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EFFECT OF SUPPLEMENTATION OF NANO COPPER, NANO COBALT AND NANO ZINC ON HAEMATOLOGY AND SERUM BIOCHEMISTRY IN GOATS

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Abstract: Supplementation of trace minerals as nano particles increases absorption and bioavailability leading to reduction in the required quantity and ultimately reduction in feed cost. Hence, a feeding trial was conducted for a period of 120 days to assess the effect of supplementation of nano copper, nano cobalt and nano zinc at 75% and 50% dose levels on bioavailability in growing goats. Eighteen, three month old kids were divided into three groups of six animals in each. Mineral mixture with inorganic sources of copper, cobalt and zinc at 100% level (MM1) was fed to control group (T1) and the other two groups T2 and T3 were fed with mineral mixtures containing nano forms of copper, cobalt and zinc at 75% (MM2) and 50% (MM3) levels respectively completely replacing the inorganic sources. Blood samples were collected from all the kids of the three treatment groups at the end of the feeding trial and haematological parameters and serum biochemical profile were estimated. The results of haemoglobin, RBC count, WBC count were within the normal range and revealed no significant difference ($p>0.05$) between the treatment groups. The serum biochemical parameters such as blood urea nitrogen, creatinine, total protein, albumin, globulin, glucose, triglyceride and cholesterol were observed to be at optimum levels and did not vary significantly ($p>0.05$) between the treatment groups. Hence it is concluded that the inorganic sources of copper, cobalt and zinc could be effectively replaced by nano forms of these minerals even up to reduced dose level of 50 percent in the mineral mixture fed to growing kids without any adverse effect on the bioavailability.

Keywords: Nano minerals, supplementation, haematology, serum biochemistry, goats

Introduction

Trace minerals are essential in goat diets, especially for young kids, as insufficient availability can significantly reduces their performance, leading to serious economic consequences. Zinc is required for the functional and structural integrity of over 2000 transcription factors and almost every signaling and the metabolic pathway is dependent on

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one or more zinc-requiring proteins. Copper is a vital trace element essential for the proper functioning of various enzyme systems and also plays a key role in physiological functions of haematological, nervous, cardiovascular, reproductive, antioxidant and immune systems (Riaz and Muhammad, 2018). Cobalt functions as a component of vitamin B_{12} (cobalamine). Ruminants are not dependent on a dietary source of vitamin B_{12} because ruminal microorganisms are capable of synthesizing B_{12} from dietary cobalt, whereas non- ruminant are dependent on the dietary source. Nano form of supplementation of these trace minerals increases the surface area that would increase mineral absorption (Desai *et al.,* 1997) and thereby its utilization leading to reduction in the quantity of its supplementation and ultimately reduction in feed cost. Nano minerals exhibit improved bioavailability due to their increased surface area, higher surface activity, enhanced catalytic efficiency and stronger adsorption capacity. Hence, a study was conducted in goat kids to assess the impact of supplementation of critical trace minerals *viz.,* zinc, copper and cobalt in nano form on haematological and serum biochemical profile to understand the bioavailability.

Materials and Methods

The study was conducted at Livestock Farm Complex, Veterinary College and Research Institute, Tirunelveli located in the semi-arid region of the country between 8°05' and 9°30' N latitude, 77°05' and 78°25' E longitude and at altitude of 48 m above mean sea level. A total of eighteen Kanni breed goat weaned kids of three months age, with mean body weight of 8.50 kg were randomly divided in a completely randomized design into three treatments (T1, T2 and T3) with each treatment group consisting of six animals (three males and three females). The feeding trial was conducted for a period of 120 days. During the trial period, the kids were fed a daily ration consisting of 65% green fodder (equal parts of Cumbu Napier Hybrid grass and *Desmanthus virgatus* legume fodder) and 35% concentrate mash feed. The concentrate mixture was *isonitrogenous* and *isocaloric* with 18% crude protein and 2800 kcal metabolisable energy. Three types of mineral mixtures (M1, M2, M3) were prepared which were added up to 2% level in the concentrate feed fed to the three experimental groups (T1, T2 and T3) respectively. Mineral mixture M1 contained 100% inorganic sources of copper, cobalt and zinc whereas M2 and M3 contained only 75% and 50% copper, cobalt and zinc in nano form respectively. Nano Cu, Nano Co and Nano Zn were synthesized by the physical top down method using Planetary Ball mill (Retsch – PM 100) using feed grade copper sulphate, cobalt sulphate and zinc oxide respectively. During the first month of the experiment, the quantity of concentrate mixture offered was 120 g per animal per day, which

was increased to 250 g per animal per day in the fourth month depending on the biweekly body weight gain. The animals had *ad libitum* access to water throughout the experimental period. Blood samples were collected from all the experimental animals of the three treatment groups at the end of the feeding trial. Haematological parameters *viz.* Haemoglobin, PCV, RBC count and WBC count were assessed using automatic analyzer (MINDRAY BC-2800). Serum was separated from the blood samples and analyzed for Glucose, Total Protein, Albumin, Total Cholesterol, Triglycerides, Blood Urea Nitrogen (BUN) and Creatinine using automatic analyzer (A 15 BIOSYSTEMS). The results were analysed using statistical methods as per Snedecor and Cochran (1994).

Results and Discussion

A) Haematological parameters

The effect of supplementation of Nano Cu, Nano Co and Nano Zn on haematological parameters of the experimental kids is presented in Table 1. The haemoglobin, PCV, RBC and WBC values did not vary significantly ($p>0.05$) among the treatment groups.

Table 1. Effect of supplementation of Nano Cu, Nano Co and Nano Zn on haematological parameters in growing kids (Mean±SE) (n=6)

S. No.	Parameter	T1 (Control)	T2 (75 % Nano)	T3 (50 % Nano)	F value	P value
1.	Haemoglobin (g/dl)	7.99±0.37	8.82±0.50	8.47±0.30	1.11	0.36
2.	Packed Cell Volume (%)	26.75±0.38	29.23±1.42	28.23±0.17	2.16	0.15
3.	Red Blood Cells (x 10^6/ µ l)	12.39±0.36	12.92±0.43	12.90±0.40	0.58	0.58
4.	White Blood Cells (x 10^3/ µ l)	10.67±1.23	10.11±0.72	10.80±0.44	0.18	0.84

The results of the haematological parameters revealed that there is no significant difference ($p>0.05$) between the treatment groups. All the parameters were found to be within the reference range (Feldman *et al*., 2002). Results obtained in the present study corroborate with earlier findings of Swain *et al.* (2019), who reported that supplementation of nano zinc in goat ration had no effect ($p>0.05$) on RBC, WBC, PCV and haemoglobin levels. Anil (2017) had reported that ZnO nanoparticle supplementation did not cause significant changes in mean haemoglobin concentration, RBC count, WBC count, platelet count, or mean

corpuscular volume in crossbred calves, with all haematological parameters remaining within the normal range. Hassan *et al.* (2021) observed no significant difference for blood parameters between the nano cobalt supplemented group and the control group in goats. Gowtham *et al.* (2026) also reported that in broilers, the haematological parameters such as haemoglobin, packed cell volume, total erythrocyte count and total leukocyte count did not vary significantly ($p>0.05$) between the nano copper and nano zinc supplemented group and other treatment groups.

B) Serum biochemical parameters

The effect of supplementation of Nano Cu, Nano Co and Nano Zn on serum biochemical parameters in experimental kids is presented in Table 2.

Table 2. Effect of supplementation of Nano Cu, Nano Co and Nano Zn on serum biochemical parameters in growing kids (Mean±SE) (n=6)

S. No.	Parameter	T1 (Control)	T2 (75 % Nano)	T3 (50 % Nano)	F value	P value
1.	BUN (mg/dl)	61.65±6.46	58.42±3.68	52.70±4.22	0.84	0.45
2.	Creatinine (mg/dl)	0.35±0.04	0.30±0.003	0.27±0.01	1.48	0.26
3.	Total Protein (g/dl)	6.26±0.16	6.25±0.14	6.29±0.12	0.03	0.97
4.	Albumin (g/dl)	3.02±0.12	2.90±0.17	3.16±0.05	1.14	0.35
5.	Globulin (g/dl)	3.24±0.25	3.35±0.14	3.14±0.11	0.37	0.70
6.	Glucose (mg/dl)	52.42±2.93	52.52±2.67	58.85±2.11	2.02	0.17
7.	Triglyceride (mg/dl)	94.67±11.29	94.50±9.31	104.33±5.50	0.39	0.68
8.	Cholesterol (mg/dl)	59.09±0.89	59.50±1.17	58.96±0.26	0.11	0.90

The serum biochemical parameters such as blood urea nitrogen, creatinine, total protein, albumin, globulin, glucose, triglyceride and cholesterol levels did not vary significantly ($p>0.05$) between the treatment groups reflecting optimum nutrient absorption and utilization protein metabolism, kidney function, hydration status, nutrient absorption and utilization in all the experimental animals. Serum biochemical indicators serve as key markers for assessing nutrient absorption and utilization (Xie *et al.,* 2020). Total protein, which consists of albumin and globulin, not only reflects the efficiency of protein absorption but also plays a crucial role in humoral immunity (Tian *et al.,* 2009). El-Katcha *et al*. (2017) found that

supplementation with ZnO nanoparticles did not significantly affect serum levels of uric acid, total protein, or albumin in broilers. Mozhiarasi *et al.* (2024) reported that supplementation of ZnONPs did not significantly ($p > 0.05$) alter the serum glucose, total protein, albumin, cholesterol and uric acid values of the birds. Singh *et al.* (2018) noticed the effect of nano zinc oxide on blood biochemical changes in pre-ruminant lambs and reported that all the blood parameters were non-significant between the treatment groups. Khatami Khalkhoran *et al.* (2024) studied the effects of copper nano oxide and copper sulphate in lambs and observed that blood parameters such as albumin, protein, glucose, cholesterol, triglyceride and total antioxidant capacity were not affected by the experimental treatments. Similarly, the serum glucose, total protein, albumin, globulin, urea, creatinine and total cholesterol, were comparable with no significant changes among nano zinc and control group of guinea pigs (Uniyal *et al.,* 2017).

Conclusion

The results of the present study revealed that supplementation of trace minerals copper, cobalt and zinc in nano forms (75%, 50%) in the mineral mixture of goat kid diet did not adversely affect the hematological and serum biochemical profile. Hence it is concluded that the inorganic sources of copper, cobalt and zinc could be effectively replaced by nano forms of these minerals even up to reduced dose level of 50 percent in the mineral mixture fed to growing kids without adversely affecting the bioavailability.

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