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Effect of Zinc Nanoparticles Supplementation on plane of Nutrition and weight of Vital organs in Guinea Pigs

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ABSTRACT
A study was conducted to assess the effect of zinc nanoparticles on plane of nutrition and weight of vital organs in guinea pigs. The treatments, groups (T_1, control (inorganic zinc; $ZnSO_4$); T_2, organic Zn (Zn methionine), commercial zinc nanoparticle (T_3), two zinc nanoparticles prepared in our laboratory (T_4, T_5) were formed with six guinea pigs in each group (289±3.5 g body weight) in a completely randomized design. They were each supplemented with 20 mg Zn per kg feed on dry matter basis for 90 days experimental period. The results showed that supplementation of 20 ppm Zn nanoparticles had no beneficial effect on plane of nutrition and weights of vital organs were also comparable in all the treatment groups.
Keywords: *Zn, nanoparticles, ALT, AST*

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INTRODUCTION

Zinc (Zn) is a trace element essential for every living being [1]. It is an important component of various metallo-enzymes and activator of more than 300 enzymes plays vital role in hormone secretion, especially related to growth, reproduction and immune-competence[2]. Zinc is an essential component of both DNA and RNA polymerases [3]. It is a part of liver enzymes as cofactor including alanine aminotransferase (ALT), gamma glutamyl transferase (GGT) and aspartate aminotransferase (AST) and found in large quantities in liver enzymes [4]. Zinc is one of the structural component of wide variety of proteins and dependent enzymes like superoxide dismutase (SOD) that act as essential component of antioxidant defense system [5]. Zinc is required for normal activity of NK cells and function of B and T lymphocytes and maintains the integrity of immune system by preventing atrophy of lymphoid organs [6]. It is required for normal testicular development and spermatogenesis [7]. So far, the major source of Zn for animal feed supplementation has been its inorganic salts, such as zinc sulphate ($ZnSO_4$), zinc oxide (ZnO) and zinc chloride ($ZnCl_2$). However, bioavailability of Zn from inorganic sources has been reported to be quite low [8]. Recently, it has been demonstrated that material at nano meter dimension exhibit novel properties different from its normal sized particles. Studies showed that nanoparticles of minerals have higher bioavailability

MATERIAL AND METHODS

Synthesis of Zinc Nanoparticles

Zinc nano particles were synthesized by two different methods i.e. direct precipitation method [9] and Chitosan/ ZnO method [10] using chitosan and ZnO as starting materials and alkali as precipitating agent.

Characterization and Quantification of Zinc

Particle size of synthesized products (zinc nanoparticles) was measured using transmission electron microscope (JEOL JEM-1400) at ICAR-National Institute of High Security Animal Diseases, Bhopal.

Animals, Feeding and Management

Thirty weaned healthy male guinea pigs (*Cavia porcellus*) were procured from Laboratory Animal Research Section of ICAR-Indian Veterinary Research Institute, Izatnagar and divided into five groups of six each on the basis of body weight (289±3.5 g) following completely randomized design. Experimental animals were housed in a well-ventilated room adopting similar management and hygienic practices throughout the experiment. Clean drinking water was provided *ad libitum.* Experimental feeding was similar in all five groups, except for the source of zinc, which was zinc sulphate in group T_1, organic zinc (Zn-methionine) in group T_2, commercial zinc nanoparticles (SRL chemicals) in group T_3, zinc nanoparticles prepared by the method of [9] in group T_4 and by the method of [10] in group T_5. The weighed amount of the basal diet [20% ground maize (*Zea mays*) hay, 32% ground maize grain, 22.5% bengal gram (*Cicer arietinum*), 9% soybean (*Glycine max*) meal, 9% wheat (*Triticum aestivum*) bran, 6% fish meal, 1% mineral mixture (without zinc), 0.45% common salt and 0.05% vitamin C, 20 ppm zinc along with about 10-20 g green maize fodder daily (to meet their vitamin A requirement)] was offered daily at 09.30 h to meet the nutrient requirement. The amount of feed was regularly revised at weekly interval as per body weight of the animals during entire experimental feeding period of 90 days

Plane of nutrition

To determine plane of nutrition a four days metabolism trial was carried out after 45 days of experimental feeding. For this purpose, four animals from each group were randomly selected and kept in individual metabolic cages. Animals were adapted to these metabolic cages for three days before starting the actual collection of feces and urine. The feeding schedule during the metabolism trial was the same as was during the experimental feeding. During the metabolism trial representative samples of feeds offered and residue were dried, pooled and stored in airtight containers for further analysis. The total feces voided by individual animal during 24 hour period was separately collected and weighed at a fixed time daily. Half of the faeces were taken for DM estimation and dried samples were pooled for all four days in the polythene bags. Remaining half of the faeces for each animal was collected daily into a glass bottle containing 20% sulphuric acid and pooled for four days for nitrogen estimation. Urine excreted was also collected daily and pooled and preserved in 20% H_2SO_4 for the estimation of minerals and nitrogen.

Chemical Analysis

The feed and fodder were dried in a hot air oven until a constant weight is achieved and then ground to pass 1 mm sieve and stored in airtight polythene bags for further analysis. Analyses of proximate principles [11].

Estimation of weight of vital organs

At the end of experimental period of 90 days four animals from each group were sacrificed and vital organs like liver, kidney, spleen and testes were collected and washed with normal saline solution and there after weight of each vital organs were recorded on as such basis.

Statistical Analysis

All the data generated in the above experiment were statistically analyzed using IBM SPSS version 13 computer package. For comparison of groups, generalized linear model ANOVA procedure and Duncan's multiple range test were used [12].

RESULT AND DISCUSSION

Chemical composition of basal diet

A level of 20.29% CP in the basal diet (Table 1) fed to the guinea pigs in different groups was comparable to the requirement of guinea pigs as per [13].

Plane of nutrition

Comparable ($P>0.05$) intake of DCP and TDN and nutritive value of diet in all experimental groups (Table 2), indicated that supplementation of zinc either through organic source (Zn methionine) or as its nano particles at 20 ppm level in the diet had no effect on plane of nutrition of guinea pigs. However, similar to our observation [14] in kids,[15]in lambs [16] in guinea pigs and [17]in bulls did not observe any difference in DCP and TDN intake on supplementation of 20-40 ppm of either organic Zn or $ZnSO_4$.

Estimation of weight of vital organs

Similar ($P>0.05$) weights of liver, kidney, spleen and testes among different groups, (Table 3), indicated that supplementation of Zn either through organic source (Zn methionine) or as its nano particles at 20 ppm level in the diet had no effect on weights of vital organs in the guinea pigs. Similar to our observations, [16] did not observe any difference in weight of liver and spleen in guinea pigs supplemented 20 ppm Zn as organic or through $ZnSO_4$. [18] also did not observe any significant difference in weights of vital organs in broilers supplemented with 80-120 ppm organic or inorganic Zn.

Table 1 Chemical composition (% DM basis) of basal diet and green fodder

Nutrients	Basal diet	Green maize
OM	92.51	92.24
CP	20.29	4.90
EE	2.35	2.24
NDF	48.77	70.69
ADF	20.08	39.67
Ca	2.17	0.85
P	1.20	0.58
Zn (ppm)	18.0	7.75
Cu (ppm)	14.98	11.42
Fe (ppm)	50.2	10.60
Mn (ppm)	39.72	17.11
Co (ppm)	1.77	0.36

Table 2 plane of nutrition of guinea pigs in different groups during metabolic trail

Attributes	G 1	G 2	G 3	G 4	G 5	SEM	P value
Mean BW (g)	498.0±7.2	492.0±31.6	504.2±17.0	506.9±36.3	496.3±4.4	9.7	0.807
DMI (g/kg$^{0.75}$)	41.2±3.9	43.6±4.7	44.0±1.5	44.3±3.5	44.9±1.0	1.3	0.817
OMI (g/kg$^{0.75}$)	38.1±3.6	40.3±4.4	40.7±1.4	41.0±3.3	41.5±0.9	1.2	0.817
CPI (g/kg$^{0.75}$)	7.56±0.8	8.03±0.9	8.14±0.3	8.19±0.7	8.31±0.2	0.3	0.821
DCPI (g/kg$^{0.75}$)	5.35±0.6	5.82±0.7	5.99±0.2	5.86±0.5	5.86±0.1	0.2	0.849
TDNI (g/kg$^{0.75}$)	31.4±3.3	33.8±4.4	33.9±0.6	34.8±3.1	34.5±0.7	1.1	0.850
Nutritive value of diet (%)							
CP	18.31±0.19	18.35±0.22	18.47±0.08	18.47±0.08	18.50±0.03	0.06	0.831
DCP	12.93±0.26	13.28±0.27	13.59±0.20	13.19±0.19	13.05±0.08	0.10	0.283
TDN	76.0±2.39	76.9±2.86	77.1±1.66	78.3±1.26	76.8±1.19	0.79	0.948

Table 3 Weight of vital organs of guinea pigs in different groups

Attributes	G 1	G 2	G 3	G 4	G 5	SEM	P Value
Mean Body wt (g)	527.1±32.0	522.7±34.42	548.1±11.56	527.2±25.55	509.6±20.31	10.4	0.895
Organ wt (g)							
Liver	21.90±1.50	19.00±1.27	21.35±2.10	21.60±2.38	20.55±1.03	0.76	0.805
Kidney	4.20±0.60	4.15±0.25	3.95±0.26	4.35±0.13	4.25±0.10	0.1	0.778
Spleen	0.70±0.10	0.75±0.10	0.80±0.12	0.75±0.10	0.80±0.08	0.04	0.996
Testes	4.40±0.40	5.05±0.13	5.65±0.41	5.35±0.26	5.15±0.22	0.14	0.163
Organ wt (as % of BW)							
Liver	4.15±0.03	3.63±0.11	3.88±0.34	4.08±0.31	4.03±0.11	0.10	0.589
Kidney	0.81±0.16	0.80±0.01	0.72±0.04	0.83±0.04	0.84±0.03	0.02	0.457
Spleen	0.14±0.03	0.14±0.01	0.15±0.02	0.15±0.02	0.16±0.02	0.01	0.944
Testes	0.84±0.03	0.97±0.05	1.03±0.06	1.02±0.02	1.01±0.03	0.02	0.115

CONCLUSION

Results reveal that there were no significant difference in the plane of nutrition and weights of vital organs in guinea pigs supplemented 20 ppm of zinc nanoparticles as compared to other treatment groups.

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