

Original Research Article

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Impact of Nano Zinc Oxide (nZnO) Dietary Supplementation on Crossbred Calves Growth Performance

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ABSTRACT

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An investigation on the impact of supplementation with nano zinc oxide (nZnO) on crossbred calves' growth performance was carried out. Twenty Four numbers of crossbred calves (Jersey × Holstein Friesian) of 6-9 months age were randomly assigned to three groups containing 8 number of animals in each group- T0, T1 and T2. The T0, T1, and T2 groups, which received supplements containing inorganic ZnO @ 40mg/kg DM, Nano ZnO @ 10mg/kg DM and Nano ZnO @ 20mg/kg DM, respectively, in addition to the basic diet. The findings of the experiment confirm that the average daily gain (g/day) and body weight gain (kg) were significantly ($P < 0.01$) greater in the T2 group, T1 group came in second, and the T0 group had the lowest gains. In terms of cost per kg weight gain (Rs) was lowest in T2 group. From the current study, it can be concluded that nano zinc can be supplemented in calf ration up to 20mg /kg DMI for their economic growth rate.

Introduction

Zinc is a trace mineral that promotes various animal processes, including growth, skin health, hair and hoof growth, wound healing, cell division, and reproduction. It also meets various demands of the animal directly or indirectly.

Even a slight lack of Zinc element, can have a detrimental impact on an animal's ability to thrive. Zinc intake for cattle should be approximately 33 milligrams per kilogram per animal, with a typical serum zinc content of 0.7 to 1.3 g/ml. But according to Nagalakshmi *et al.*, (2009), there is a zinc deficiency in the soil of

other regions of India, which affects the feed. It is usual practice to add traditional zinc sources over the prescribed level when the body lacks storage reserve of zinc in order to prevent zinc insufficiency. The poor solubility of conventional forms of zinc contributes to their decreased bioavailability, which is an additional disadvantage.

In this study, the idea of "formulation of least cost ration" lends additional weight to the difficult challenge of locating a substitute zinc supply that can alleviate animal zinc shortage. A novel kind of zinc metal known as nano zinc oxide (nZnO) has been created by the application of nanotechnology principles. Various preparation

techniques have been used to modify the size, shape, and crystalline structure of the metal (Swain *et al.*, 2016). Notably, the enormous surface area and particle size in the 1-100 nm range of these nano-minerals accounts for their unique feature of improved bioavailability in biological systems (Bulghavan *et al.*, 2014). The primary benefit of nano zinc is its ability to lower the rate of inclusion in animal diets. Small ruminants and poultry growth performance in response to dietary nZnO supplementation has been studied by a small number of researchers worldwide. Adding nZnO in place of traditional zinc was found to improve feed intake (Ahmadi *et al.*, 2013), growth rates (Mishra *et al.*, 2014), and favorable feed conversion ratio (Zhao *et al.*, 2014; Sahoo *et al.*, 2016) in a number of species. Thus, the main objective of the study was to see how nZnO affected the growth performance of crossbred calves.

Materials and Methods

In this study, 24 numbers of crossbred calves (Jersey × Holstein Friesian) of 6-9 months age were randomly assigned to three groups containing 8 number of animals in each group. The T0, T1, and T2 groups, which received supplements containing inorganic ZnO @ 40 mg/kg DM, Nano ZnO@ 10mg/kg DM and Nano ZnO @ 20 mg/kg DM, respectively, in addition to the basic diet. The selected calves were dewormed, vaccinated and treated against ectoparasites prior to commencement of the study. Each experimental animal was kept in a concrete cement flooring shed with enough ventilation, as well as individual food and watering facilities. Cleaning and disinfecting the shed on a regular basis. All the experimental calves were provided with hybrid Napier and Para grass with concentrate mixture as per their need. The ingredients of concentrate mixture is given in Table 1. The inorganic zinc oxide (98.5% purity) was procured from EMPLURA and Nano zinc oxide (99.9% purity) powders were procured from Anand Agricultural University, Gujrat. The experiment was conducted for 84 days. The feeding trails of calves were done in individual pen system. The feeding of concentrate to calves were done twice daily at morning 9.00 am and evening 3.00 pm in divided dose. The paddy straw and green grasses were given daily at 10.00 am and 5.00 pm. Clean drinking water was offered at 9.15 am and 3.15 pm. Record of daily feed offered, feed intake water intake and residue left is weight after one hour of providing feed is kept. Fortnightly body weight, feed intake of the animals were recorded. Body weights were recorded on an electronic platform weighing scale. Table

2 shows the body weight gain (kg) and average daily gain (g) of the animal. The amount of feed that the calves consumed overall throughout the trial period and the cost of ingredients at the local market were taken into account to determine the cost of feeding.

Results and Discussion

The impact of dietary supplementation with nano zinc oxide (nZnO) on calve's body weight increase is shown on Table 2. Statistical analysis showed that at the end of the trial, there was a significant difference ($P < 0.05$) in the body weight gain (kg) of calves between the test groups. The T2 group exhibited highest growth rates followed by T1 and T0 ($P < 0.05$) group. The average daily gain (g/day) was also significantly ($P < 0.05$) higher in the T2 group supplemented with nano zinc 20 mg/kg DM compared to the other groups. This could be explained by the fact that the gastrointestinal system was able to absorb the zinc nanoparticles more effectively than the other groups (Mishra *et al.*, 2014). Similar findings was observed with Seifdavati *et al.*, (2018) who reported significant effect on final weight and weight gain in the calves supplemented with nano zinc oxide (30 and 60 mg/kg DMI in their diet) then the control group (without zinc). The result is in agreement with Garg *et al.*, (2008) who observed significantly higher average body weight gain in the Zn –meth (@ 20mg/ kg of diet) supplemented lamb group than the control (without zinc) and ZnSO₄ (@ 20mg/ kg of diet) supplemented groups. Similar findings is also relatable to Hongfu *et al.*, (2008) who observed significant increase in average daily gain in the nano zinc oxide supplemented piglet group. Similar result was also found by Anil *et al.*, (2019) who observed significantly higher body weight gain and average daily gain in the 20 ppm nano zinc supplemented calves group followed by 10 ppm nano zinc, 5 ppm nano zinc supplemented group and control group (25 ppm ZnSO₄).

Results of Table 3 shows the overall cost of feeding crossbred calves during the 84 days of experimental period as well as the cost of feeding per kilogram of weight gain. The findings of the present experiment indicated that over the course of the experiment, the mean cost of feeding increased. Nonetheless, the groups that received nano zinc oxide supplements saw a decrease in the cost (Rs) per kilogram of weight gain. The groups supplemented with 20 mg/kg DM nano zinc oxide and the control groups showed the lowest and highest cost per kg weight increase, respectively.

Table.1 Ingredient composition of concentrate feed used for experimental calves

Ingredients	Parts (100)
Maize	37
Wheat bran	5
Rice Polish	15
GNC	30
MOC	10
Mineral Mixture	2
Salt	1
TOTAL	100

Table.2 Initial and final body weights of crossbred calves in different groups

Parameters	Groups			SEM	p value
	T0	T1	T2		
Average initial body weight (Kg)	91.1±4.16	91.7±2.80	92.5±3.20	1.90	0.96
Average final body weight (Kg)	113.56±4.16	115.925±2.90	117.8±3.39	1.98	0.69
Average total body weight gain (Kg)	22.46 ^b ±0.54	24.22 ^a ±0.50	25.35 ^a ±0.45	0.37	0.002
Average daily gain in body weight (g)	267.42 ^b ±6.45	288.39 ^a ±6.01	301.79 ^a ±5.35	6.65	0.002

^{fab} Mean values with different superscripts within row differ significantly

Table.3 Effect of nano zinc oxide supplementation on the total cost of feeding Crossbred calves

Parameters	T0	T1	T2
Cost of feed consumed/head/day (Rs.)	29.72	30.32	31.17
Cost of feed per kg live weight gain	111.1	105.1	103.28

Nano zinc oxide supplemented groups showed higher growth and weight gains than inorganic zinc supplied groups, despite the fact that their mean feeding costs were higher. This resulted into lower feeding costs per kilogram of weight gained. The result of the present study is relatable with [Anil et al., \(2019\)](#) who also observed the lowest cost of production in terms of per kg live weight gain in nano zinc supplemented calves group.

Similar observation was also made by [Lina et al., \(2009\)](#) who noticed reduced cost of production in nano zinc oxide supplemented broiler groups. The findings of the present study indicate that by adding 10 ppm of nZnO to the diet of crossbred calve’s will increase the economic growth rate.

Author Contributions

Barman Ajay: Investigation, formal analysis, writing—original draft. Borah Lakhyajyoti: Validation, methodology, writing—reviewing. Bhuyan Robin:—Formal analysis, writing—review and editing. P.

Talukdar: Investigation, writing—reviewing. Saikia Reema: Resources, investigation writing—reviewing. Katole Shrikant: Validation, formal analysis, writing—reviewing. Kalita Meenakshi: Conceptualization, methodology, data curation, supervision, writing—reviewing the final version of the manuscript.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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