

IMPACT OF MINERAL MIXTURE FEEDING ON MILK PRODUCTION AND MILK COMPOSITION OF LACTATING COWS AT DAIRY FARM, BHU

काशी हिन्दू
विश्वविद्यालय



BANARAS HINDU
UNIVERSITY

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE AWARD OF DEGREE OF

Master of Science (Agriculture)
In
Animal Husbandry and Dairying
(Livestock production and management)

Supervisor

Dr. Rajendra Kumar Pandey

Professor & Head
In-charge-Gowshala (Dairy farm)

Submitted by

Nirupama Deep

DEPARTMENT OF ANIMAL HUSBANDRY AND DAIRYING
INSTITUTE OF AGRICULTURAL SCIENCES
BANARAS HINDU UNIVERSITY
VARANASI (U. P.) - 221005
INDIA

I.D. No. - 16AHD10

2018

Enrolment No. 389382

Dr. R.K. Pandey
Professor
Department of Animal
Husbandry and Dairying



Department of Animal Husbandry and Dairying
Institute of Agricultural Sciences
Banaras Hindu University
Varanasi - 221 005 (U.P.)

Ref. No.....

Date:

CERTIFICATE

To,
The Registrar (Academic)
Banaras Hindu University,
Varanasi – 221005, India

Through: The Head, Animal Husbandry And Dairying, Institute of
Agricultural Sciences, BHU, Varanasi.

Dear Sir,

I have great pleasure in forwarding the thesis entitled “**Impact of Mineral Mixture Feeding on Milk Production and Milk Composition of Lactating Cows at Dairy Farm, BHU** of the Post Graduate Students of Institute of Agricultural Science, BHU” submitted by **Nirupama Deep, Id. No. 16AHD10**, in partial fulfillment of the requirements for the degree of **Master of Science (Agriculture) Animal Husbandry And Dairying**, from Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P).

I certify that the work has been carried out solely under my guidance and the data forming the basis of the thesis, to the best of my knowledge are original and genuine and no part of the work has been submitted for any other degree or institution.

Thanking you.

Yours faithfully,

Forwarded by:

(Prof. R.K. Pandey)

Chairman of Advisory committee

IMPACT OF MINERAL MIXTURE FEEDING ON MILK PRODUCTION AND MILK COMPOSITION OF LACTATING COWS AT DAIRY FARM, BHU.



by
Nirupama Deep

Id. No. D-16AHD10

2018

Enrolment No. 389382

Thesis submitted in partial fulfillment of the requirements for the award of the degree of **Master of Science (Agriculture) in Animal Husbandry And Dairying**, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi - 221 005

APPROVED BY ADVISORY COMMITTEE

Chairman : **Prof. R. K. Pandey**
Associate Professor
Department of **Animal Husbandry and Dairying**
Institute of Agricultural Sciences, BHU, Varanasi

Members : **Dr. V. K. Paswan**
Associate Professor
Department of **Animal Husbandry and Dairying**
Institute of Agricultural Sciences, BHU, Varanasi

Er. D. C. Bunker
Assistant Professor
Department of **Center for Food Processing and Technology**
Institute of Agricultural Sciences, BHU, Varanasi

EXTERNAL EXAMINER:

ACKNOWLEDGEMENT

I bow my head in great reverence to the omnipotent and omnipresent GOD for his blessings and true love towards me and to every individual residing on this wonderful planet. I also bow my head with great reverence under the pious feet of esteemed Late 'Mahamana Pandit Madan Mohan Malviya ji, a great patriot, nobleman and patriarch of this university. Whose visionary thought in the form of the Banaras Hindu University is continuously serving mankind from last 101 years and will serve in time immortal to the whole world.

It is my sublime privilege to express my deep sense of gratitude to my supervisor Prof. R.K. Pandey, Department of Animal Husbandry And Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for his inspiring and ingenious guidance, incisive and articulated criticism, cordial discussion, valuable suggestion, everlasting zeal and constant encouragement which assisted me to overcome every problem that come in my way during the period of investigation and preparation of this manuscript. I shall always remain deeply obliged to him for his affectionate glances and generosity bestowed on me.

I am deeply thankful to members of my advisory committee Dr. V.K. Paswan, Associate Professor, Department of Animal Husbandry and Dairying Institute of Agricultural Sciences, Banaras Hindu University, Varanasi and Er. D.C. Bunker, Assistant Professor, Center of Food Science and Technology, Banaras Hindu University, Varanasi for their guidance and blessings.

I also want to present my gratitude to Prof. (Mrs.) Bandana Bose, Dean, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi and Prof. S. Vaishampayan, Director, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for providing all kind of facilities at Institute of Agricultural Sciences, BHU for completing my course work and research work.

I feel immense gratefulness to express my heartfelt gratitude for my Head Prof. R. K. Pandey, Department of Animal Husbandry And Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for all kind of support, guidance, motivation and blessing during my study. I also want to thank from the core of my heart to my respected teacher Dr. K. Ghadei, Associate Professor, Department of Extension Education, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for their academic guidance, motivation and blessings.

I also want to present my heartily thanks to Dr. O.P. Singh, Assistant Professor, Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi for their support and guidance during my study.

Help rendered by non-teaching staff members Sri Nandi, Sri Rambriksh, Sri Vijaya and Sri Anand, is duly acknowledged.

*I have no word to express my feeling about the contribution of my father **Mr. Hutasan Deep** and mother **Mrs. Padmini Deep** for their unbound affection, sacrifice, everlasting encouragement, benevolent help, blessings and faith that enables me to work efficiently.*

I am over whelmed with rejoice to avail this rare opportunity to evince my profound sense of veneration and gratitude to my elder Sister's Anupama, Subhagni, Jogaprabha and my lovely elder brother's Nirmal, Sanjog, Vimal and Younger brother Phalguni Deep and all my relatives.

*Without the help of seniors no one can learn the lesson of life so, heartfelt and special thanks to my seniors Satya parkas Yadav, **Pankaj Gupta**, Rajendra Kumar, Aman, Pankaj Anne, Himansu Rai, Smita Singh, Hemavati.M and my very helpful Md. Abdulla for their co-operation during the investigation.*

I am thankful to my dear batchmates Priyanka Umratkar, Pritee Yadav, Tusar Bhosle, Bhim raj, Suresh Bharti, Shashi, Pradeep, Dheeraj, Bindu, Akanshi, Rituparna, Anju and Soumya for their moral support, co-operation and priceless suggestions.

The grace of the God has always been upon me and given me patience and power to overcome the difficulties which came my way in accomplishment of this endeavour. I have no words to thank him but only pray to bless me always.

Last but not the least I record my sincere thanks to all respectable people and teachers who helped and guided me but could not find separate mention.

Place: Varanasi

Date: June, 2018

(Nirupama Deep)

CONTENTS

Chapter	Title	Page No
I	INTRODUCTION	1-6
II	REVIEW OF LITERATURE	7-28
III	MATERIALS AND METHODS	29-36
IV	RESULT AND DISCUSSION	37-52
VI	SUMMARY AND CONCLUSION	53-57
	REFERENCES	i-viii
	APPENDICES	

LIST OF TABLES

Table No.	Particulars	Page No.
3.1	Concentrate farm feed.	30
3.2	Composition of mineral mixture supplement in each 100ml	30
3.3	Feeding management.	31
3.4	Daily Nutrients Requirements for Cattle.	32
4.1	Effect of mineral mixture supplements on total milk yield of cows	37
4.2	Milk yield mean.	38
4.3	Milk yield ANOVA.	39
4.4	Impact of various feed supplement on milk fat %	40
4.5	FAT% analysis of variance.	41
4.6	Impact of various feed supplement on SNF during experimental period (SNF %).	43
4.7	SNF % analysis of variance.	44
4.8	Impact of various feed supplement on daily milk protein during experimental period (Protein %).	45
4.9	Protein % analysis of variance.	46
4.10	Impact of various feed supplement on daily milk Density during experimental period (DEN %).	48
4.11	DEN % analysis of variance.	49
4.12	Impact of various feed supplement on Lactose of milk during experimental period	50
4.13	Lactose Analysis Variance Table	51

LIST OF FIGURES

Figure No.	Particulars	Page No.
1.	Total Milk yield in 0 day,10 days, 20 days and 30 day of feeding.	38
2.	Milk Fat% in 0 day, 15 days, and 30 days of feeding.	41
3.	Milk SNF Before, after 15 days and 30 days after supplemental feeding.	43
4.	Milk Protein Before, after 15 days and 30 days after supplemental feeding.	46
5.	Milk Density Before, after 15 days and 30 days after supplemental feeding	48
6.	Lactose Before, after 15 days and 30 days after supplemental feeding	51

LIST OF ABBREVIATIONS

AAS	Atomic absorption spectrophotometry
ADG	Average daily gain
AIA	Acid insoluble ash
ALP	Alkaline phosphatase
ANSA	Amino naphthol sulphonic acid
AOAC	Association of Official Analytical Chemists
ASMM	Area Specific Mineral Mixture
AST	Aspartate aminotransferase
BCG	Bromocresol green
CB	Crossbred
BUN	Blood urea nitrogen
CF	Crude fiber
CLR	Corrected Lactometer Reading
CP	Crude protein
DE	Digestible energy
DM	Dry matter
DEN	Density
SNF	Solid Not Fat
DCP	Digestible Crude fiber
EE	Ether extract
FAO	Food and agricultural Association
FCR	Feed conversion ratio g Gram
TDN	Total Digestible Nutrient
NDDB	National Dairy Development Board
Sp	Specific

INTRODUCTION

Now a day's Indian dairy industry is at cross roads. As per economic survey 2015-16, India ranks first in milk production, accounting for 18.5 per cent of world production, achieving an annual output of 146.3 million tons during 2014-15 as compared to 137.69 million tons during 2013-14 recording a growth of 6.26 per cent. Whereas, the Food and Agriculture Organization (FAO) has reported a 3.1 percent increase in world milk production from 765 million tons in 2013 to 789 million tons in 2014 and in 2016-2017 that became **165.4 million tons** (NDDB) The success of the dairy industry has resulted from the integrated co-operative system of milk collection, transportation, processing and distribution, conversion of the same to milk powder and products, to minimize seasonal impact on suppliers and buyers, retail distribution of milk and milk products, sharing of profits with the farmer, which are ploughed back to enhance productivity and needs to be emulated by other farm produce/producers. (Panchbhai *et al.*, 2017)

India's livestock sector is one of the largest in the world. It has 56.7% of world's buffaloes, 12.5% cattle, 20.4% small ruminants, 2.4% camel, 1.4% equine, 1.5% pigs and 3.1% poultry. In 2010-11 livestock generated outputs comprised 4% of the GDP and 26% of the agricultural GDP. The total output worth was higher than the value of food grains. Animal husbandry is an integral component of Indian agriculture supporting livelihood of more than two-thirds of the rural population. Animals provide nutrient rich food products, draught power, dung as organic manure and domestic fuel, hides & skin, and are a regular source of cash income for rural households. (Agrawall., 2016)

In India Utter Pradesh ranks first in milk production 26.4 million tonnes followed by Rajasthan, is 18.5 million tonnes (2015-16 Statistics, NDDB), making a per capita availability of 337 gm (2015-16 Statistics, NDDB) per day against 285 g

per day per capita recommended by the Indian Council of Medical Research (ICMR). It is more than the world average of 294 gm per day during 2013. The results of the December 2015 Livestock Survey show the total number of cattle was 6,422,200, an increase of 179,200 (+2.9%) on December 2014. The number of cattle of two year or over (excluding cows and bulls) decreased by 89,100 (-17.70%), (Central statistical office, 2012).

However, in other aspect present level of productivity of cattle in the country is very low. Underproduction is mainly result of involuntary culling due to poor body conditioning, low fertility and some health issue; eventually it affects profitability from the animals. Balanced nutrition is very essential for keeping animal body in good condition and renders them to maintain their optimum production. Out of all nutrients minerals and vitamin play a crucial role in metabolism, lactation, reproduction and even for microbial fermentation in rumen (Bindari, Garg *et al.*, 2014). Problem of mineral deficiency and metabolic diseases in all categories of dairy livestock have been reported by many scientists due to lower content and low bioavailability of some essential macro and micro mineral in different feedstuffs. More than 90 percent of mineral deficiencies exist at subclinical level in livestock (Underwood and Suttle, 1999). Garg and Bhandari (2005) reported low animal productivity and impaired reproductive behavior due to mineral deficiency and corrected these ailments through supplementation of various minerals. Supplementation of area specific mineral mixture and vitamin are not practicing in most of the part of country (Garg *et al.*, 2004). A survey work in various states, conducted by NDDB indicated that Zn, Cu, S, Mn, and Co were deficient in the ration of dairy livestock (Bhandari Garg *et al.*, 2006). Hence, animal depend for their mineral and vitamins requirement on feed and fodders fed. Most of the feed ingredients available for feeding livestock are deficient in one or other mineral. So, present study was designed with objective to find out the effects of mineral mixture feeding on the milk production and reproductive behavior of dairy cattle. Mineral deficiency in livestock animals is responsible for poor growth, deficiency disease, decreased milk yield, reproductive disorders, and decreased immunity. During the past decade, significant advances have been made in understanding the effects of

trace-element supplements on the milk production of dairy cows. Data regarding the role of mineral supplementation affecting milk yield performance in cattle is scant. Supplementation of all the elements in diet may not be desirable always, because many of them such as Mg, S, K, I, Co, Fe and Mn are present in required concentrations in feeds and fodders of specific areas. Significant changes in major physiological and biochemical parameters have been observed due to deficiencies of minerals like Ca, Cu and Zn.(Pandey *et al.*, 2018)

1.1 Important of Mineral in Animals :

Mineral deficiencies and imbalances for cattle are reported from almost all regions of the world. The mineral elements most likely to be lacking under grazing conditions for ruminants are Ca, P, Na, Co, Cu, I, Se and Zn. In some regions, under specific conditions, Mg, K, Fe and Mn may be deficient and excesses of F, Mo and Se can be extremely detrimental. In most countries of the world, the principal means by which cattle producers attempt to meet mineral requirements of their grazing herds is through use of free-choice dietary minerals. As a low cost insurance to provide adequate mineral nutrition, a modified 'complete' mineral supplement should be available free-choice. Calcium, Cu or Se, when in excess, can be more detrimental to cattle production than any benefit derived by providing a mineral supplement. The major disadvantage to free-choice minerals is lack of uniform consumption by animals. Factors influencing consumption of mineral mixtures include: soil fertility and forage type, season of year, available energy and protein, individual requirements, palatability of mineral mixture, availability of fresh minerals and physical form of minerals. Safe, biologically available and palatable forms of minerals, at a fair price, allow both the user and manufacturer to realize a profit from their use. Mineral supplements need to be evaluated for accuracy of formulation and suitability for cattle. Most studies have shown positive responses of mineral chelates and complexes when compared to inorganic sources. (McDowell., 1996)

1.2 Different types minerals and there functions:

Calcium	Essential for milk production Necessary for bone & teeth formation Required for contraction of muscles
Phosphorus	Essential for milk production Required in energy metabolism Required for bone & teeth formation
Magnesium	Important for the integrity of bone & teeth Involved in protein synthesis and metabolism of carbohydrates & lipids
Sulphur	Required for protein synthesis and metabolism of carbohydrates & lipids Sulphur is a part of B-complex vitamins, thiamine & biotin
Sodium & potassium	Required for maintenance of osmotic balance Required in acid- base equilibrium
Copper	Required for haemoglobin synthesis Necessary for tissue pigmentation & component of several metalloid-enzymes Required for normal reproductive functions Spermatogenesis & the development of primary & secondary sex organs
Zinc	Required for normal functioning of epithelial tissue Activates vitamin A & its deficiency leads to night blindness
Manganese	Co-factor for many enzymes involved in carbohydrate metabolism Activator in the synthesis of fatty acids Required for the synthesis of thyroid hormone (T &T)

- Iodine** Necessary for reproduction & growth of animals
- Component of Glucose Tolerance Factor (GTF)
- Required for the metabolism of carbohydrates, protein and fat
- Helps in improving immune status

(Animal Husbandry, NDRI Karnal , 2015)

The health and degree of productivity of dairy cows and buffaloes are depended on balanced and adequate quantities of all necessary nutrients to meet their requirements for a given physiological stage. The usual feed nutrients given to livestock are protein for growth and repair of body tissues, carbohydrate and fat as source of energy, minerals and vitamins for different metabolic functions including supporting structure of body plus water. Mineral and vitamins are the most important nutrients of lactating animals, which are required in very minute quantity, but have a great role in metabolism, milk production, reproductions even for microbial fermentation in the rumen. Deficiency of certain minerals may not affect crop yields but their availability for such forage may be inadequate for requirements of livestock which obtain most of the minerals required feed and fodder (Garg *et al.*, 2005). The concentration of mineral elements in plants is dependent on the interaction of a number of factors including soil pH, plant species and stages of maturity, yield and climate. The shedding of the seed is normally responsible for losses of many minerals. The straw is a poor source. Sometimes, there is a difference of minerals content in feeds and fodders between hilly and plane region (Sharma *et al.*, 2002) and variation in minerals content in fodder growth in different agro climatic zones (Garg *et al.*, 2004). Therefore information on the mineral composition of such feeds and fodder is essential for formulating area specific mineral mixture, as recommendations leading to excess may have detrimental effect on the animals (Garg *et al.*, 2003 a, b).

While many scientists and dairy farmers play major emphasis on dry matter intake, protein, fat, fibre and energy needs. Supplementation of minerals helps in efficient utilization of absorbed nutrients and many other ways, for improving growth,

milk production reproduction efficiency. Feeding animals with feed additives can improve utilization efficiency of the concentrate feeds available in limited quantity. The main and effective function of mineral feed additives in livestock to help in extreme cold and in high temperature maintaining their health and productive potential in winter and summer stress respectively.

In view of the aforesaid the present research work entitled “Impact of feed additives supplement on milk production of lactating cow” was undertaken with following objectives:

- 1. To study the impact of feeding mineral mixture Feeding on milk production of cross bred.**
- 2. To study the impact of mineral mixture supplement on milk composition of cross bred.**



REVIEW OF LITERATURE

2.1. Effect of feed additives on production performance in crossbred cows:

Hayden *et al.* (1930) studied the effect of Dicalcium phosphate was fed to one of two groups of cows over a period of 5 years and 11 months, the total production of milk from the two groups averaged 30.54 pounds daily for the mineral group and 29.73 pounds daily for the non-mineral group. The total production corrected to 4 per cent fat milk showed a daily production of 27.81 pounds per cow by the mineral group and 27.28 pounds per cow by the non-mineral group. The daily production per cow during the first 7 months of the various lactation periods, corrected to 4 per cent fat, was by the mineral group 31.8 pounds and by the non-mineral group 33.33 pounds. The daily production per cow during the first 7 months of lactation, corrected for quality of milk and for age of cow, was 37.3 pounds by the mineral group and 39.8 pounds by the non-mineral group. Comparison of production in lactations before and after the experiment started showed an increase in both groups, but a greater increase by the non-mineral group. Comparison of production in the first and second lactations of heifers during the experiment showed an increase in both groups, but a greater increase by the non-mineral group. None of the above differences were large enough to be really significant when the probable error is considered. When rations containing legume hays and a grain mixture containing bran and linseed oilmeal or cottonseed meal are fed, cows probably will not be benefited by the addition of dicalcium phosphate.

Ballantine *et al.* (2002) Three hundred multiparous Holstein cows (150 cows per treatment) were blocked according to calving date and randomly assigned to a study to determine the effect of trace mineral source on incidence and severity of claw lesions, reproduction, and lactation performance of dairy cattle. Treatments were 1) all trace minerals supplied by sulfates (ITM) or 2) 360 mg Zn from Zn amino acid

complex, 200 mg Mn from Mn amino acid complex, 125 mg Cu from Cu amino acid complex, and 12 mg Co from Co glucoheptonate per day (CTM; Availa®; Zinpro Corporation, Eden Prairie, MN) replacing an equivalent amount of Zn, Mn, Cu, and Co from sulfates. Cows received assigned treatments from 21 d prior to calving through 250 d of lactation. Cows fed CTM produced 1.2 kg more ($P < 0.05$) milk, energy-corrected milk, and 3.5% fat-corrected milk than cows supplemented with ITM. The CTM treatment reduced ($P < 0.05$) days open by 22 d and tended to increase ($P < 0.15$) percentage of cows pregnant by 150 d in milk (54.8% vs 42.7%) and first service conception rate (27.4% vs 18.4%). The CTM treatment increased yield of milk, decreased days open, and tended to increase first service conception rates, increase percentage of cows pregnant at 150 d in milk, and decrease claw disorders at 75 d postpartum.

Biswas *et al.* (2002) This study was conducted to investigate the effect of supplementing mineral-vitamin-mixture (MVM) with usual feeding of paddy straw and limited amount of green fodder and concentrated mixture on the milk production and dry matter (DM) intake of cows. 54 milch cows were divided into 6 treatment groups (T1, T2, T3, T4, T5, and T6) and given MVM at 25 g per day per cow. Daily milk yield was recorded for 120 days and profit and cost benefit ratio was assessed. Total DM intake increased for about 10% in treatment groups compared to control groups, with values ranging 4.78 kg DM in group C to 5.27 kg DM in group T. Average milk production values were 3.08, 1.26, 2.4, 1.98, 1.73, and 2.88 kg in groups T1 to T6, respectively. As for control groups C1 to C6, the average milk production values were 2.84, 1.15, 2.3, 1.84, 1.54, and 2.65 kg, respectively. Average milk yield increased in all treatment groups. The costs per lit milk production (Rs/lit) was 4.45, 11.63, 12.5, 9.31, 6.99, and 5.74 in groups T1 to T6, respectively. The cost benefit ratios were 2.55, 1.2, 1.11, 1.50, 2.0, and 2.43 for groups T1 to T6, respectively. It is concluded that the dietary supplementation of MVM at 25 g per day is economical in lactating cows under straw based diet in a village condition.

Baker *et al.* (2003) study the reviewed a paper on Trace mineral metabolism in ruminants: impact on production, reproduction and the environment.

Kellogg *et al.* (2004) objective of this review was to summarize 12 trials (13 comparisons) evaluating effects of zinc methionine (ZM) complex (ZINPRO®; Zinpro Corporation, Eden Prairie, MN) on lactation performance and udder health. Summarized trials were conducted in Washington (2), New York, Missouri, Georgia, Great Britain, Germany, and Israel. In 5 of the trials, ZM provided between 180 and 200 mg of zinc/d per head; in the remaining 7 trials (8 comparisons), ZM supplied 360 to 400 mg of zinc. In all diets, cows received additional zinc from inorganic sources, with the exception of the control diet in one of the Missouri comparisons. For statistical evaluation, each trial was considered as a block, and the treatment least squares mean within a trial was treated as an observation using a mixed model. Cows fed ZM produced more ($P < 0.01$) milk (31.8 vs 30.5 kg/d), energy-corrected milk (31.7 vs 30.4 kg/d), and fat-corrected milk (31.6 vs 30.0 kg/d) than control cows. Milk composition did not differ ($P > 0.15$) between treatment and control cows. Somatic cell count (SCC; 1000/ml) was reduced from 294 to 196 ($P < 0.01$) in cows receiving ZM. This summary of 12 dairy trials indicates that ZM increases lactation performance and improves udder health, as a 33.3% reduction in SCC occurred.

Ashmead *et al.* (2004) studied the residual or long-term effects of organic minerals on consecutive lactations has not been studied to date. They compared the effects of copper, magnesium, zinc, and manganese as amino acid chelates (AACs) or as inorganic minerals (IOMs) on milk and milk component production through three lactation periods in Holstein cows. A high-production herd was divided into two groups. One group ($n = 64$) received AACs for the first 180 days of lactation. The second group ($n = 65$) received equivalent amounts of metals as oxides of magnesium, zinc, manganese, and copper sulfate for the first 180 days of lactation. The AAC group had significantly higher ($P < 0.005$) total milk production (kilograms of milk) and increasingly more milk in each successive lactation period compared with the IOM group. The AAC group also produced more milk fat by weight when milk was corrected to 3.5% fat. Milk protein was consistently higher in the AAC group. Feeding AACs favorably affected genetic potential for milk production, with significant increases in predicted transmitting ability ($P = .08$). Feeding dairy cows

metal AACs improved dairy milk and milk component production, with the largest improvements occurring in later lactation periods.

Garg *et al.* (2006) presented in this paper some of the interventions in the area of feeding and management that can be implemented under Indian conditions to improve the milk production of dairy animals (cattle, buffaloes, goats and sheep). The livestock population and dairy husbandry in India as well as the status of feed resources are discussed. The following technologies in utilizing feed resources are described: implementation of the ration-balancing programme; enrichment and densification of crop residues; bypass protein technology; use of urea molasses mineral block licks as supplement to straw-based diet; use of specific mineral mixtures in the ration; production and use of different types of compound cattle feed; improvement of green fodder yield from the cultivable land; and use of wastelands for green fodder production.

Patil *et al.* (2008) presented the effect of organic minerals (in chelated forms) on animal health and production. The types of chelated minerals and benefits of organic minerals over inorganic ones are discussed. The bioavailability of organic and inorganic minerals and its mode of action are also considered. The effects organic minerals on rumen fermentation, reproductive performance, milk production and immunity and health as well as the economic considerations are also discussed. The impact on soil organisms or crops of using metal proteinated and metal polysaccharide complexes in livestock is determined.

Sahoo *et al.* (2009) conducted an on farm trial in hills of Uttarakhand to assess the effect of urea molasses mineral block (UMMB) supplementation on productive performance of lactating cows. Ten crossbred cows (*Bos indicus*) were divided into two groups (T1 and T2) consisting 5 animals each. Animals were fed on homemade concentrate mixture and grass hay. The animals in group T2 were additionally supplemented with UMMB of around 300 g/day/animal. DM intake, milk yield, milk composition were recorded at fortnight intervals in a 3 month lactation trial. A digestibility trial of 7 days was conducted at the end of the lactation trial. Daily DM intake through concentrate (kg/d) was significantly lower ($P<0.05$) in T2 (0.63) than

T1 (0.87) with concomitant increase ($P < 0.05$) in roughage intake (8.35 vs 7.58 kg/d). The total DM intake (kg/d) was significantly higher ($P < 0.05$) by 10.1% in UMMB supplemented group (T2) than control (9.30 vs 8.45). Milk yield, FCM yield and milk composition were significantly increased ($P < 0.05$) in T2 compared to the control T1. The total income, net return over feed cost along with feed efficiency was better in animals of group T2. It was concluded that UMMB supplementation economically improved the feed efficiency and milk production of lactating cows in hilly region of Uttarakhand.

Hackbart *et al.* (2010) evaluated potential effects of organic trace mineral supplementation on reproductive measures in lactating dairy cows. Cows were blocked by breed and randomly assigned at dry-off to receive inorganic trace mineral supplementation (control; $n = 32$) or to have a portion of supplemental inorganic Zn, Cu, Mn, and Co replaced with an equivalent amount of the organic forms of these minerals (treatment; $n = 31$). Trace minerals were provided through control or treatment premixes fed at $100 \text{ g} \cdot \text{cow}^{-1} \cdot \text{d}^{-1}$. Premixes were fed to dry cows (range = 40 to 72 d before calving) in $1.8 \text{ kg} \cdot \text{cow}^{-1} \cdot \text{d}^{-1}$ concentrate pellets through a computer feeder to provide 40, 26, 70, and 100% of supplemented Zn, Mn, Cu, and Co, respectively, and to lactating cows (range = 69 to 116 d after calving) in a total mixed ration to provide 22, 14, 40, and 100% of supplemented Zn, Mn, Cu, and Co, respectively. Treatment increased milk production at wk 14 ($P = 0.047$) postcalving, milk urea N content ($P = 0.039$), and BW loss from calving to 1 mo postcalving ($P = 0.040$), and decreased milk fat percentage ($P = 0.045$) and BCS ($P = 0.048$). Treatment tended to increase milk production at wk 13 ($P = 0.089$) postcalving and endometrial tissue concentrations of Fe ($P = 0.070$), BW at mo 1 ($P = 0.056$), and milk protein percentage ($P = 0.064$). However, the entities that were fertilized, the percentage of viable embryos, embryo quality, accessory sperm number, and embryo cell number were not affected ($P > 0.1$) by treatment. We conclude that replacing a portion of inorganic supplemental trace minerals with an equivalent amount of these organic trace minerals (Zn, Mn, Cu, and Co) increased milk production in mid-lactation, but did not affect postpartum follicular dynamics, embryo quality, or liver and luteal trace mineral concentrations.

Rabiee *et al.* (2010) evaluate the effectiveness of supplementation with the organic trace minerals (OTM; Availa-4 and 4-Plex, Zinpro Corp., Eden Prairie, MN) on milk yield, composition, and component yields and reproductive performance in dairy cows. Criteria for inclusion in the study were information on the form of OTM, an adequate description of randomization, production and reproduction data, and associated measures of variance (SE or SD) and *P*-values. The OTM increased milk production by 0.93 kg [95% confidence interval (CI) = 0.61 to 1.25], milk fat by 0.04 kg (95% CI = 0.02 to 0.05), and milk protein by 0.03 kg (95% CI = 0.02 to 0.04) per day. Milk SCC was not different in cows supplemented with OTM. All production outcomes except milk solids (yield) and milk SCC were heterogeneous. Meta-regression analysis showed that feeding for a full lactation after calving, and the use of other supplements increased responses over feeding after calving only, feeding for part of lactation, or not using other supplements, respectively. Supplementation of cows with OTM reduced days open (weighted mean difference = 13.5 d) and number of services per conception (weighted mean difference = 0.27) in lactating dairy cow. The results of this meta-analysis showed that organic trace mineral supplementation could improve production and reproduction in lactating dairy cows.

Sirohi *et al.* (2010) study on Lactating crossbred cattle (10) where they randomly divided into 2 groups on the basis of milk yield (14–15 kg/day), day of calving (~50 days) to see the effect of bypass fat supplementation on nutrient utilization and production performance. Cows were fed wheat straw, concentrate mixture and green maize fodder in the control group and additional 300 g bypass fat was given in treatment group. Experimental feeding was continued up to 90 days after 2 weeks of adaptation. The average milk production and fat corrected milk yield per day was significantly higher in treatment group. Milk fat and total solids content were improved significantly in treatment group, whereas milk protein and solids-not-fat remained unaffected in both groups. The digestibility of nutrients except that of ether extract was comparable in both groups. Intake per kg of milk produced was lower in treatment group than the control group. Milk production efficiency was also significantly higher (30.22%) in bypass fat supplemented in comparison to the control group (27.03%). It was concluded that bypass fat supplementation @300 g/d/animal

in medium producing crossbred cows significantly increased the milk production and fat corrected milk yield up to 15.61 and 24.01%, respectively, over the control group.

Tyagi *et al.* (2010) study was to evaluate the effects of supplementation of bypass fat on milk production and reproductive performance of crossbred cows. 19 multiparous crossbred cows (2–4 lactation) were divided in two groups on the basis of most probable production ability (MPPA). The animals in group 1 (nine cows, MPPA 3,441.32 kg, control group G1) were fed chaffed wheat straw, chopped green maize, and concentrate mixture as per requirements while the animals in group 2 (10 cows, MPPA 3,457.2 kg, treatment group G2) were fed the same ration supplemented with 2.5% bypass fat (on DMI basis). The cows of G2 were supplemented bypass fat 40 days prepartum to 90 days postpartum and recorded effect of supplementation on milk production and reproductive parameters up to 210 days of lactation. Average birth weights of the calves were 24.94 and 27.95 kg in G1 and G2, respectively. The time taken for expulsion of fetal membranes was decreased ($P < 0.05$) by 5.4 h in G2 compared to G1. The average milk yield (210 days) in G2 was higher ($P < 0.05$) than that of G1 (18.65 vs 17.57 kg/day). Similarly, the milk yield during the carry over period (90 days) was higher ($P < 0.05$) in G2 than that of G1 (14.81 vs 13.79 kg/day). The time required for onset of cyclicity was reduced ($P < 0.05$) by 6.5 days in G2 as compared to that of G1. The service period and AI per conception were also reduced ($P < 0.05$) in G2 while bypass fat feeding showed no effect on conception rate ($P < 0.80$). There were no differences between the two groups in plasma cholesterol, progesterone and insulin concentrations. Hence, it was concluded that bypass fat supplementation at 2.5% of DMI increased the milk production.

Tufarell *et al.* (2011) they studied to examine the effects of concentrates containing different levels of a vitamin-trace elements premix on milk yield and composition of dairy cows. The trial, which lasted 14 weeks, was conducted from January to March and used 45 multiparous Brown cows in the early phase of lactation. Cows ($n = 15$ per treatment) were randomly allocated to three dietary treatments: the first group (control, C-0) was fed pelleted concentrate containing background vitamins and trace elements that supplied 1.0 times cows' daily

requirements; the second group were fed the same concentrate, but containing 2.5 g/kg of vitamin and trace mineral premix per kg of concentrate (C-2.5); the third group were fed the same concentrate, but containing 5 g/kg of vitamin and trace mineral premix per kg of concentrate (C-5). The daily ration included ad libitum chopped oat hay, and the cows also had 8 h/d grazing on a ryegrass (*Lolium multiflorum*) pasture. During the performance trial, cow milk yield was daily recorded and individual milk samples were analysed for milk composition and to determine milk renneting properties. Cows fed the intermediate premix level (C-2.5) in diet showed the highest fat-corrected milk production ($p < 0.05$) compared to other groups. None of the milk quality parameters studied were influenced by dietary treatment, except for milk rheological parameters (rennet clotting time and curd firmness) that were positively improved in cows fed the C-2.5 diet ($p < 0.05$). The findings from this study show that intermediate level of vitamin-trace elements premix in concentrate can be advantageously used in grazing dairy cows without negative effects on yield and quality of milk produced.

Somkuwar A.P. *et al.* (2011) compare the effect of feeding different mineral based formulation on dairy cow production performance, namely milk yield and fat percentage. The trial was conducted with dairy cows across various stages of lactation (Early, Mid and Late stage with 30 cows per stage). The experimental treatments included: Bestmin Gold (Metho-chelated organic minerals, given 30 gms per day), Inorganic mineral preparation (Inorg. Mineral@50 gm/day/cow). Milk yield and fat percentage of cows were measured individually on Days 0, 5, 10, 15, 20, 25, 30 and 40. The Bestmin Gold treated group (Metho-chelated organic minerals) improved the milk yield, net gain in milk and the milk fat percentage of animals across the various stages of lactation as compared to in control and inorganic mineral treated group of animals.

Ramos (2012) studied the effect of complexed trace minerals supplementation on productive, reproductive and metabolic variables during early postpartum of grazing primiparous dairy cows (=) was investigated. Pasture-fed Holstein heifers were offered (supplemented group; SG, $n = 60$) or not (control group; CG, $n = 60$) a commercial trace mineral supplement during the first 90 days of lactation. Milk

production and composition were determined monthly. Supplementation did not affect milk production or its composition, except for fat percentage that tended to be higher in SG than CG. Calving-first service and calving-conception intervals were shorter in SG than CG but number of services per conception and pregnancy rates did not differ between treatments. Organic trace mineral supplementation had a transient beneficial effect on milk composition on the intervals from calving to first service and from calving to conception, with no changes in metabolic and endocrine profiles during the transition period primiparous dairy cows on grazing conditions.

El-Ashry *et al.* (2012) objective of the study was to compare the effect of feeding mixed chelated minerals (Mn, Cu and Zn) methionine on dairy cow productive performance and milk yield and its components. The trial was conducted with dairy cows across various stage of lactation. The experimental treatments include chelated minerals (15 mg Zn as Zn Met, 20 mg Mn as Mn Met, 10 mg Cu as Cu Met). Inorganic mixture contains (15 mg Zn as ZnSO₄, 20 mg Mn as MnSO₄, 10 mg Cu as CuSO₄) in sulphate forms. The experiment was commenced in the dry period of cows, 6 weeks before calving, and after calving the first three months of lactation was taken into consideration. Milk samples were collected from each cow evening and morning for estimation of milk yield production. The treated group (chelated minerals) improved the milk yield, and the milk fat percentage of animals across various stages of lactation as compared to inorganic minerals treated group of animals, and no significant differences were observed among groups concerning the entire blood constituent.

Anton *et al.* (2013) studied the influence of copper and zinc supplements on milk production performances and health indicators was tested in a 20- week feeding trial, with 40 Holstein-Friesian lactating cows, divided in four groups (copper, zinc, copper-zinc and control). Correlations of the Cu and Zn plasma values with some animal performance criteria of health (body condition score and somatic cell counts) and production (milk yield, peak milk yield, fat and crude protein content) were done. During the 140 days of the experiment, the two added minerals caused a statistically significant increase ($p < 0.05$) of their plasma values after the peak of the cows' lactations. The Pearson correlation test showed a positive correlation ($p = 0.007$, $r =$

+0.851) between the plasma Zn and the milk production. The improvement of the nutritional status improved the milk production performances of the cows as well as their health performances.

Chester-Jones *et al.* (2013) evaluate the effect of increasing the proportion of inorganic versus organic trace minerals (polysaccharides and amino-acid chelates) on reproductive performance and milk production of multiparous and primiparous Holstein cows. Trace minerals evaluated were copper (Cu), manganese (Mn), and zinc (Zn). All minerals were supplemented to meet the NRC (1989) recommended level (10, 40, and 40 mg/kg of Cu, Mn, and Zn, respectively) in diet DM. A total of 101 cows were randomly assigned by expected calving date to 1 of 4 trace mineral treatments: 1) 100% from inorganic sulfate (SULF); 2) 67% SULF:33% polysaccharide complex (SULF-POLY); 3) 67% SULF:33% specific amino-acid complex (SULF-AA); and 4) 100% polysaccharide complex (POLY). Treatments were implemented the day of calving. Number of days open was reduced ($P < 0.05$) for all cows receiving the POLY versus SULF treatments. Milk production and composition were not affected by supplements fed. Under the conditions of this study, reproductive performance of cows fed a trace-mineral supplement composed of 100% polysaccharide complexed trace minerals was enhanced versus sulfate, sulfate and polysaccharide, or sulfate and amino acid complexed supplements.

Del Valle *et al.* (2015) They evaluated the effects of organic and inorganic sources of minerals in diets for mid-lactation dairy cows on milk yield and composition, intake and total apparent digestibility of dry matter and nutrients, microbial protein synthesis, and energy and protein balances. Twenty Holstein cows averaging 146.83 ± 67.34 days in milk and weighing 625.30 ± 80.37 kg were used. The experimental design was a crossover. Diets were composed of corn silage (50%), ground grain corn, and soybean meal, differing with regard to the sources of trace minerals, plus an organic and inorganic mix. The organic mineral source increased milk fat and fat-corrected milk yield without changing milk yield, intake, or total apparent digestibility. Blood parameters, microbial protein synthesis, and energy and protein balances were not affected by the sources of minerals. Organic sources of minerals improve milk fat yield without affecting other parameters.

Senthilkumar *et al.* (2016) Ten villages of Tirunelveli district were selected purposively for the study wherein NABARD Farmers club functioning successfully. From each village 50 NABARD Farmers club members were selected by simple random sampling techniques. Thirty percent of the respondents were involved among 500 beneficiaris of the project to study the impact of TANUVAS - mineral mixture on the productive performance. Accordingly, 15 farmers from each village were included for this study and constituted a sample size of 150. Milk sample were collected before supplementation of TANUVAS - mineral mixture and after two weeks period of supplementation of TANUVAS - mineral mixture in dairy cattle. Fat and SNF percentage of samples were analysed in the laboratory and milk yield also estimated. The study concluded that, supplementation with TANUVAS - mineral mixture increased milk yield by one litre, fat percentage increased by 1.77 per cent and SNF increased by 0.77 per cent.

Singh *et al.* (2016) conducted a study to observe the effects of area specific mineral mixture supplementation of dairy animals of central zone of Punjab on milk yield and milk components over a period of six months. Sixty nine cattle (51 in treatment group, 18 in control group) and 71 buffaloes (53 in treatment group, 18 in control group) were selected randomly from 23 villages of central Zone of Punjab. Animals from treatment group were fed area specific mineral mixture @ 50 grams/animal/day for a period of 6 months; whereas animals from control group were not supplemented. Milk yield of these animals was recorded by their owners and these values were averaged for 0-3 months and 3-6 months interval. Milk components such as milk fat, milk solids, milk proteins and milk lactose were also evaluated from milk samples collected at 0 day, 3 months and 6 months interval. In this study, area specific mineral mixture supplementation resulted in increased milk yield particularly during mid-lactation. However, no effect was observed on milk components during this feeding trial.

Martono *et al.* (2016) evaluate the effects of feed supplements containing tannins, NPN and mineral on milk yield and milk quality of dairy cattle. Nine lactating dairy cows were designed in experiment by a completely randomized design with 3 treatments and 3 replications. Treatment consists of R0: Total Mixed Ration

(TMR); RA: TMR + supplements A; RB: TMR + supplement B. The results showed that supplementation of feed supplements A and B were no effect on milk yield and quality but were had significantly different effect on Milk production efficiency for MPE (Milk yield/FCM). Feed supplement A can increase milk yield by 20.88% and feed supplement B increase milk yield by 8.07% compare with only TMR feeding. All supplementation feed supplement had average milk yield higher than control feed. In conclusion the feed supplements increase feed efficiency for dairy cattle.

Gupta *et al.* (2017) conducted a study to identify effect of mineral mixture feeding on the production and reproductive performance of crossbred cow. 50 animals were selected in their late gestation period and divided in to two groups of 25 animals each. First group (T) was fed with 60 gm mineral mixture daily till 180 days of lactation. Other group (C) was kept controled. Milk production parameters like avg. daily milk yield, peak yield, total milk yield, milk fat %, SNF %, total milk solid and reproductive parameters like days of first postpartum estrus, service period, service per conception, conception rate were compared between treatment and control groups. It was observed that avg. daily milk yield, peak yield and total 180 days milk production were found significantly ($P \leq 0.05$) higher by 13.4%, 16.17% and 13.07 % in mineral mixture fed group than control group, however milk composition parameter were differed non-significantly between treatment and control group. Finding of this experiment suggest that continuous feeding of mineral mixture bettered performance of dairy cross bred animal in respect of their production and reproductive performance.

Pramono *et al.* (2017) studied the effect of improve and optimize productivity of dairy cows require sufficient availability of nutrients, especially high energy in the early period of lactation. The research aimed to evaluate dietary protected feed supplement on milk production and quality, including: fat, protein, and lactose content of Friesian Holstein dairy cow milk. The experiment consists of two treatments i.e. P0: basal diet (control) and P1: basal diet + 3 % protected feed supplement. Each treatment was repeated 15 times. Data were analyzed by independent samples t-test analysis. Results showed that supplementation of protected sardine fish oil had no

effect on lactose content, but increased milk yield production ($p < 0.01$), milk fat content ($p < 0.05$) and protein content ($p < 0.05$).

Sahoo *et al.* (2017) examined the efficacy of supplementing area specific mineral mixture on nutrient utilization and productive performance of lactating crossbred cows. Twenty lactating cows with average lactation yield of 2100 L and average days after calving of 95 were selected from the local dairy farms in village Lohali, Majhera in the vicinity of mid hills of Uttarakhand state and randomly divided into two groups of 10 each (T1 - control; T2 -experimental). The area specific mineral mixture (@ 2% of concentrate mixture) was supplemented in T2 group while the roughage source for animals in both the groups was oak tree leaves. The concentrate and roughage ratio was maintained at about 40: 60. A digestibility trial of six days duration was conducted at the end of experimental feeding i.e. 90 days. DM intake, milk yield and milk composition were recorded at fortnightly intervals. Average daily DM intake (kg/d) was not influenced by mineral mixture supplementation with values of 11.40 and 12.16 in control and treatment group, respectively. Nutrient digestibility of CP, EE and NDF was higher ($P < 0.05$) in area specific mineral mixture supplemented animals than control group. Supplementation of area specific mineral mixture improved the mineral status of the animals as reflected in improved serum minerals level. The milk yield increased by 9.5% and FCM yield by 11.8%. It was concluded that dietary supplementation of area specific mineral developed for hills of Uttarakhand improved nutrient utilization, mineral bioavailability and milk production performance in dairy cows fed oak leaves based die.

2.2. Effect of feed additives on milk composition in crossbred cows:

Carruthers (1985) go for two trials investigated the effects of bentonite on dairy cow performance. In Trial I, 2 groups of 15 cows grazed either pasture or pasture dusted with bentonite (600 g COW-I day-I) for 4 weeks during mid lactation. In Trial 2, 3 groups of 10 cows in late lactation were stall-fed on pasture and lucerne to which 0, 3, or 6% bentonite (dry matter basis) had been added. Average daily bloat score was significantly reduced by addition of bentonite in both trials, but moderate to severe bloat was recorded on all treatments. Bentonite did not significantly affect milk

yield; milk composition; blood Mg, Ca, Cu, and Zn concentrations; or salivary Na and K concentrations.

Brzoska *et al.*(1995) a study was conducted where Grass was ensiled with formic acid 3.5 litres/t, or with powdered J5, H1 or G1 at 7 kg/t. J5, H1 and G1 were mixtures of sodium formate and various mineral acid salts. There were no significant differences between the silage types in lactic and acetic acid contents. Concentration of butyric acid was 8.2, 14.8, 24.7 and 28.1 g/kg DM, respectively; and of ammonia-nitrogen, 4.00, 5.86, 7.42 and 9.25% of total N. Pogorza wethers given the silages to appetite consumed on average 52.7 g/kg0.75. Average energy value (NE for lactation) of silages was 6.66 MJ/kg DM. In another feeding trial, the daily voluntary feed intake of Red-and-White Lowland cows, average live weight 490.5 kg, was 9.33, 9.40, 8.45 and 7.30 kg DM. Average daily yield of fat-corrected milk measured for a period of 96 days, varied from 18.9 kg, with G1, to 19.4 kg, with J5. The average fat, protein and lactose content of milk was 3.84, 3.07 and 5.15%, respectively.

Uchida *et al.* (2001) determined the effect of feeding a combination of Zn amino acid (AA), Mn AA and Cu AA complexes, and Co glucoheptonate on productive and reproductive performance of early lactation high producing dairy cows. The product used as a source of the organic trace mineral complexes was Availa4Reg. (Zinpro Corp., Eden Prairie, MN). 40 pregnant Holstein cows were blocked and randomly assigned to 1 of 2 dietary treatments at calving. After 48+or-30 days, cows were moved from the fresh groups to the high production groups within their treatment assignments. Cows were housed in a free-stall barn and group-fed total mixed rations (TMR) containing inorganic minerals (control) or inorganic minerals and Availa4Reg. The Availa4 TMR was formulated to supply each cow with 7 g/d of Availa4Reg. by partially substituting the inorganic minerals in the concentrate mix of the control TMR. Each 7g of Availa4Reg. supplied 360 mg of Zn, 200 mg of Mn, 125 mg of Cu, and 12 mg of Co. Cows fed the Availa4 TMR tended to have fewer days to first service ($P=0.071$), fewer services per conception ($P=0.069$), and fewer days to conception ($P=0.012$) as compared to cows fed with the control TMR. Feeding a combination of Zn AA, Mn AA and copper AA complexes, and Co glucoheptonate to early lactation Holstein cows improved conception rate with fewer days in milk to

pregnancy but had no effect on milk production, milk fat and protein content, linear somatic cell count, animal body condition score, or lameness score.

Calamari *et al.* (2002) study on carried out a trial on dairy cows in mid lactation to evaluate the effect of long day's photoperiod on milk yield and composition, on some cheese making properties and metabolic conditions of animals. The trial was carried out on 16 dairy cows, raised in a tied stall and subdivided in two groups homogeneous for lactation phase, milk yield and parity. The two groups were raised in two furthestmost sides of the barn. In one of that sides were installed 3 fluorescent lights, controlled by an automatic timer, to obtain 150-250 lux at eye level. Results demonstrate that only 38% of the change in milk yield was responsible for milk protein dilution in L group and indicate that the long-day photoperiod, rather than a reduction of protein content, seems favourable to a slower increase of the protein level during lactation. The pattern of protein content was different as it was constant in L while increased in N. Despite the difference in protein content, titratable acidity and clotting features were similar.

Aragon and Naranjo *et al.* (2003) observed that elaborated Chromium as mineral supplement in livestock. Chromium (Cr) has some influence in the immune system of many animals, including humans. Chromium is an anti-stress mineral because it has an inhibitor effect on the serum level of cortisol, and only expresses its effect when animals are under stress. The biological active form of Cr is a glucose tolerance factor (GTF). Chromium is an essential micronutrient for humans, rats, mice, cattle, swine, poultry, sheep, rabbits, fishes and horses. Its action is related to carbohydrate, protein and lipid metabolism because Cr improves insulin effect. Numerous recent studies have indicated that Cr, particularly during periods of stress, improved production, reproduction performance, immune status and health of several livestock.

Haldar *et al.* (2003) conducted an on-farm trial with crossbred cows of 2nd and 3rd lactation to study the effects of supplemental Cu, Mn and Zn on utilization efficiency of major (Ca and P) and trace (Cu, Fe, Mn and Zn) elements. The animals received 3 treatments in a switchover fashion to receive Cu, Mn and Zn at

approximately 120% (T1), 100% (T2) and 140% (T3) of the respective planes of requirement (NRC 1989). Intakes of Ca, P and Fe were above the level of requirements in all the treatment groups irrespective of lactation number due perhaps to the fairly high concentrations of these elements in diet. Milk mineral concentrations were also within the normal ranges of variation with little effects of either treatments or lactation numbers. It was concluded that there is need to optimize the dietary levels of various major and trace elements in order to maximize their efficiency of utilization in lactating cows.

Mottos (2004) determined the effect of dietary fish oil (FO) on uterine secretion of PGF₂ α , milk production, milk composition, and metabolic status during the periparturient period. Holstein cows were assigned randomly to diets containing FO (n = 13) or olive oil (OO, n = 13). Cows were fed prepartum and postpartum diets that provided approximately 200 g/d from 21 d before the expected parturition until 21 d after parturition. The FO used contained 36% eicosapentaenoic acid (EPA, C20:5, n-3) and 28% docosahexaenoic acid (DHA, C22:6, n-3). Blood samples were obtained from 14 d before the due date until d 21 postpartum. A total of 6 FO and 8 OO cows without periparturient disorders were used in the statistical analyses of PGF₂ α -metabolite (PGFM) and metabolite concentrations. Length of prepartum feeding with OO or FO did not differ. Proportions of individual and total n-3 fatty acids were increased in caruncular tissue and milk of cows fed FO. Production of milk and FCM were similar between cows fed the two oil diets. However, cows fed FO produced less milk fat. Feeding FO reduced plasma concentrations of glucose. Dietary fatty acids given during the periparturient period can alter the fatty acid profile of milk fat.

Kinal *et al.* (2005) reveal an effect of application in dairy cows rations of organic compounds of Zn, Cu, and Mn on the yield, quality and composition of milk in dairy cows during the first trimester of lactation. In the dry period and during 3 months of lactation the cows received the elements in sulphate form (group I – control) and as sulphate and bioplex in proportion inorganic to organic – 80:20 (group II) and 70:30 (group III). The daily milk yield, milk fat, and milk protein, as well as urea concentration, total bacteria count (TBC) and somatic cell count (SCC) in milk

were determined. Higher daily milk and protein yield was found in the 2nd and 3rd month of lactation, receiving 20% of Zn, Cu, and Mn as bioplexes (group II). In milk of these cows SCC was decreased and in the 3rd month of lactation TBC went down.

Matras *et al.* (2005) studied the effectiveness of mineral mixtures balancing the mineral nutrition of cows in 8 chosen dairy farms using different winter feeding models, traditional (T) or modern (M), was evaluated. A positive influence of mixture A used in barns with the traditional feeding model was noted on milk yield (8% increase) and also on the level of some deficient minerals (Ca, P, K, Cu $\leq$ 0.05) in cows' blood serum and on the potassium content in milk. Mixture (B), balancing mineral nutrition of cows from barns where the modern feeding model was used, did not significantly affect either milk yield or mineral level in blood plasma or milk in comparison with the commercial mixture.

Toni *et al.* (2007) taken 180 Holstein cows (90 cows/treatment) to determine the effect of trace mineral source on milk production performance. Treatments were 1) all trace minerals supplied by inorganic sources or 2) inorganic minerals (360 mg Zn/d, 200 mg Mn/d, and 125 mg Cu/d) replaced with amino acid complexes of Zn, Mn, and Cu (CTM, Availa-4, Zinpro Corporation). Neither level nor source of Co supplementation differed between dietary treatments. Cobalt was supplemented as Co carbonate to supply 12 and 23 mg Co/d to dry and lactating cows, respectively. Cows received their respective treatments from 60 d prior to calving through 200 d of lactation. Replacing inorganic trace minerals with CTM tended to increase ($P = 0.06$) milk protein yield (1.09 vs. 1.05 kg/d) and tended to decrease ($P = 0.15$) linear SCC. There was no effect of treatment on milk yield and yields of 3.5% fat-corrected milk and energy corrected milk. Replacing inorganic trace minerals with those supplied by CTM tended to improve lactation performance.

Zielinska *et al.* (2009) study the problem of accumulation of Zn and Cu in the topsoil as a result of application of mineral feed additives that possess low bioavailability in animal diet. The review considered the production process of mineral feed additives in which a product supplies microelements in highly bioavailable form. Addition of natural biomass of edible microalgae with

microelement metal ions, which supply microelements of feeding significance in livestock diet, is considered in term of sustainable production.

Herdts and Hoff *et al.* (2011) observed that effects and evaluation of 8 trace minerals considered significant in ruminant nutrition in this article, both for nutritional deficiencies as well as production-related toxicosis: cobalt, copper, iron, iodine, manganese, molybdenum, selenium, and zinc. Changes in availability, metabolism, and amounts needed for optimum health and productivity in animals are their major effect; frank clinical toxicosis or severe nutritional deficiency are of limited concern in modern production agriculture. The information provided in this article can help to manage the risk of subtle effects that may alter performance and lifetime productivity.

Astawa *et al.* (2011) observed the influence of vitamin-mineral supplementation on digestibility and rumen fermentation in Bali cattle. The randomized block design with 4 treatments and 4 replications were used in the research. In this study was used 16 Bali cattle with body weight around 295.31±23.07 kg. Rations used in the treatments were Treatment A (control): rice straw *ad libitum* plus commercial feed; Treatment B: Treatment A ration plus 0.2% vitamin-mineral in commercial feed; Treatment C: Treatment A ration plus 0.3% vitamin-mineral in commercial feed, and Treatment D: Treatment A ration plus 0.4% vitamin-mineral in commercial feed. The results showed that supplementation of vitamin-mineral at 0.2-0.4% in commercial feed did not increase the digestibility of dry matter, organic matter, crude protein and crude fiber, except for dry matter and organic matter digestibilities at 0.2% supplementation ($p < 0.05$).

Cortinhas (2012) evaluate the effects of feeding dairy cows with organic or inorganic sources of zinc (Zn), copper (Cu) and selenium (Se) on blood concentrations of these minerals, blood metabolic profiles, nutrient intake and milk yield and composition. Nineteen Holstein cows were selected and randomly assigned to two groups for receiving organic ($n = 9$) or inorganic ($n = 10$) sources of Zn, Cu and Se from 60 days before the expected date of calving to 80 days of lactation. Samples of feed, orts and milk were collected for analysis. Body condition score

(BCS) was determined and blood samples were collected for analysis of Zn, Cu and Se concentrations, as well as for metabolic profile. Supplying organic or inorganic sources of Zn, Cu, and Se did not affect dry matter and nutrient intake, milk yield and composition, plasma concentration of these minerals, and BCS or change the BCS in cows from 60 days before the expected date of calving to 80 days of lactation. An effect of time was observed on all feed intake variables, plasma concentrations of Zn and Se, milk yield, milk protein content, BCS and change in BCS.

Ray and Banerjee *et al.* (2012) noted that combined effect of an herbal heat inducer and mineral mixture of M/S Nugen Pharma, India on the fertility parameters and blood biochemical profile of Holstein Friesian x Jersey (F1) crossbred cows with postpartum anoestrus. For clinical trial, 32 cows were randomly divided into four groups of eight each. Group I cows were administered 40 ml liquid herbal heat inducer per day for 4 consecutive days along with 40 gm mineral mixture per day for 15 consecutive days with feed. Group II animals were administered 40 gm mineral mixture per day for 15 consecutive days with feed. Group III animals received 40 ml liquid heat inducer daily for 4 consecutive days, while Group IV animals received no treatment and served as control. The blood biochemical analysis indicated significant ($P \leq 0.05$) elevation of total protein (9.04 ± 0.31 g/dl), copper (183.29 ± 4.75 micro g/dl), zinc (301.0 ± 7.73 micro g/dl), and iron (249.29 ± 7.42 micro g/dl) in group I cows, post-treatment. This study implied that herbal heat inducer and mineral mixture combination exhibited synergistic effect in enhancing the levels of blood protein and minerals in anoestrus cows, resulting in improved fertility. The combination of the treatments was better than either mineral mixture or herbal heat inducer alone.

Adamovic *et al.* (2014) investigate the influence of partial substitution of magnesium oxide with natural bentonite in feed mixtures used in feeding of cows during their exposure to heat stress. The investigation lasted 30 days and was carried out during last ten days and first twenty days of June. In the experiment there were included 30 cows of Holstein breed in first phase of lactation, which were divided into two groups of 15 cows: control (C) and experimental (E). Group C was fed with experimental mineral mixture that contained 60% of magnesium oxide during the whole investigation period. Group E was fed with experimental mineral mixture that

contained 40% of magnesium oxide as well as 20% of natural bentonite. The control and experimental mineral mixtures were mixed into complete feed mixture (18% UP) in the amount of 1%. At the end of the investigation period, on the 30th day, there were taken samples of rumens contents for determining pH, and after that blood samples, in which, after the separation of blood serum, were determined glucose concentration, total proteins, calcium and phosphorus, . Daily allowance and milk chemical composition (percentage of fat, proteins and dry substance) were determined at the end of the investigation period, that is on the 30th day of lactation, for each cow individually. Partial substitution of magnesium oxide with bentonite influenced milk production increase, but it was statistically insignificant. Besides that, in E group of cows, percentage of fat and dry substance in milk was significantly increased ($p < 0.05$ and 0.01 respectively), while percentage of protein increase was insignificant. From the obtained results it can be concluded that substitution of magnesium oxide with bentonite in feed mixtures that are used for feeding cows can prevent rumen acidosis, which high yielding cows incline to under the conditions of elevated. Besides that, this kind of substitution leads to improvement of milk composition, especially when percentage of fat and dry substance in milk is concerned.

Overton TR *et al.* (2014) study that Trace minerals such as Zn, Cu, Mn, and Se are essential with classically defined roles as components of key antioxidant enzymes and proteins. Available evidence indicates that these trace minerals can modulate aspects of oxidative metabolism and immune function in dairy cattle, particularly during the transition period and early lactation. Chromium has been shown to influence both immune function and energy metabolism of cattle; dairy cows fed Cr during the transition period and early lactation have evidence of improved immune function, increased milk production, and decreased cytological endometritis. Trace mineral nutrition modulates production, health, and reproduction in cattle although both formal meta-analysis and informal survey of the literature reveal substantial heterogeneity of response in these outcome variables. The industry has largely moved away from oxide-based programs toward sulfate-based programs; however, some evidence favors shifting supplementation strategies further toward more bioavailable forms of inorganic and organic trace minerals. Furthermore, opportunities for specific modulation of aspects of health, milk production, and

reproduction through supplementation strategies for diets of transition dairy cows are attractive because of the known dynamics of energy metabolism, immune function, and oxidative metabolism during this timeframe.

Agrawal (2016) she taken Three hundred and thirty four numbers of crossbred cows and heifers were surveyed for assessment of reproductive disorders in Kakatpur block of Puri district in Odisha. Animals were divided into five groups having 20 animals each (8 anoestrus and 12 repeat breeding) and treatment was done for 60days. Group I was kept as control (farmer practice), Group II; Group I + mineral mixture (50g/day/animal) comprising of Ca, P, Zn, Cu and Mn, Group III; Group II + Bypass protein (100g/day/animal), Group IV; Group II+ hormone (Double sync), Group V; Group II+ hormone (Estra-double sync). After 60 days there was no significant difference in body weight gain among the treatments. The blood biochemical parameters like glucose, total protein, albumin level increased and urea level decreased significantly ($P<0.05$) among the groups. Hb% level was found to be increased significantly after treatment. Highest pregnancy percentage was observed in group V followed by IV, III and II. So it may be concluded that mineral mixture, bypass protein and hormone supplementation improved blood bio chemicals like glucose, total protein and albumin, decreased serum urea concentration; increased Hb%; and improved mineral concentration and reproductive performances of cross bred cows.

Atkare *et al* .(2017) they studied on productive performance and quality of milk was collected by contacting with 200 buffalo owners and chemical quality in terms of fat, SNF and TS percentage in milk of buffaloes were evaluated and analysed statistically to see the productive performance and to know the chemical quality of milk. Average maximum weekly milk yield was recorded in Thanegaon village (59.28 ± 0.69) and minimum in the Akapur village (58.87 ± 0.84) buffaloes supplemented with Bypass fat mineral mixture. Average maximum weekly milk yield performance showing increasing trend with respect to weekly milk yield for a period of eight weeks from 1st to 8th week with peak milk yield was (63.60 lit.). Thereafter declining trend was upto 12th week of lactation. In relation to chemical quality the overall fat, SNF and TS were recorded as 8.44 %, 9.59% and 18.02% respectively. The results indicated that the milk production increased all selected village due to

supplementation of Bypass fat mineral mixture. The chemical quality of milk of buffaloes in terms of fat, SNF and TS percentage also improved.

Pandey *et al.* (2018) study effect of area specific mineral mixture on the serum enzymes viz. alanine transaminase (ALT); aspartate transaminase (AST) and alkaline Phosphatase (ALP), biochemical parameters viz. serum total protein, albumin, globulin and cholesterol concentration of cattle at Chhattisgarh state were studied. Fifteen dairy cows in each zone were randomly distributed into three groups viz. negative control- natural grazing without mineral supplementation; control group - common mineral mixture supplemented @ 80 gm/day/animal along with natural grazing and treatment group area specific mineral mixture (80 gm/day/animal) supplemented along with natural grazing. The serum albumin and cholesterol levels were non-significantly different among the groups except total protein, globulin, ALT and milk yield. The serum total protein values were significantly ($p<0.05$) higher in both the supplemented groups in all the agro-climatic zones, however value of globulin was significantly higher in plain zone, milk yield was significantly higher in plateau zone and ALP value was significantly higher in plateau and plain zones with commercial and area specific mineral supplemented groups than negative control group. It may be concluded that the effect of commercial and area specific mineral mixture revealed similar effect on serum enzymes, biochemical parameters and milk yield.

Weiss (2018) study and found that NRC (2001) requirements for most trace minerals and vitamins appear adequate but modest safety factors (~1.2 to 1.5 times the NRC) should be used to reduce risk. The trace minerals contained in basal ingredients, including forages, have some degree of availability and concentrations should not be set to 0. NRC (2001) requirements for Co and Mn are too low and concentrations need to be increased substantially. Be wary of long term overfeeding of Cu. Health issues may develop at dietary concentrations as low as 20 ppm when fed over long periods. Supplying vitamin E in excess of NRC (2001) requirement to peripartum cows provides health benefits. Supplying vitamin D in excess of NRC (2001) to cows with limited sun exposure may be needed to maintain adequate D status relative to general health.



MATERIALS AND METHODS

This investigation was undertaken to study the milk production, milk components in lactating cross bred cows on diet containing different feed supplements. The trial was conducted on crossbred heifers and lactating cows maintained at dairy farm, Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

3.1 Location and climate

The city of Varanasi is located in eastern part of Uttar Pradesh, which extends from 80°45' E to 84°30' E and 23°45' N to 28°30' N. It is situated approximately in the center of North Gangetic alluvial plain on the left bank of river Ganga at an altitude of 128.93 meters from sea level. It comes under subtropical climate and is often subjected to extremes of weather condition, with an average rainfall of about 110 cm per annum.

3.2 Duration of study

The experiment was carried out for a period of 30 days (November, 2016 to December, 2016) cows at the Dairy Farm, Department of Animal Husbandry and Dairying, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi.

3.3 Selection of experimental animals

A total of 6 crossbred cows were selected for experiment. The animals were quite healthy and all the 6 cross bred cows was randomly divided into 3 groups with 2 animals in each group. Cows group was selected according to their milk production, three lactation period and body weight to maintain the similarity in the trial. Grouping of the cows used in the study are given in Table 1. The milk yield of such cows was recorded separately for each schedule.

Grouping of experimental animals:

- (1) 2 cattle of group T₁ was feeding only concentrate farm feed roughages without mineral mixture supplements.
- (2) 2 cattle of group T₂ was feeding mineral mixture supplement 50ml/calf/day with concentrate farm feed, roughages as per instruction.
- (3) 2 cattle of group T₃ was feeding mineral mixture supplement 100ml/calf/day with concentrate farm feed, roughages as per instruction.

Table No-3.1
Concentrate farm feed

Feed	Amount
Constraint mixture (maize + rice + mustard + cotton cake + Gram Chuni)	12 kg
Green fodder(oat+ Berseem+ Sorghum)	15 kg
Dry fodder	8 kg
Salt	50 gm
Calcium	100 ml

Table No -3.2
Composition of Mineral Mixture Supplements in Each 100 ml Contain

Minerals	Quantities
Vitamin D ₃	1500 IU
Vitamin B ₁₂	220 mcg
Phosphorus	1800 mg
Calcium	3600 mg
Zinc Glycinate	540 mg
Potassium Glycinate	8 mg
Iodine	5.9 mg
Chromium Glycinate	8 mg
Manganese Glycinate	270 mg
Copper Glycinate	120 mg
Cobalt Glycinate	5 mg

3.4 Management and housing

The animals were housed in well ventilated cemented sheds which was washed and cleaned daily. The animals were maintained in experimental sheds with arrangement for individual feeding and watering. Proper attention was paid to cleanliness and other related hygienic conditions. The cross bred cows were dewormed and vaccinated against Foot and Mouth disease, Black quarter and Haemorrhagic septicaemia disease.

3.5 Feeding management

The cross bred cows of all the groups were fed according to NRC feeding Standards (1985) and calculate the amounts of D.M., D.C.P., TDN on the body weight basis and treatments applied as given below:

Table No- 3.3

Requirement Stage	Quantity Fed (Kg/Head/Day)
Maintenance	1 Kg
Production	1 Kg/ 3 kg milk production
Pregnancy	1.5 Kg in addition to maintenance for last 3 months

Table No- 3.4**Daily Nutrients Requirements for Cattle (Source- ICAR Bulletin No. 25)**

Body weight (Kg)	Dry Feed (Kg)	DCP (Kg)	TDN (Kg)
Maintenance requirement			
300	5.0	0.230	2.7
400	5.5	0.250	3.0
450	6.0	0.280	3.4
500	6.5	0.300	3.7
Maintenance plus pregnancy requirement (Kg)			
400	7.2	0.35	4.0
450	7.9	0.40	4.4
500	8.6	0.43	4.8
550	9.3	0.46	5.2
Production requirement per Kg Milk (Kg)			
Fat %			
4	-	0.045	0.315
5	-	0.051	0.370

3.5.1 Concentrate-

The concentrate mixture was prepared at the dairy farm with the following ingredients:

Amount of each concentrate (40 % cake, 30 % cereals, 30 % by-products)

Feed Formulation Ratio at the dairy farm :

i)-	Sorghum	20%	7%	68%
ii)-	Pearl millet	10%	6.5%	58%
iii)-	Arhar chuni	12%	13%	68%
iv)-	Gram Chuni	8%	12.8%	75%
v)-	Wheat bran	10%	11%	67%
vi)-	Mustard Cake	20%	26%	80.5%
vii)-	Cottonseed cake	20%	18%	72%

In winters- Pearl millet:Gur = 70: 30

3.5.2 Roughages-

a)-	Dry Fodder-	Wheat straw 0% DCP, 48.3% TDN	
b)-	Green Fodders-	DCP	TDN
	Berseem	14.6%	59.20%
	Oat	2.42%	53.12%

The feeding trial was conducted for 30 days duration in one season. Water was offered ad-lib twice daily in the morning at 10 A.M. and again in the afternoon at 4 P.M. to all the animals.

Lactation trial:

3.6.1 Milking and milk recording:

Milking was done by hand milking twice daily from individual animal i.e. early morning at 4.00 A.M. and again at 4.00 P.M. during the experimental period.

3.6.2 Milk yield

Daily milk yield was recorded for individual animals at each milking time by using a circular, dial type spring balance with the capacity to weight up to 10 kg with accuracy of 0.10 kg.

3.6.3 Sampling and analysis of milk

Milk samples from individual animals were collected fortnightly for the analysis of milk for its composition. Each time 100 ml of milk sample was collected in a clean, dry plastic bottle after uniform mixing of total milk of each animal. Representative amount from each sample was used determination of total fat, protein, DEN and SNF content in milk.

3.6.4 Milk composition

(a)- Milk fat:

Percentage of milk fat was estimated by using Gerber's method in IS: 1224 (1977). For this, first 10 ml of Sulphuric acid (Sp. gravity-1.807-1.812 at 27⁰C) was transferred into butyrometer by automatic tilt measure taking care not to wet the neck of butyrometer. 10.75 ml thoroughly mixed milk sample was added in butyrometer by pipette followed by 1 ml of amyl alcohol (Sp. gravity 0.803-0.805) was added by an automatic tilt measure. Mouth of butyrometer was firmly closed with lock stopper and

shaken it thoroughly until all the curd was dissolved and no white particle was seen in the liquid. Butyrometer was placed in a Gerber's centrifuge and centrifuged at 1100 rpm. For 4 minute stand then transferred the butyrometer in water bath at $65^{\circ} \pm 2^{\circ}\text{C}$ for 3 minutes. Before taking the reading adjusted the position for fat column to bring the lower end of column to main graduation mark. Scale reading was noted corresponding to the lowest point of the fat and the surface of separation of fat and acid. The difference between the two readings gave the percentage by weight of fat in milk.

(b) Specific gravity:

Sp. Gr. Of milk determined by mixing the sample of milk in a jar and lower the lactometer gently into milk to float. Leave it for few seconds. When it is stationary and does not touch side of jar, then read the scale of lactometer and note down the temp. If the temp. is above or below the standard temp. (60°F) then the lactometer reading should corrected by adding 0.1 for each degree temp.

$$\text{Sp. Gr. Of milk} = 1 + \frac{\text{CLR}}{1000}$$

Where CLR- Corrected Lactometer Reading

(c)- Total solids in milk:

Total solids in milk were determined by following Richmond's Formula:

$$\text{T.S.} = \frac{G}{4} + 1.2 F + 0.14$$

Where,

T.S. represents total solids % in milk;

G = Corrected lactometer reading of milk at 60°F

F = % fat in milk

(d)- Solid Not Fat (SNF):

The SNF in milk sample was calculated by subtracting milk fat from total solids in the milk.

(e)- Milk protein:

The protein in the milk sample was determined by following method of (AOAC, 1995), 5 ml of milk sample was transferred into 100 ml kjeldahl flask with the help of pipette. To this 1 gm of digestion mixture and 10 ml concentrated sulphuric acid were added. The samples were digested distilled and distillate collected was titrated with 0.1 N H₂SO₄ to determine nitrogen content. The protein content in milk was obtained by multiplying this nitrogen content with factor 6.38.

(f)- Density percentage (DEN %):

DEN percentage was measured by the help of electronic Ecko milk machine.

2.7 Statistical analysis

Data were analysed using the model of the Two Factorial CRD Statistical analysis with the help of software OPSTAT and simple calculation for mean is done by formula given below:-

$$\bar{x} = \frac{\sum x}{n}$$

Here:

$\sum$ = represents the summation

x = represents treatment

n = represents number of treatment



RESULT AND DISCUSSION

The experiment was conducted to observe the effect of mineral mixture supplement on cross bred lactating cows. For this purpose 6 cross bred cows were selected from the university dairy farm and divided into three groups and consisting of 2 cattle in each group.

During investigation following parameters were studied and after completion of experiment the same were analyzed and interpreted here as under.

1. Total milk yield (Liter)
2. Milk composition (%)

4.1. Effect of mineral mixture supplements on total milk yield of cows:

Table No 4.1 -: Impact of various feed supplement on total milk yield during experimental period (in Litre/day)

Treatment No	No of Cow	0 days	10 days	20 days	30 days
T1(Controlled)	1	5.2	5.4	5.7	5.6
	2	7.3	7.6	7.3	7.7
T2	3	8	8.3	8.6	8.9
	4	9.2	9.5	9.7	10
T3	5	8.3	8.8	9.2	9.6
	6	10.2	10.7	11	11.8

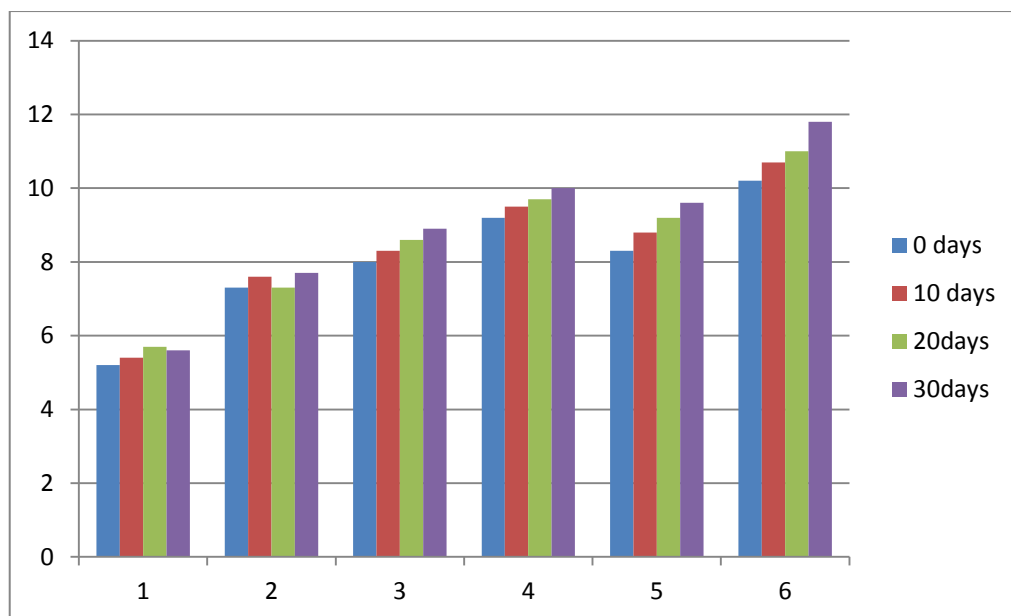


Fig. 1:-Total Milk yield in 0 day, 10 days, 20 days and 30 day of feeding.

Table No 4.2:- Milk yield Mean Table

T1	6.4750	T2	9.0250	T3	9.9500		
D1	8.0333	D2	8.3833	D3	8.5833	D4	8.9333

	D1	D2	D3	D4
T1	6.2500	6.5000	6.5000	6.6500
T2	8.6000	8.9000	9.1500	9.4500
T3	9.2500	9.7500	10.1000	10.7000

Table No 4.3:- Milk Yield ANOVA Table:

Source	df	SS	MS	F	PROBILITY
TOT	23	73.413333	3.191884	2.0805	
TRT	11	55.003333	5.000303	3.2593	0.006 **
ERR	12	18.410000	1.534167	1.0000	
T	2	51.823333	25.911667	16.8897	0.003 **
D	3	2.550000	0.850000	0.5540	0.664 NS
TD	6	0.630000	0.105000	0.0684	0.998 NS
ERR	12	18.410000	1.534167	1.0000	

CV = 1.57%

	SED	CD(0.05)	CD(0.01)
T	0.61931	1.34937	1.89179
D	0.71511	1.55812	2.18445
TD	1.23861	2.69873	3.78358

Mean Comparison by LSD

Descending Order

The following Treatments under each Group are on par.

❖ Group A- T2 T3

❖ Group B-T1

Group A has the best treatments and Group B has the poorest performing treatments.

Milk yield was recorded at pre treatment (0 day) then at 10 days, 20 days and at 30 days. The overall average milk yield at pre experiment of all six cows was 8.03(lit) with an average of 6.25 (lit) in T₁ (control) group; and 8.6 (lit) in T₂ (Treatment) group and 9.25 (lit) in T₃ (Treatment) group.

Average milk yield was post treatment of all six cows was 8.9 (lit) with an overall average 6.65(lit) in T₁ (control) group; and overall 9.45(lit) in T₂ (Treatment) group and 10.7(lit) in T₃ (Treatment) group.

In three group milk production of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group also the average milk production after and before supplemental feeding is changed.

To see the effect of various mineral mixtures on milk yield in treated milk different types of variances were analyzed. The milk yield in various groups differ significantly ($P < 0.05$).

4.2. Effect of mineral mixture supplements on milk of composition cows:

4.2.1 Fat Percentage:

Table No 4.4 - : Impact of various feed supplement on milk fat during experimental period (Fat %)

	No of Cow	Fat % before mineral feeding	Fat % after 15 days	Fat % after 30 days
T ₁ (Controlled)	1	3.1	3.2	3.2
	2	2.9	3	3
T ₂	3	3.3	3.4	3.5
	4	3	3.2	3.3
T ₃	5	3.2	3.5	3.7
	6	3.3	3.5	3.8

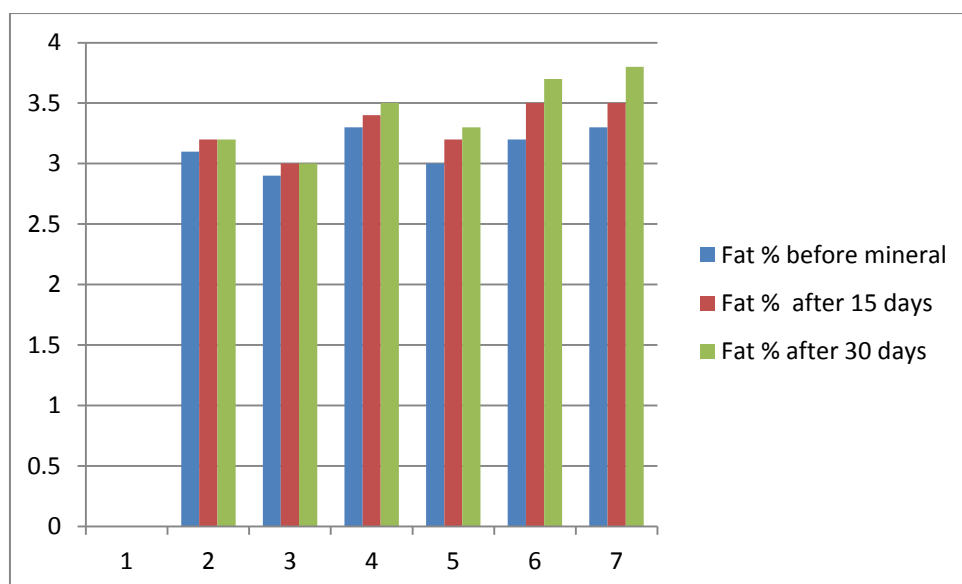


Fig.2:- Milk Fat% in 0 day, 15 days, and 30 days of feeding.

Table No 4.5:- Fat% Analysis of Variance Table

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	2	2.370	1.185	16.408	0.00100
Factor B	2	1.293	0.647	8.954	0.00724
Interaction A X B	4	2.027	0.507	7.015	0.00755
Error	9	0.650	0.072		
Total	17	6.340			

Two Way Mean Table

	B1	B2	B3	Mean A
A1	1.500	3.000	3.100	2.533
A2	3.100	3.150	3.300	3.183
A3	3.400	3.250	3.500	3.383
Mean B	2.667	3.133	3.300	

TABLE OF SEM,SE(d) AND C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.356	0.155	0.110
Factor(B)	0.356	0.155	0.110
Factor(A X B)	0.617	0.269	0.190

Fat% was recorded at pre treatment (0 day) and post treatment that is after 15 days another at 30days. The average fat% at pre experiment of all group was 3% in T₁ (control) group; 3.15% in T₂ (Treatment) group and 3.25% in T₃ (Treatment) group.

Average Fat% was recorded at post treatment of all six cows was in 15 days interval it show 3.1% in T₁ (control) group, 3.3% in T₂ (Treatment) group and 3.5% in T₃ (Treatment) group.

After 30 days it show another incremental value that is 3.1% in T₁ (control) group, 3.4% in T₂ (Treatment) group and 3.75% in T₃ (Treatment) group.

In three group Fat % of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group.

To see the effect of various mineral mixtures on Fat% in treated milk different types of variances were analyzed. The Fat% in various groups differ significantly ($P < 0.05$).

4.2.2 SNF (Solid Non Fat) Percentage:

Table No 4.6 -: Impact of various feed supplement on SNF during experimental period (SNF %)

	No of Cow	SNF % Before supplemental feeding	SNF % after 15 days supplemental feeding	SNF % 30 days after supplemental feeding
T1(Controlled)	1	7.7	8	8.3
	2	8	8.4	8.6
T2	3	8.1	8.6	9
	4	8.2	8.7	9.1
T3	5	7.9	8.5	8.9
	6	7.4	8.2	8.9

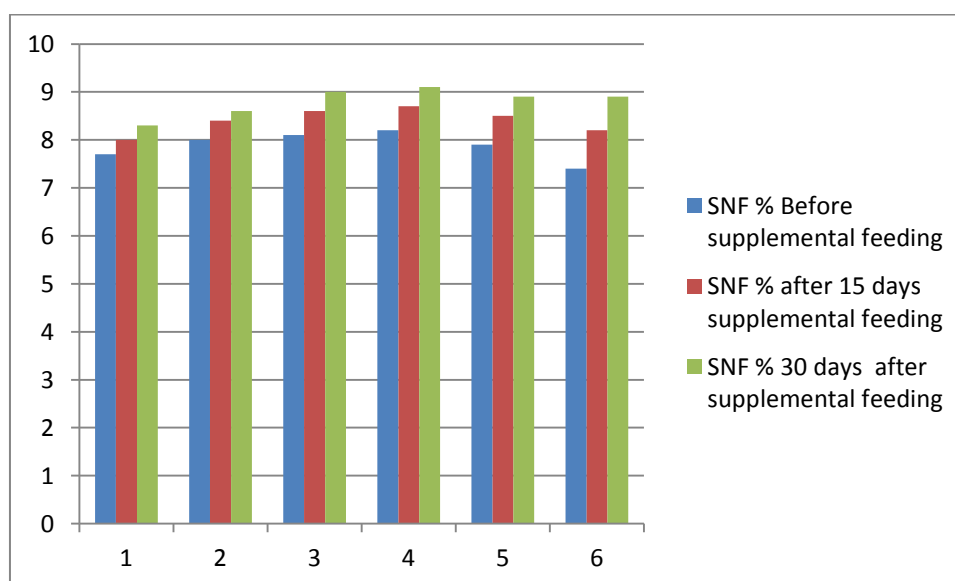


Fig.3:- Milk SNF Before, after 15 days and 30 days after supplemental feeding.

Table No 4.7 -: SNF% Analysis of Variance Table

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	2	0.641	0.321	8.129	0.00962
Factor B	2	2.535	1.267	32.129	0.00008
Interaction A X B	4	0.212	0.053	1.344	0.32598
Error	9	0.355	0.039		
Total	17	3.743			

Two Way Mean Table

	B1	B2	B3	Mean A
A1	7.850	8.200	8.450	8.167
A2	8.150	8.650	9.050	8.617
A3	7.650	8.350	8.900	8.300
Mean B	7.883	8.400	8.800	

TABLE OF SEM, SE(d) AND C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.263	0.115	0.081
Factor(B)	0.263	0.115	0.081
Factor(A X B)	N/A	0.199	0.140

Average SNF% was recorded at pre treatment (0 day) and post treatment that is after 15 days another at 30days. The average SNF% at pre experiment all group was 7.85% in T₁ (control) group; 8.15% in T₂ (Treatment) group and 7.65% in T₃ (Treatment) group.

Average SNF% was recorded at post treatment of all six cows was in 15 days interval it show 8.2% in T₁ (control) group, 8.65% in T₂ (Treatment) group and 8.35% in T₃ (Treatment) group.

After 30days it show another incremental value that is 8.45% in T₁ (control) group, 9.05% in T₂ (Treatment) group and 8.9% in T₃ (Treatment) group.

In three group SNF % of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group.

To see the effect of various mineral mixtures on SNF% in treated milk different types of variances were analyzed. The SNF% in various groups differ significantly ($P < 0.05$).

4.2.3 Protein Percentage:

Table No 4.8:- Impact of various feed supplement on daily milk protein during experimental period (Protein %)

	No of Cow	Protein % before supplemental feeding	Protein % 15 Days after supplemental feeding	Protein % 30 Days after supplemental feeding
T ₁ (Controlled)	1	3.1	3.1	3.2
	2	2.9	3	3
T ₂	3	3	3.1	3.3
	4	3.3	3.4	3.4
T ₃	5	3.1	3.2	3.3
	6	3.2	3.4	3.5

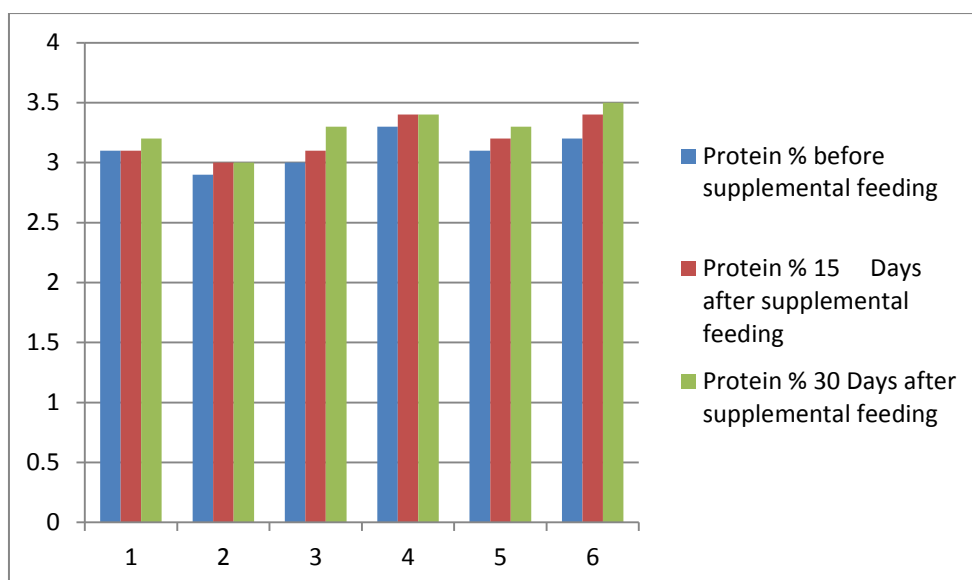


Fig.4:- Milk Protein Before, after 15 days and 30 days after supplemental feeding

Table No. 4.9:- Protein Analysis of Variance Table

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	2	0.188	0.094	4.568	0.04273
Factor B	2	0.101	0.051	2.460	0.14053
Interaction A X B	4	0.016	0.004	0.189	0.93814
Error	9	0.185	0.021		
Total	17	0.489			

Two Way Mean Table

	B1	B2	B3	Mean A
A1	3.000	3.050	3.100	3.050
A2	3.150	3.250	3.400	3.267
A3	3.150	3.300	3.350	3.267
Mean B	3.100	3.200	3.283	

TABLE OF SEM, SE(d) AND C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.190	0.083	0.059
Factor(B)	N/A	0.083	0.059
Factor(A X B)	N/A	0.143	0.101

Average Protein% was recorded at pre treatment (0 day) and post treatment that is after 15 days another at 30days. The average Protein% at pre experiment of all group was 3% in T₁ (control) group; 3.15% in T₂ (Treatment) group and 3.15% in T₃ (Treatment) group.

Average Protein% was recorded at post treatment of all six cows was in 15 days interval it show 3.05% in T₁ (control) group, 3.25% in T₂ (Treatment) group and 3.3% in T₃ (Treatment) group.

After 30days it show another incremental value that is 3.1% in T₁ (control) group, 3.35% in T₂ (Treatment) group and 3.4% in T₃ (Treatment) group.

In three group Protein % of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group. But the increment is not significant ($P>0.05$).

4.2.4 Density of milk:

Table No. 4.10:- Impact of various feed supplement on milk density during experimental period (Density %)

	No of Cow	Milk Density before supplemental feeding	Milk Density 15 Days after supplemental feeding	Milk Density 30 Days after supplemental feeding
T ₁	1	30.2	30	31.2
	2	31	31.1	32
T ₂	3	27	29	30
	4	26.5	28.5	31
T ₃	5	32.3	33.5	34.2
	6	30.3	31.4	32.5

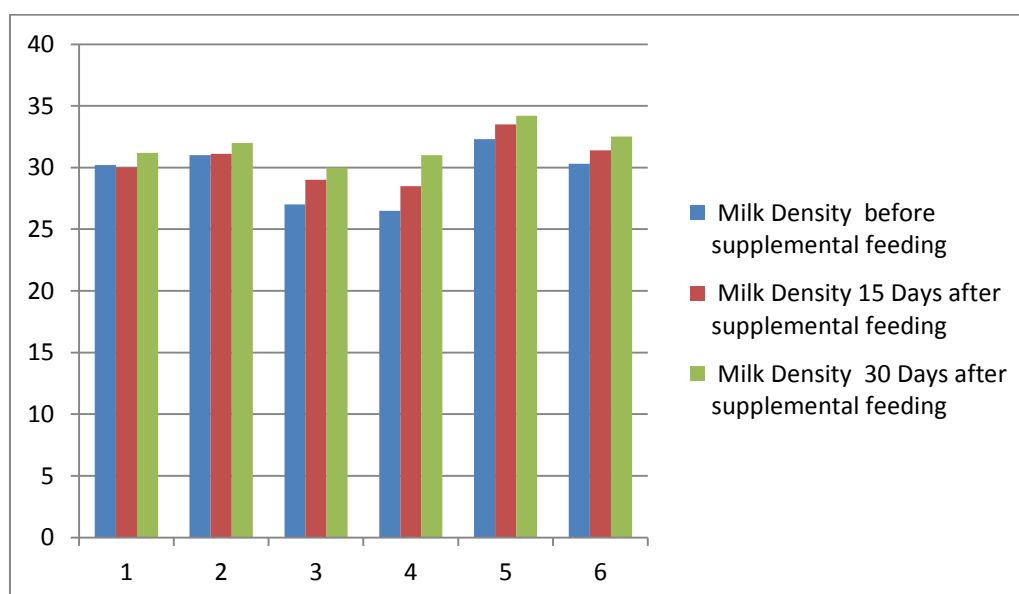


Fig.5:-Milk Density Before, after 15 days and 30 days after supplemental feeding

Table No 4.11:- Milk Density Analysis of Variance Table

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	2	41.713	20.856	24.552	0.00023
Factor B	2	15.455	7.728	9.097	0.00690
Interaction A X B	4	4.255	1.064	1.252	0.35626
Error	9	7.645	0.849		
Total	17	69.068			

Two Way Mean Table

	B1	B2	B3	Mean A
A1	30.600	30.550	31.600	30.917
A2	26.750	28.750	30.500	28.667
A3	31.300	32.450	33.350	32.367
Mean B	29.550	30.583	31.817	

TABLE OF SEM, SE(d) AND C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	1.221	0.532	0.376
Factor(B)	1.221	0.532	0.376
Factor(A X B)	N/A	0.922	0.652

Average Milk Density % was recorded at pre treatment (0 day) and post treatment that is after 15 days another at 30days. The average Milk Density% at pre experiment of all group was 30.6% in T₁ (control) group; 26.75% in T₂ (Treatment) group and 31.3% in T₃ (Treatment) group.

Average Milk Density% was recorded at post treatment of all six cows was in 15 days interval it show 30.55% in T₁ (control) group, 28.75% in T₂ (Treatment) group and 32.45% in T₃ (Treatment) group.

After 30days it show another incremental value that is 31.6% in T₁ (control) group, 30.55% in T₂ (Treatment) group and 33.35% in T₃ (Treatment) group.

In three group Milk Density % of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group.

To see the effect of various mineral mixtures on Milk Density % in treated milk different types of variances were analyzed. The Milk Density in various groups differ significantly ($P < 0.05$).

4.2.5. Lactose % in milk:

Table No. 4.12:- Impact of various feed supplement on Lactose of milk during experimental period

	No of Cow	Lactose before supplemental feeding	Lactose 15 Days after supplemental feeding	Lactose 30 Days after supplemental feeding
T ₁ (Controlled)	1	4.33	4.5	4.6
	2	4.6	4.8	5.1
T ₂	3	5	5.6	5.9
	4	5.1	5.7	6.1
T ₃	5	4.04	4.7	5.4
	6	4.34	4.81	6.2

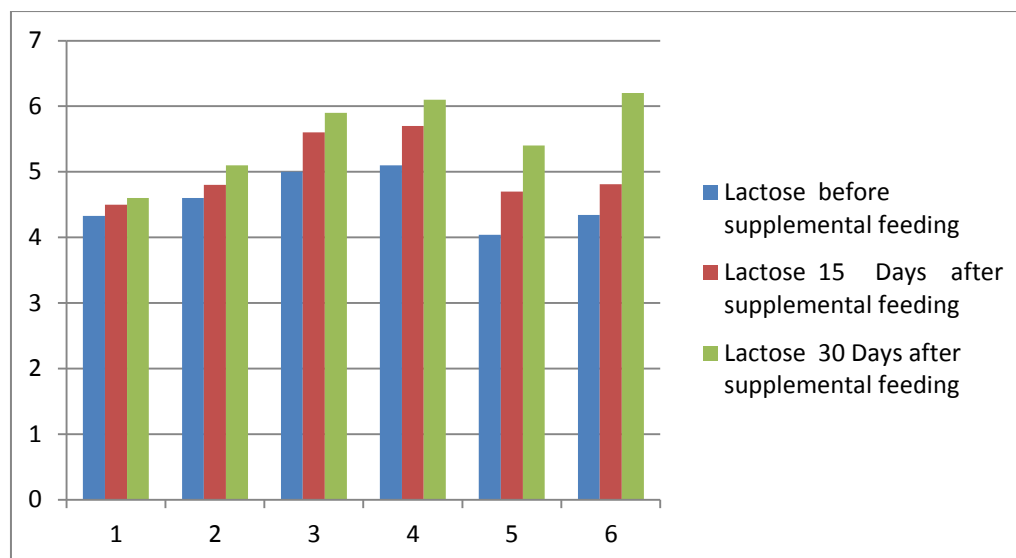


Fig 6:- Lactose Before, after 15 days and 30 days after supplemental feeding

Table No -13 Lactose Analysis Variance Table

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated	Significance
Factor A	2	2.647	1.323	19.608	0.00052
Factor B	2	2.898	1.449	21.466	0.00038
Interaction A X B	4	0.843	0.211	3.121	0.07205
Error	9	0.607	0.067		
Total	17	6.995			

Two Way Mean Table

	B1	B2	B3	Mean A
A1	4.465	4.650	4.850	4.655
A2	5.050	5.650	6.000	5.567
A3	4.190	4.755	5.800	4.915
Mean B	4.568	5.018	5.550	

TABLE OF SEM, SE(d) AND C.D.

Factors	C.D.	SE(d)	SE(m)
Factor(A)	0.344	0.150	0.106
Factor(B)	0.344	0.150	0.106
Factor(A X B)	N/A	0.260	0.184

Average Lactose% was recorded at pre treatment (0 day) and post treatment that after 15 days another at 30days. The average Protein% at pre experiment of all group was 4.46% in T₁ (control) group; 5.05% in T₂ (Treatment) group and 4.19% in T₃ (Treatment) group.

Average Lactose% was recorded at post treatment of all six cows was in 15 days interval it show 4.65% in T₁ (control) group, 5.65% in T₂ (Treatment) group and 4.75% in T₃ (Treatment) group.

After 30days it show another incremental value that 4.85% in T₁ (control) group, 6% in T₂ (Treatment) group and 5.8% in T₃ (Treatment) group.

In three group Lactose% of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group.

To see the effect of various mineral mixtures on Lactose % in treated milk different types of variances were analyzed. The Lactose % in various groups differ significantly ($P < 0.05$).



SUMMARY AND CONCLUSION

India ranks first in milk production, accounting for 18.5 % of world production, achieving an annual output of 146.3 million tons during 2014-15 as compared to 137.69 million tonnes during 2013-14 recording a growth of 6.26 % (Panchbhai *et al.*, 2017). Supplementation of minerals helps in efficient utilization of absorbed nutrients and many other ways, for improving growth, milk production reproduction efficiency. Feeding animals with feed additives can improve utilization efficiency of the concentrate feeds available in limited quantity. In view of the aforesaid the present research work entitled ‘Impact of feed additives supplement on milk production of lactating cows’ was undertaken with following objectives:

1. To study the impact of feeding mineral mixture supplement on milk production performance of cross bred.
2. To study the impact of mineral mixture supplement on milk composition

The present study carried out during November to December 2018 (for 30 days) at dairy farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, to the effect of mineral mixture supplement on the cross bred heifer and lactating cows.

Six crossbred cow was selected for present investigation and placed into three groups (T_1 , T_2 , T_3) having two cattle in each. All the cattle maintained in an experimental shed of dairy farm undergo hygienic condition. The three groups were randomly assigned one of the feeding regimes as:

1. 2 cattle of group T_1 was feeding only concentrate farm feed roughages without mineral mixture supplements.

2. 2 cattle of group T₂ was feeding mineral mixture supplement 50ml/calf/day with concentrate farm feed, roughages as per instruction.
3. 2 cattle of group T₃ was feeding mineral mixture supplement 100ml/calf/day with concentrate farm feed, roughages as per instruction.

Following parameters were taken into consideration during present investigation:

- (1) Daily milk yield.
- (2) Milk composition (FAT %, SNF%, Protein%, DEN %).

The result shows that:

Milk yield was recorded at pre treatment (0 day) then at 10 days, 20 days, and at 30 days. The overall average milk yield at pre experiment of all six cows was 8.03(lit) and all three treatment group wise were of 6.25 (lit) in T₁(control) group; and 8.6 (lit) in T₂ (Treatment) group and 9.25 (lit) in T₃ (Treatment) group respectively. Average milk yield was post treatment of all six cows was 8.9 (lit) with an overall average 6.65(lit) in T₁ (control) group; and overall 9.45(lit) in T₂ (Treatment) group and 10.7(lit) in T₃ (Treatment) group. In three group milk production of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group also the average milk production after and before supplemental feeding is changed. To see the effect of various mineral mixtures on milk yield in litter different types of variances were analyzed. The milk yield in various groups differ significantly ($P < 0.05$).

Fat% was recorded at pre treatment (0 day) and post treatment i.e after 15 days another at 30days. The average fat% at pre experiment of all groups were 3% in T₁(control) group; 3.15% in T₂ (Treatment) group and 3.25% in T₃ (Treatment) group. Average Fat% was recorded at post treatment of all six cows was in 15 days interval it show 3.1% in T₁ (control) group, 3.3% in T₂ (Treatment) group and 3.5% in T₃ (Treatment) group. After 30days it show another incremental value i.e 3.1% in T₁ (control) group, 3.4% in T₂ (Treatment) group and 3.75% in T₃ (Treatment) group. In three group Fat % of T₃ (Treatment) group was increase followed by T₂ (Treatment) and T₁ (control) group. To see the effect of various mineral mixtures on

Fat% in treated milk different types of variances were analyzed. The Fat% in various groups differ significantly ($P < 0.05$)

Average SNF% was recorded at pretreatment (0 day) and post treatment i.e after 15 days another at 30days. The average SNF% at pre experiment all groups were 7.85% in T1(control) group; 8.15% in T2 (Treatment) group and 7.65% in T3 (Treatment) group. Average SNF% was recorded at post treatment of all six cows was in 15 days interval it show 8.2% in T1 (control) group, 8.65% in T2 (Treatment) group and 8.35% in T3 (Treatment) group. After 30days it show another incremental value i.e 8.45% in T1 (control) group, 9.05% in T2 (Treatment) group and 8.9% in T3 (Treatment) group. In three group SNF % of T3 (Treatment) group was increase followed by T2 (Treatment) and T1 (control) group. To see the effect of various mineral mixtures on SNF% in treated milk, different types of variances were analyzed. The SNF% in various groups differ significantly ($P < 0.05$).

Average Protein% was recorded at pre treatment (0 day) and post treatment i.e after 15 days another at 30days. The average Protein% at pre experiment of all groups were 3% in T1(control) group; 3.15% in T2 (Treatment) group and 3.15% in T3 (Treatment) group. Average Protein% was recorded at post treatment of all six cows was in 15 days interval it show 3.05% in T1 (control) group, 3.25% in T2 (Treatment) group and 3.3% in T3 (Treatment) group. After 30days it show another incremental value i.e 3.1% in T1 (control) group, 3.35% in T2 (Treatment) group and 3.4% in T3 (Treatment) group. In three group Protein % of T3 (Treatment) group was increase followed by T2 (Treatment) and T1 (control) group. But the increment is non significantly ($P > 0.05$).

Average Milk Density % was recorded at pre treatment (0 day) and post treatment i.e after 15 days another at 30days. The average Milk Density% at pre experiment of all groups were 30.6% in T1(control) group; 26.75% in T2 (Treatment) group and 31.3% in T3 (Treatment) group. Average Milk Density% was recorded at post treatment of all six cows was in 15 days interval it show 30.55% in T1 (control) group, 28.75% in T2 (Treatment) group and 32.45% in T3 (Treatment) group. After 30days it show another incremental value i.e 31.6% in T1 (control) group, 30.55% in

T2 (Treatment) group and 33.35% in T3 (Treatment) group. In three groups Milk Density % of T3 (Treatment) group was increased followed by T2 (Treatment) and T1 (control) group. To see the effect of various mineral mixtures on milk density in treated milk different types of variances were analyzed. The milk density in various groups differ significantly ($P < 0.05$).

Average Lactose% was recorded at pre treatment (0 day) and post treatment i.e. after 15 days another at 30 days. The average Protein% at pre experiment of all groups was 4.46% in T1 (control) group; 5.05% in T2 (Treatment) group and 4.19% in T3 (Treatment) group. Average Lactose% was recorded at post treatment of all six cows was in 15 days interval it shows 4.65% in T1 (control) group, 5.65% in T2 (Treatment) group and 4.75% in T3 (Treatment) group. After 30 days it shows another incremental value i.e. 4.85% in T1 (control) group, 6% in T2 (Treatment) group and 5.8% in T3 (Treatment) group. In three groups Lactose% of T3 (Treatment) group was increased followed by T2 (Treatment) and T1 (control) group. To see the effect of various mineral mixtures on Lactose in treated milk different types of variances were analyzed. The Lactose in various groups differ significantly ($P < 0.05$).

This experiment shows that adding of mineral mixture feeding in feed of lactating cow gives a great increment in milk production and the composition. Farmers should adopt it and take benefits.

Conclusion:

Feeding the minerals and vitamin requires of dairy cattle is crucial to achieving high levels of milk production and maintaining cows' health and productive performance of lactating cows. It is important to evaluate the feeding situation, the level of management and what is to be accomplished prior to the selection of an appropriate feed additive. Feed additives have consistently proven to be an asset of productive performance and are well accepted as a means to increase the profitability of most cattle owners.

So the results of this study will help individual farmers, commercial herds as well as the feed industry to ensure balanced nutrition along with appropriate circulation of mineral mixture to dairy stock under widely varying conditions of environment and feed resources for enhanced milk production with optimum composition.



REFERENCES

- Adamovic, M., Samanc, H., Kirovski, D., Vujanac, and I. Valcic, O.(2014) Effects of buffering mineral mixtures on milk yield, milk composition, rumen pH and some blood biochemical parameters in heat stressed dairy cows. [Serbian] Veterinarski Glasnik, **68**(1/2):31-42
- Agrawal, J. (2017). Effect of area specific mineral mixture, by-pass protein and hormonal treatment on the performance of crossbred cows in Kakatpur block (Doctoral dissertation),14.
- Anton, A., Solcan, G. and Solcan, C. (2013). The impact of copper and zinc deficiency on milk production performances of intensively grazed dairy cows on the North-East of Romania. *Proceedings of World Academy of Science Engineering and Technology*. World Academy of Science, Engineering and Technology (WASET), 80: 478.
- Aragon, E.F. Naranjo, A. Del P. 2003. Chromium as mineral supplement in livestock. *Veterinaria Noticia*, **9** (1):117-128.
- Ashmead, H.,D. and Samford, R.A. (2004). Effects of metal amino acid chelates or inorganic minerals on three successive lactations in dairy cows. *International Journal Applied Research Veterinary Medical*, **3**: 181-188.
- Astawa, P. A., Partama, I. B. G. Suyadnya, P. Sutarpa, I. N. S. 2011. Effect of vitamin - mineral supplementation in commercial feed on

- the digestibility coefficient and rumen fermentation of Bali cattle. *Journal of the Indonesian Tropical Animal Agriculture*, **36** (1): 69-74.
- Atkare, V.G., Shambharkar, A.D. and Khupse, S.M. 2018. Effect of Feeding of Bypass Fat Mineral Mixture on Productive Performance and Quality of Milk of Buffaloes in Armori Tahsil. *International Journal Current Microbiological Applied Science* **7**(01): 2949-2957.
- Baker, D. S., Ahola, J. K., Burns, P. D. and Engle, T. E. (2003). Trace mineral metabolism in ruminants: Impact on production, reproduction and the environment. Nutritional biotechnology in the feed and food industries. Beyond the tornado: natural technologies, the calm before the storm, *Lexington, Kentucky, USA*, 275-287.
- Ballantine, H. T., Socha, M. T. Tomlinson, D. A. D. Johnson, A. B. Fielding, A. S., Shearer, J. K., and Van Amstel, S. R. (2002). Effects of feeding complexed zinc, manganese, copper, and cobalt to late gestation and lactating dairy cows on claw integrity, reproduction, and lactation performance. *The Professional Animal Scientist*, **18**(3):211-218.
- Biswas, P. K., Goswami, A., Biswas, B. K., Chand, B. K. and Biswas, A (2002) Effect of supplementation of mineral-vitamin-mixture on DM intake and milk production of cow under straw-based diet in village condition. *Indian Journal of Animal Health*, **41**(2):145-148
- Brzoska, F., Zyzak, W. and Sala, K.(1995). Effect of mixtures of organic acids and mineral acid salts on nutritive value of grass

- silages, cow productivity and milk composition. *Roczniki Naukowe Zootechniki*, **22**(2):183-195.
- Calamari, L., Maianti, M. G. and Azzoni, A. (2002). Effect of photoperiod on milk production and metabolic conditions of Italian Friesian dairy cows. *Scienza e Tecnica Lattiero-Casearia*, **53**(3): 189-206.
- Carruthers, V.R. (1985) Effect of bentonite on incidence of bloat, milk production, and mineral status in dairy cows. *New Zealand Journal of Agricultural Research*, **28**:221-223.
- Chester-Jones, H., Vermeire, D., Brommelsiek, W., Brokken, K., Marx, G., and Linn, J. G. (2013). Effect of trace mineral source on reproduction and milk production in Holstein cows. *The Professional Animal Scientist*, **29**(3): 289-297.
- Cortinhas, C. S., Freitas Júnior, J. E. D., Naves, J. D. R., Porcionato, M. A. D. F., Rennó, F. P., and Santos, M. V. D. (2012). Organic and inorganic sources of zinc, copper and selenium in diets for dairy cows: intake, blood metabolic profile, milk yield and composition. *Revista Brasileira de Zootecnia*, **41**(6): 1477-1483.
- Del Valle, T. A., Jesus, E. F. D., Paiva, P. G. D., Bettero, V. P., Zanferari, F., Acedo, T. S. and Rennó, F. P. (2015). Effect of organic sources of minerals on fat-corrected milk yield of dairy cows in confinement. *Revista Brasileira de Zootecnia*, **44**(3): 103-108.
- El Ashry, G., M. Hassan, A., A M., and Soliman, S. M. (2012). Effect of feeding a combination of zinc, manganese and copper methionine

- chelates of early lactation high producing dairy cow. *Food and Nutrition Sciences*, **3**(08):1084.
- Garg, M. R., Bhandari, B. M. and Sherasia, P. L. 2005. Mineral status of feeds and fodders in Dahod and Panchmahal districts of Gujarat. *Indian Journal of Dairy Science*, **58**(5): 341-346.
- Gupta, R., Singh, K., Kumar, M. and Sharma, M. (2017). Effect of Supplementation of Minerals on the Productive and Reproductive Performance of Crossbred Cattle. *International Journal of Livestock Research*, **7**(12): 231-236.
- Hackbart, K. S., Ferreira, R. M., Dietsche, A. A., Socha, M. T., Shaver, R. D., Wiltbank, M. C., and Fricke, P. M. (2010). Effect of dietary organic zinc, manganese, copper, and cobalt supplementation on milk production, follicular growth, embryo quality, and tissue mineral concentrations in dairy cows. *Journal of Animal Science*, **88**(12): 3856-3870.
- Halder, S., Ghosh, T. K. and Pal, N. 2003. Effects of trace elements supplementation in commercially reared dairy cows of different lactation in relation to mineral metabolism. *Indian Journal of Animal Sciences*, **73**(4):437-443
- Hayden, C. C., Monroe, C. F., & Crawford, C. H. (1930). Dicalcium phosphate as a mineral supplement for dairy cows.
- Herd, T. H. and Hoff, B. 2011. The use of blood analysis to evaluate trace mineral status in ruminant livestock. *Veterinary Clinics of North America, Food Animal Practice*, **27**(2): 255-283.

- Kalyani, R., and Utpal, B. (2012). Fertility parameters and blood biochemical profile of Holstein Friesian× Jersey crossbred cows treated with herbal heat inducer and mineral mixture combination for induction of postpartum oestrus. *Animal Science Reporter*, **6**(3):109-115.
- Kellogg, D. W., Tomlinson, D. J., Socha, M. T., and Johnson, A. B. (2004). Effects of zinc methionine complex on milk production and somatic cell count of dairy cows: Twelve-trial summary. *The Professional Animal Scientist*, **20**(4): 295-301.
- Kinal, S., Bodarski, R. A. F. A. L., Korniewicz, A. D. O. L. F., Nicpon, J. and Slupczynska, M. (2005). Application of organic forms of zinc, copper and manganese in the first three months of dairy cow lactation and their effect on the yield, composition and quality of milk. *BULLETIN-VETERINARY INSTITUTE IN PULAWY*, **49**(4): 423.
- Martono, S., Negara, W., Gopar, R. A., and Rofiq, M. N. (2016). Combination Effect of Feed Supplements on Milk Yield and Milk Quality of Dairy Cattle. *Journal of Advanced Agricultural Technologies*, **3**(2):136 .
- Matras, J., Bujanowicz-Haras, B., and Wojtasik, J. (2005). Influence of balancing mineral nutrition of dairy cows on milk yield and the content of some minerals in blood and milk. *Journal of Animal and Feed Sciences*, **14**: 275.
- Mattos, R., Staples, C. R., Arteché, A., Wiltbank, M. C., Diaz, F. J., Jenkins, T. C., and Thatcher, W. W. (2004). The effects of feeding

- fish oil on uterine secretion of PGF2 α , milk composition, and metabolic status of periparturient Holstein cows. *Journal of Dairy Science*, **87**(4): 921-932.
- McDowell, L. R. (1996). Feeding minerals to cattle on pasture. *Animal Feed Science and Technology*, **60**(3-4):247-271.
- Overton TR(1), and Yasui T, (2014), Practical applications of trace minerals for dairy cattle. *Journal Animal Science*, **92**(2):416-26
- Panchbhai, G. J., Siddiqui, M. F., Sawant, M. N., Verma, A. P., and Parmeswaranaik, J. (2017). Constraints Faced by Co-Operative Dairy Farmers in Adoption of Recommended Dairy Management Practices. *International Journal Current Microbiological Applied Science*, **6**(3): 1962-1966.
- Pandey V. K., Gendley M.K., Tiwari S.P., and Prusty sonali (2018) Effect of Area Specific Mineral Mixture on Serum Biochemical Parameters and Milk Yield in Dairy Cattle. *International Journal of Agriculture Sciences*, **10**(1):4965-4968.
- Patil, N., Jain, R. K., Tewari, and D. Sharma, C. S. 2008. Effect of organic minerals in animal health and production. *Veterinary Communications*, **3**: 3-8.
- Pramono, A., Handayanta, E., Widayati, D. T., and Putro, P. P. (2017). Dietary Protected Feed Supplement to Increase Milk Production and Quality of Dairy Cows. *IOP Conference Series: Materials Science and Engineering*, **193**(1):1.
- Rabiee, A.R., Lean, I.J., Stevenson, M.A. and Soch, M.T. (2010). Effects of feeding organic trace minerals on milk production and

- reproductive performance in lactating dairy cows: A meta-analysis
Journal of Dairy Science, **99**(9):4239-4251.
- Ramos, J. M., Sosa, C., Rupprechter, G., Pessina, P. and Carriquiry, M. (2012). Effect of organic trace minerals supplementation during early postpartum on milk composition, and metabolic and hormonal profiles in grazing dairy heifers. *Spanish Journal of Agricultural Research*, **10**(3):681-689.
- Sahoo, B., Bhushan, C., Kwatra, J. and Agarwal, A. (2009). Effect of urea molasses mineral block supplementation on milk production of cows (*Bos indicus*) in mid hills of Uttarakhand. *Animal Nutrition and Feed Technology*, **9**(2):171-178.
- Sahoo, B., Kumar, R., Garg, A.K., Mohanta, R. K., Agarwal, A. and Sharma, A. K. (2017). Effect of Supplementing Area Specific Mineral Mixture on Productive Performance of Crossbred Cows. *Indian Journal of Animal Nutrition*, **34**(4): 414-419.
- Singh, S., Chhabra, S., Randhawa, S. N. S., Randhawa, C. S. and Gupta, D. K. (2016). Effect of Area Specific Mineral Mixture Feeding On Milk Yield and Composition of Dairy Animals of Central Zone of Punjab. *International Journal of Livestock Research*, **6**(3):62-65.
- Sirohi, S. K., Walli, T. K. and Mohanta, R. K. (2010). Supplementation effect of bypass fat on production performance of lactating crossbred cows. *Indian Journal of Animal Sciences*, **80**(8):733.
- Senthilkumar, S. (2016). Impact assessment of TANUVAS–mineral mixture on the productive performance of dairy cattle.
- Somkuwar, A. P., Kadam, A. S., Kumar, S., & Radhakrishna, P. M. (2011). Efficacy Study of Metho-Chelated Organic Minerals

- preparation for Feeding on Milk Production and Fat Percentage in dairy cows. *Veterinary World*, **4**(1).
- Toni, F., Grigoletto, L., Rapp, C. J., Socha, M. T. and Tomlinson, D. J. (2007). Effect of replacing dietary inorganic forms of zinc, manganese, and copper with complexed sources on lactation and reproductive performance of dairy cows. *The Professional Animal Scientist*, **23**(4):409-416.
- Tyagi, N., Thakur, S.S., and Shelke, S.K. (2010). Effect of bypass fat supplementation on productive and reproductive performance in crossbred cows. *Tropical animal Health and Production*, **42**(8), 1749-1755.
- Tufarelli, V., Khan, R U., and Laudadio, V. (2011). Effect on milking performance of vitamin-trace element supplements to early lactation Italian Brown cows grazing ryegrass (*Lolium multiflorum*) pasture. *Asian-Australasian Journal of Animal Sciences*, **24**(9):1227-1232.
- Uchida, K. Mandebvu, P. Ballard, C. S. Sniffen, and C. J. Carter, M. P. (2001) Effect of feeding a combination of zinc, manganese and copper amino acid complexes, and cobalt glucoheptonate on performance of early lactation high producing dairy cows *Animal Feed Science and Technology*, **93**(3/4):193-203.
- Weiss, W. P. (2018). Trace Minerals and Vitamins for Dairy Cows.
- Zielinska, A., Chojnacka, K. and Simonic, M. (2009). Sustainable production process of biological mineral feed additives. *American Journal of Applied Sciences*, **6**(6):1093-1105.



APPENDICES

Grouping of Animals as per the BREED

SL.NO	TAG NO OF COWS	NAME OF BREED
1.	602	HOLSTEIN FRIESAN × SAHIWAL
2	565	HOLSTEIN FRIESAN × HARYANA
3	508	HOLSTEIN FRIESAN × HARYANA
4	563	HOLSTEIN FRIESAN × HARYANA
5	512	HOLSTEIN FRIESAN × SAHIWAL
6	502	HOLSTEIN FRIESAN × SAHIWAL

Grouping of Animals as per the TREATMENT

SL.NO	TAG NO OF COWS	TREATMENT NO
1.	602	CONTRELLED
2	565	CONTRELLED
3	508	TREATMENT NO 1
4	563	TREATMENT NO 1
5	512	TREATMENT NO 2
6	502	TREATMENT NO 2