res. 2014;48(2):109-119.
11. Nagalakshmi D, Sridhar K, Swain PS, Reddy AG. Effect of substituting increasing levels of organic Zn for inorganic Zn on performance, hematological and serum biochemical constituents, antioxidant status and immune response in rat. Iranian Journal of Veterinary Research. 2016;2(55):111-117.
12. NRC. Nutriet Requirements of Dairy Cattle. National Academy og Science, Washington, DC, 2001.
13. Rajendran D, Kumar G, Ramakrishnan S, Thomas KS, Enhancing the milk production and immunity in Holstein Friesian crossbred cow by supplementing novel nano zinc oxide. Research Journal of Biotechnology. 2013;8:11-17.
14. Shakweer IME, EL-Mekass AAM, EL-Nahas HM. Effect of two different sources of zinc supplementation on productive performance of Friesian dairy cows. Egyptian J Anim. Prod. 2010;47(1):11-22.
15. Schalm OW, Carroll EJ, Jain NC. Bovine mastitis. Lea and Febiger, Philadelphia, U.S.A, 1971.
16. Singh AK, Bhakat C, Mandal DK, Chatterjee A. Effect of pre and postpartum Alpha- tocopherol supplementation on Body Condition and Some udder health parameters of Jersey crossbred cows at Tropical Lower Gangetic Region. Journal of Animal Research. 2020;10(5):697-703.
17. Snedecor GW, Cochran WG. Statistical methods. 8th edition. Iowa State University Press, Iowa, USA, 1994.
18. Steel RGD, Torrie JH. Principles and procedures of statistics. A Biometrical approach. 2nd edition. McGraw – Hill International Book Company, 1984.
19. Swain PS, Rao SBN, Rajendran D, Krishnamoorthy P, Mondal S, Pal D, *et al*. Nano zinc Supplementation in goat ration improves immunity, serum zinc profile and

IGF-I hormones without affecting thyroid hormones. Journal of Ani. Physiology & Ani. Nutrition, 2021. https://doi.org/10.1111/jpn.13500.
20. Yadav BK, Singh VK, Singh SK. Lipid mobilization and serum metabolites dynamics of Sahiwal cows during the transition period. Biological Rhythm Research, 2019, 1-8.