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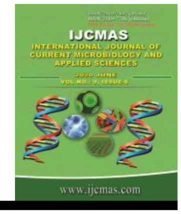

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Cost Effectiveness of Feeding Chelated Zinc on Milk Production in Lactating Cows

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ABSTRACT

An experiment was conducted to ascertain the efficacy of adding chelated zinc on milk production of lactating cows across various stages of lactation. Twelve cross-bred cows were selected from different locations of Alwar district of Rajasthan and randomly assigned to three groups for receiving either chelated or inorganic sources of zinc, organic zinc glutamate and inorganic zinc oxide (n=4). The experimental treatments include control, T_1 - zinc-citrate glutamate (organic mineral @ 9.26g/cow/day) and T_2 - zinc oxide (inorganic mineral @ 0.833g/cow/day). The cost effectiveness of zinc-citrate glutamate and zinc oxide supplements needed for producing 1 litre of milk was calculated using the data on total milk yield during the experimental period and cost of zinc supplements used. From the present study, it could be concluded that the group supplemented with organic zinc had better returns over other groups that feeding of organic zinc (zinc-citrate glutamate) in dairy cows.

Introduction

Trace elements have an important role in various metabolic activities in animals. Two categories of trace element sources are available: organic and inorganic sources. The organic source is also called as chelates and it helps to enhance the gut absorption and also improve the bioavailability of trace minerals to the animals. Inorganic sources are the commonly available foms of sulphates, oxides, chlorides and carbonates and they can differ from organic forms based on their bioavailability.

It may interact with fibre, phytate, tannin, oxalate, silicates and other minerals in the gastro-intestinal tract, which may interfere with their absorption. The traditional inorganic forms of trace minerals rapidly dissociate in the rumen and interact with antagonists, resulting in the loss of availability of trace minerals prior to absorption by the animal (Henry *et al*., 1992; Ward *et al*., 1996). Commonly available organic bound trace minerals used in animal nutrition are iron, copper, zinc, manganese, chromium and selenium. The micronutrient Zn has been established as an essential component for maintaining health and performance of animals. Dairy cows require zinc, copper and selenium to maintain antioxidant activity of their immune system (Weiss *et al.*, 2005). Zinc plays an important role in DNA and RNA synthesis by increasing replication and cell proliferation (Spears *et al.*, 2008), and in catalytic, structural and regulatory functions (Mc Dowell, 2003). The present study was designed to ascertain the effect of supplementation of organic zinc and inorganic zinc on cost effectiveness in milk production on experimental dairy cows for 20 days.

Materials and Methods

Biological experiment

An experiment was conducted to study the effect of feeding chelated zinc on milk production and fat content in lactating cows in the Alwar district of Rajasthan. This is located around 150 km south of Delhi, and about 150 km north of Jaipur, the capital of Rajasthan. Alwar is fairly rich in mineral wealth. It has an important place in agriculture production in Rajasthan. Animal husbandry is the secondary source of income for the people living in this area.

Experimental animals

The experiment was carried out for a period of 20 days in cross bred lactating dairy cows by feeding diets containing the zinc supplements of different sources such as organic (zinc-citrate glutamate) and inorganic zinc (zinc oxide) to assess the effect of feeding chelated zinc on milk production, fat and solid not fat content. Twelve cross-bred cows having a peak yield of minimum 6 litres in the previous lactation were selected from the different herds maintained at the Alwar district of Rajasthan as experimental animals.

The animals were randomly divided into three groups of four each as uniformly as possible with regard to age, body weight, parity, previous milk yield and stage of lactation and were randomly allotted to three dietary treatments *viz.*, control, T_1 and T_2. Stall feeding was practiced throughout the experimental period. Stalls were cleaned twice daily before the morning and afternoon milking with frequent removal of dung.

Experimental ration

The animals were fed with iso-caloric and iso-nitrogenous experimental rations comprising of supplementation of zinc chelates and inorganic zinc oxide. The concentrate mixture and roughage were fed depending upon their body weight and level of production as per NRC (2001). The three dietary treatments used in the feeding trial were Control - Ration without zinc supplements.T_1 - Ration with organic zinc chelate supplement (zinc-citrate glutamate @9.26g/cow/day). T_2 - Ration with inorganic zinc supplement (zinc oxide @ 0.833 g/cow/day).

Preparation of chelated zinc-citrate glutamate

Chelation are formed from the reaction of a metal ion from a soluble metal salt with amino acids having a mole ratio of one mole of metal to one to three (preferably two) moles of amino acids to form coordinate-covalent bonds. The molecular size of such chelates should not exceed 800 Dalton.

Process of chelation

Zinc-citrate glutamate chelate

(United State Patent, Patent Number: 5,504,055, Date of Patent: Apr. 2, 1996)

1000 g of water were boiled for 30 min to remove air.
After the water cooled, 81.4 g of zinc oxide were added to the deaerated water with constant stirring.
30 g of citric acid were mixed with 294.2 g of glutamic acid and then added to the zinc oxide - water mixture.
The mixture was held at 80^{o}C.
With continuous stirring until no more material would dissolve and the mixture was passed through a filter to remove the undissolved materials.
The filtrate was dried at less than about 110^{o}C to obtain a zinc amino acid chelate.

Preparation of organic zinc and calculation of its dose for dairy cows

For the preparation of dietary dose of 0.583 g of zinc to the dairy cows, 9.26 g of zinc-citrate glutamate was taken and the basal material such as ground maize was mixed thoroughly. The general requirement of zinc content for the animal is 0.583 g (9.26 g of zinc-citrate glutamate).

The zinc content in the zinc-citrate glutamate, prepared in the Department of Animal Nutrition, Veterinary College and Research Institute, Namakkal, was analyzed at the Animal Feed Analytical and Quality Assurance Laboratory, Veterinary College and Research Institute, Namakkal using Atomic Absorption Spectrophotometer (AAS) and the zinc content in the zinc-citrate glutamate was found to be 6.3 per cent. The present work was designed to ascertain the efficacy of organic zinc in 4 lactating animals for a period of 20 days. Thus, the requirement was 9.26 g of zinc-citrate glutamate (0.583*100/6.3=9.26 g). The supplementation of organic zinc for 4 animals for 20 days period requires about 740.8 g (9.26 *4*20 = 740.8 g).

Premix preparation

3.9334 kg of ground maize (base material) and 740.8 g of organic zinc-citrate glutamate was taken and both the contents were mixed properly and packed in air tight pouch for further use. 58.43 g of premix/cow was supplemented for 20 days of period for 4 cows.

Calculation of inorganic zinc oxide dose for dairy cows

Requirement of zinc for dairy cattle is 47-55 mg/kg of body weight (fresh matter basis). In dry matter terms, the requirement of zinc is 50 mg (90% DM). Maximum DM requirement of feed is 2.5- 3% of body weight of cows. Total DM requirement was 10.5 kg and on fresh matter basis, the requirement was 11.67 kg.

Zinc requirement in dairy cattle is 583.33 mg (50*11.67=0.584 g) per day. Zinc content in zinc oxide is 70 per cent (0.584*100/70 = 0.833 g) and 0.833 g of zinc oxide is required to meet out the daily requirement of zinc in a dairy cow. For four dairy cattle and for 20 days of experiment, it needs 66.64 g of zinc oxide (0.833*4*20=66.64 g).

Premix preparation

3.9334 kg of ground maize (base material) and 66.64 g of zinc oxide were taken for the preparation of zinc oxide supplement. For each cow, 50 g of premix is fed for 20 days on daily basis.

Feeding

The experimental animals were stall fed with iso-caloric and iso-nitrogenous experimental ration. The experimental animals had free access to clean, wholesome drinking water. The animals were fed with the concentrate twice daily, in the morning and in the afternoon before milking. Roughage was fed in 3 divided lots every day to ensure minimum wastage. The premix with zinc supplement organic (zinc-citrate glutamate) or inorganic zinc (zinc oxide) was given routinely through the feed to the experimental cows for the entire period of 20 days. Individual data on milk produced was recorded throughout the experiment.

Milk yield and its analysis

Data on milk yield of individual animal was recorded daily at morning and evening throughout the experimental period. Milk samples were collected and analyzed for its fat and solids not fat (SNF) content.

Economics

The cost effectiveness of zinc-citrate glutamate and zinc oxide supplements needed for producing 1 litre of milk was calculated using the data on total milk yield during the experimental period and cost of zinc supplements used.

Statistical analysis

The data on mean daily milk yield, fat and soilds not fat (SNF) content were analyzed using Analysis of Variance (ANOVA) as per Snedecor and Cochran (1994).

Results and Discussion

The total milk production and cost of zinc supplements with base material such as ground maize per kg milk production of experimental cows maintained on three dietary treatments such as control, T_1 and T_2 are depicted in Table 1. The effects of zinc-citrate glutamate and zinc oxide on cost effectiveness of milk production in experimental dairy cows are Rs. 215.6 (Control vs. T_1), Rs. 88.0 (control vs. T_2) and Rs.127.6 (T_1 vs. T_2). The mean milk production (litres) in dairy cows was maintained on three dietary treatments such as control, organic zinc (T_1) and inorganic zinc (T_2). The average milk production (ltr.) throughout the experimental period for control, T_1 and T_2 was 9.36±0.14, 9.47±0.18 and 9.40±0.15, respectively.

Data on milk production and economical assessment such as additional cost of organic and inorganic zinc supplements per litre of milk produced by the experimental cows maintained in T_1 and T_2 groups are Rs. 40.24/- and Rs.60.62/- respectively. The total milk produced in 20 days by the experimental cows fed on three dietary treatments such as control, T_1 and T_2 were 785.9, 795.7 and 789.9 litres, respectively. There was statistically no difference was observed between dietary treatment groups. The excess milk production for the entire experimental period of 20 days was 9.8 and 4 litres in T_1 and T_2 respectively, over the control.

Similarly, between T_1 and T_2, the difference was 5.8 litres. The additional cost of zinc glutamate and zinc oxide for the experimental cows with base material such as ground maize were Rs. 394.37/- and Rs. 242.47/- respectively over control. The cows supplemented with organic zinc had better returns compared to inorganic zinc supplementation and control, which is likely to be achieved in the commercial conditions where organic zinc supplementation are reported to be used in the cows yielding milk to overcome the zinc deficiency by increasing the bioavailability compared to inorganic zinc supplementation.

Table.1 Effect of supplementation of organic zinc and inorganic zinc on cost effectiveness in milk production on experimental dairy cows for 20 days

Attribute	Control	T_1	T_2
Mean milk yield (litres)	9.36 ± 0.14	9.47 ± 0.18	9.40 ± 0.15
Total milk yield (litres)	785.90	795.70	789.90
Difference in milk yield over control (litres)	-	9.80	4.00
Difference in cost of milk yield over control (Rs.)	-	215.60	88.00
Zinc supplements used (g)	-	740.8	66.64
Cost of ground maize @ Rs.19/-per kg (A)	-	75.87	75.87
Cost of Zinc Supplement per gm (Rs.)	-	0.43	0.25
Total cost of zinc supplement (Rs.) (B)	-	318.50	166.60
Total cost of supplements (Rs.) (A+B)	-	394.37	242.47
Supplemental cost of zinc for production of additional one litre of milk (Rs.)	-	40.24	60.62

Cost of zinc-citrate glutamate per kg = Rs. 430/- ; Cost of zinc oxide per kg = Rs. 251/-
Milk procurement price = Rs. 22/- per litre; T_1 = 9.8litres/740.8gm = 75.59 gram is needed per litre x 0.43 = Rs. 40.24/-; T_2 = 4litres / 66.64 gm = 16.66 gram is needed per litre x 0.25 = Rs.60.62/-
Ground maize used = 3.993 kg.

Similarly, Shakweer *et al.*, (2010) reported that feed cost/kg milk produced (1.11) decreased with added zinc methionine when compared to the control group (1.17). The economical return was more prominent with diet contained zinc methionine (12.96) than the control (9.86) other treatment ration (10.54). The economic efficiency was also improved with added zinc methionine or zinc sulfate, respectively compared to control group.

From the present study, it could be concluded that, the dairy cows supplemented with organic zinc had better returns over other groups. Hence, it is recommended that supplementation of zinc-citrate glutamate @ 9.26g/cow/day would increase the SNF content in milk significantly and profitably in dairy cows.

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