Short Research Article

Efficacy evaluation of an Organic Trace Mineral (OTM) powder formulation ~~in~~ on the reproductive performance of Heifers

ABSTRACT

Nutritional management during gestation is essential for optimizing the efficiency and profitability of livestock production systems. Changes in maternal nutritional status may lead to such adaptations which can permanently alter the parameters of growth, physiology, and metabolism of the offspring. Supplementation of essential trace minerals to gestating cows,which are inadequate in diet to suffice the health requirement of a pregnant cattle mayenhance progeny performance and health. This study investigated the impacts of supplementing Organic Trace Mineral (OTM) powder formulation on the reproductive health of heifers. The feeding experiment was performed in the Arvind Dairy Farm, Haryana, India with two groups of 6 pregnant heifer cows each (control: T0 and experimental: T1) between January and September 2022. Both groups were fed rations adjusted with regard to body weight of animals. T1 fed OTM at 10 gm/animal/day for 28-days and T0 was provided access to standard basal diet only. Experimental model investigated reproductive health of heifers for the physical and chemical parameters of estrus exhibition, duration of estrus and conception rate in comparison to controls. Significant improvement observed in the physical and clinical parameters of estrus exhibition in treatment group (T1) compared to control group (T0), higher conception rate in T1 (84%) in comparison to T0 (66%); and improvement in estrus duration in T1 (27 ± 1.53 h) as compared to the T0 (31.5 ± 2.81 h), indicating supplementation of OTM to pregnant heifers has significant influence in improving reproductive health in heifers.

Keywords: gestation; conception rate; estrus; heifer; trace minerals; gestation.

1. INTRODUCTION

Maternal health status in livestockis highly dependent on trace mineral status in the diet of the animal. Requirement of trace mineral as part of diet is variable and depends on a slew of factors such as age, feed quality, health status, lactation, gestation progression, and pregnancy status[1]. Mineral utilization for physiological requirement of foetal development and subsequently neonate calf health depends on the status of maternal intake and health status. Minerals are often supplied time to time as free-choice as salt or block lick, but such intake cannot be used to estimate if adequate dietary requirements are fulfilled or not [2]. Ahuja *et al*., 2017 [3] investigated the influence of macro- and micronutrients on reproductive performance of animals. Reproductive efficiency of animals plays a very essential role in determining the success of a dairy farm. Several factors impact mineral intake, such as physiological requirements, forage, water quality, protein and energy supplements, palatability of mineral supplements, freshness of the mineral, and mineral access among some of the major factors [4]. Literature highlights the importance of prior evaluation of an animal's physiological profile for mineral supplementation needs, as higher than NRC suggested supplementations have even ~~lead~~led to reduce~~d~~ reproductive performance on supplementation with copper, cobalt, manganese, and zinc prior to breeding [5]. Findings of a two-dose mineral supplementation study in dairy cattles, one prior to calving and a second prior to AI indicated a lowerconception rate on first service [6]. Such findings indicate that unregulated mineral supplementation may have adverse effects instead of beneficial, so the correct nutritional and physiological status of animal is of prime importance to understand the adequate mineral supplementation need.

Multiple studies exist on supplementation of trace minerals but most of such literature focuses on studying effects of multiple trace minerals together or on overall mineral nutrition, while many studies focused on post-weaning or during feedlot phase supplementation. The research on the effects of supplementation of trace minerals on maternal and offspring health is still being explored. Based on the requirements by the body, essential minerals have been classified as macro- i.e., calcium, phosphorus, potassium, sodium, chlorine and magnesium or micro- also termed as trace elements, i.e. copper, cobalt, selenium, manganese, zinc, iron, molybdenum, an chromium; respectively [7]. The trace minerals which are of prime importance for maintaining as well as improving the reproductive traits in cattle are copper, manganese and zinc. Adequate levels of these minerals are essential to achieve normal conception [9, 10, 11]. Variations from the normal levels, deficiency as well as excess can cause abnormalities in reproductive efficiency. From various studies, it is established that adequate supplementation with trace minerals is essential for proper growth and reproduction, and most of the time the impaired equilibrium of trace minerals in diet needs to be corrected to enhance reproduction and growth of animals [12].

Minerals are part of physiological pathways which lead to manufacture of hormones essential for reproduction, especially calcium and phosphorus [1]. Uniyal*et al*., 2018 [13] outlined that trace elements had an essential positive effect on fertility, and being necessary for the synthesis of reproductive steroid hormones and for the optimum function of cell enzymes involved in reproductive efficiency. The regular provision of these elements in animal rations is very important for their reproductive health. In this study, a clinical trial is designed to study the efficacy of an Organic Trace Mineral (OTM) powder formulation CARUS-OTM manufactured by M/S Carus Laboratories Ltd. Karnal in improving the reproductive function in heifers.

2. MATERIAL AND METHODS

2.1 Experimental design

For this study, 12 healthy Holstein Friesians (HF) graded heifers having exhibited oestrus once, free from endometirits and having BCS (Body condition score) between 2.7 to 3 were selected in Arvind Dairy Farm, Nalvi Khurd, Kunjpura, Karnal, Haryana, India. Veterinarian from Government Veterinary Hospital, Karnal carried out the selection and randomisation after checking the case history and current health status of heifers. Selected heifers were randomly divided into two group of 6 animals each. Group I: T0 is untreated control and group II: T1 is the treatment group. The present study was conducted in accordance with the guidelines set by National Animals Ethics guidelines for ruminants. Group T0 (n=6) was kept as control and was provided access to standard basal diet only, and Group T1 (n= 6) was supplemented with organic mineral supplement CARUS-OTM powder (Carus Laboratories Private Limited) at the rate of 10 gm/animal/d once daily orally along with the standard diet for 28 days, ~~totalling~~totaling 280 gm/animal over a period of 28 days. Parameters such as oestrous exhibition, conception rate and body condition score were evaluated. The dose rate of the product is chosen on the basis of pre- experimental studies done to standardize dose rate of the product and it was followed as per manufacturer's instruction.

2.2 Parameters studied

Different reproductive parameters were investigated for assessment of reproductive efficacy. i.e.behavioural and physical parameters of estrus exhibition observed during study were bellowing, off-fed, mounting, restlessness and discharge. Clinical parameters of estrus exhibition observed during study were amount of discharge, standing estrus, and tone of uterus. In addition, the duration of oestrus and conception rate were observed in comparison to control group.

3. RESULTS

3.1 Estrus Exhibition (Physical Parameters):

The physical parameters such as bellowing, mounting, restlessness, discharge, and off- feed were evaluated in the control and supplemented groups. The bellowing was found to be excellent in the OTM supplemented group T1 while it was recorded as poor in the control group T0 (Table 1). Mounting and discharge were found to be excellent in supplemented groups T1 and average in control group T0. Off- fed behavior manifestation was graded as average in the supplemented groups T1 which is similar to the control group T0.

Table 1. Estrus exhibition (Physical parameters) in each group of animals

Groups	Bellowing	Off fed	Mounting	Restlessness	Discharge
Control (T0)	Poor	Average	Average	Poor	Average

Treated (T1)	Excellent	Average	Excellent	Average	Excellent

3.2 Estrus Exhibition (Clinical parameters)

The clinical parameters such as amount of discharge, standing estrus, tone of uterus were also evaluated. The amount of discharge was found to be excellent in both OTM supplement group T1 and control group T0. The standing estrus was recorded average in the treatment group T1 and poor in the control group T0. The tone of the uterus was found to be excellent in the supplemented group T1 and average in the control group T0 (Table 2).

Table 2. Estrus exhibition (clinical parameters) in each group of animal

Groups	Amount of discharge	Standing estrus	Tone of Uterus
Control (T0)	Excellent	Poor	Average
Treated (T1)	Excellent	Average	Excellent

3.3Duration of Estrus

The duration of estrus was reported to be lowest in the OTM supplement group T1 (27 ± 1.53 hrs) as compared to the control group T0 (31.5 ± 2.81 hrs) (Table 3).

Table 3. Duration of Estrus exhibition in different groups of animals (Hrs. ± SE)

Groups	Duration of Estrus (Avg. Hours)
Control	31.5 ± 2.81
Treated	27 ± 1.53

3.4 Conception Rate

The Conception rate was found to be highest in treatment group T1 (84%) as compared to the control group T0 (66%) (Table 4).

Table 4. Conception rates in different groups of heifers

Groups	Conception rate
Control	66% (4 out of 6)
Treated	84% (5 out of 6)

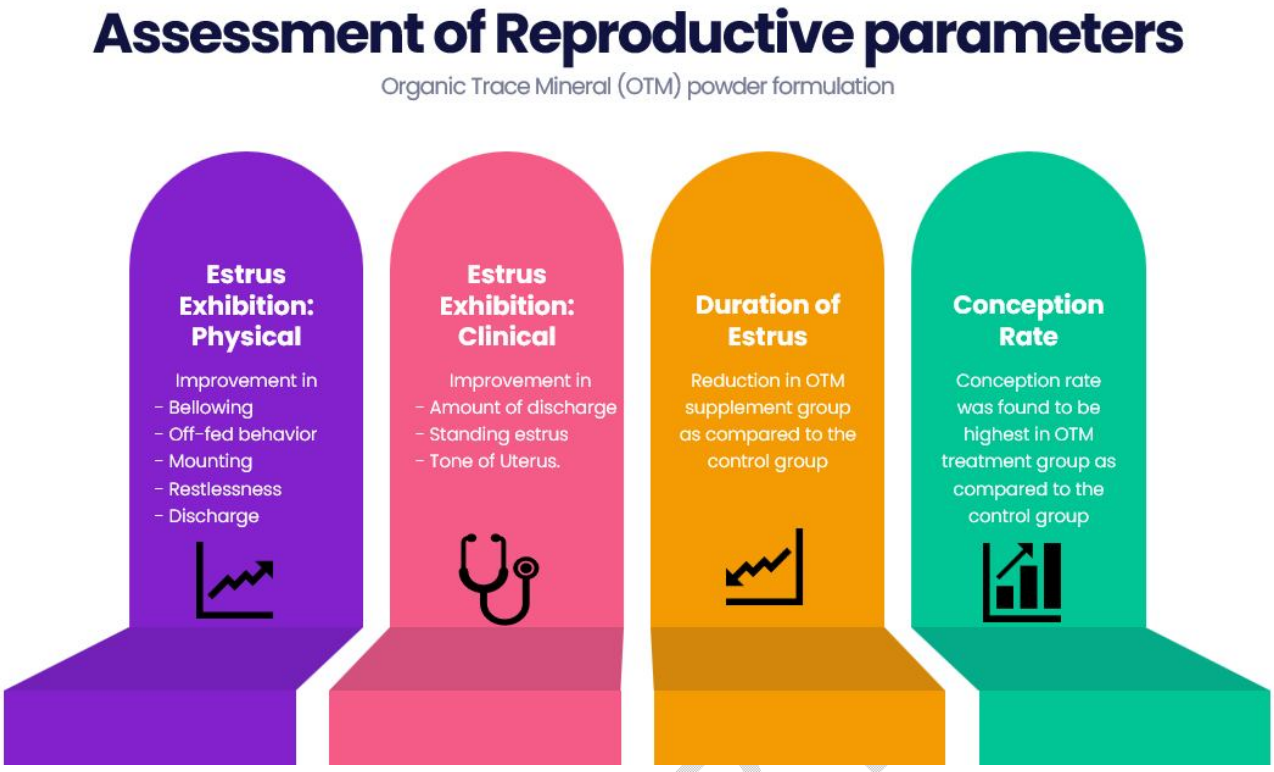

Fig. 1.Representation of reproductive assessment following 28-d oral OTM supplementation

4. DISCUSSION

The physical and chemical parameters of estrus exhibition were very prominent and the conception rate was higher in the organic trace element supplement OTM administered group T1. As per the manufacturer composition sheet, each 1 kg OTM powder contains: Zinc = 55 gm, Manganese = 30 gm, Copper = 22 gm, Cobalt = 2 gm, Chromium = 0.6 gm, and Iodine (as EDDI) = 1.46 gm. Here, we discuss studies on these minerals individually or in some combinations.

It is quite difficult to scientifically evaluate the role of each trace mineral element exactly on reproductive health as each such element is also part of many other physiological processes, and thus is responsible for many life process cycles resulting in overall growth and development [14]. Trace minerals function right from very primordial levels wherein the developing ovary utilizes them to interact with enzymes to ultimately control reactive oxygen species (ROS) and thus cellular integrity is maintained [15, 16, 17]. Zinc specifically is a trace mineral whose deficiency can lead to epigenetic defects and also can cause impaired ovarian development during the fetal period [18].

It is important for livestock to have proper mineral nutrition in order to maintain good health. Studies have shown that cows that were given supplements of Co, Cu, Mn, and Zn from either organic or inorganic sources had higher concentrations of these minerals in their liver compared to cows that did not receive supplements [19]. However, the effect on their overall health was not evaluated. Additionally, supplementing with inorganic or organic trace minerals did not affect the body weight or body condition of the cows, but cows that were given high levels of inorganic trace minerals lost more weight during the calving period than those given high levels of organic trace minerals [20]. This suggests that organic trace minerals have a greater impact on cows during the calving period. Furthermore, supplementing dairy cattle with Mn, Cu, and Zn 21 days prior to calving increased their dry matter digestibility. Also, supplementing cows with an organic methionine chelated source of Mn, Zn, and Cu post-calving increased their total antioxidant capacity and immune response compared to cows that were not supplemented or were supplemented with inorganic or glycine chelated minerals. This suggests that supplementing cows with organic, chelated forms of trace minerals may improve their immune status and production [21].

Trace minerals play a significant role in the health and performance of cattle. These minerals can affect various aspects of the animal's well-being including maternal health, reproductive performance, colostrum and milk quality, and offspring health, either directly or indirectly through changes in enzymatic function, DNA replication, and antioxidant formation. The mineral requirements of cattle are not constant and are dependent on the animal's physiological state such as pregnancy,

lactation, and age, which impacts when specific minerals should be supplemented. This knowledge allows producers to ensure that minerals are supplemented at the most appropriate times for maximum biological and economic benefit [22].

Trace minerals are essential for maintaining the health and performance of cattle. As studies have shown, mineral supplementation can directly or indirectly affect maternal health, reproductive performance, colostrum and milk quality, and offspring health through alterations in enzymatic function and antioxidant formation [23, 24]. The mineral needs of cattle vary depending on their physiological state, such as pregnancy and lactation, and this impacts the timing of when specific minerals should be supplemented [24, 25]. By understanding this, producers can ensure that minerals are supplemented at the most biologically and economically beneficial times. For example, studies have shown that lower levels of zinc and manganese are associated with increased cases of repeat breeding in cattle. Manganese plays a crucial role in hormone synthesis and cholesterol production, while zinc is important for normal estrus and fertility. Copper is also essential for maintaining fertility and preventing delayed or depressed estrus [26, 27, 28]. In addition, cobalt supplementation has been shown to improve reproductive performance in cattle and deficiency in cobalt can lead to reproductive abnormalities such as delayed uterine involution, irregular estrus cycle and decreased conception rate [29, 30]. The presence of trace minerals such as Cu and Co in organic trace mineral supplements further supports the importance of mineral supplementation in improving reproductive function and overall productivity in cattle [31, 32].

5. CONCLUSION

The inclusion of trace minerals in the diet of heifers has been shown to result in significant improvements in estrus exhibition and conception rate. These results highlight the importance of trace minerals in promoting reproductive health in heifers.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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