"INFLUENCE OF CHROMIUM, ZINC AND SELENIUM ON NUTRIENT UTILIZATION AND BLOOD BIOCHEMICAL PARAMETERS IN GOAT FED ON UREA MOLASSES MINERAL BLOCK SUPPLEMENTED DIET"

Ph. D THESIS

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RAIPUR (C.G.)

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By

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VITA

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CERTIFICATE – I

This is to certify that the thesis entitled **"Influence of Chromium, Zinc and Selenium on nutrient utilization and blood biochemical parameters in goat fed on urea molasses mineral block supplemented diet**" submitted in partial fulfillment of the requirements for the degree of **"Doctor of Philosophy"** of the Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.), is a record of bonafide research work carried out by **Manoj Kumar Gendley** under my guidance and supervision. The Student's Advisory Committee and the Director of Instruction have approved the subject of the thesis.

No part of the thesis has been submitted for any other degree or diploma or has been published/ published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

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This is to certify that the thesis entitled "**Influence of Chromium, Zinc and Selenium on nutrient utilization and blood biochemical parameters in goat fed on urea molasses mineral block supplemented diet**"**,** submitted by **Manoj Kumar Gendley** to the Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) in partial fulfillment of the requirements for the degree of **Ph. D** in the Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Anjora, Durg has been approved by the student's Advisory Committee after oral examination in collaboration with the external examiner.

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ABBREVIATIONS

%	Per cent
/	Per
As	Arsenic
AGL	Average gestation length
A:G ratio	Albumin/ globulin ratio
ADFI	Average daily feed intake
ADF	Acid detergent fibre
ADL	Acid detergent lignin
ADG	Average daily gain
AIA	Acid insoluble ash
ALP	Alkaline phosphatase
Avg.	Average
B. wt	Body weight
Ca	Calcium
CF	Crude fiber
cm	Centimeter
CP	Crude protein
CL	Cellulose
Cr	Chromium
Cu	Cupper
d	Day
DC	Digestibility Coefficient
DCP	Digestible crude protein
DM	Dry matter
Edn.	Edition
EDTA	Ethylene diamine tetra acetate
EE	Ether Extract
et al	And other (Latin *et alii)*
FCR	Feed Conversion Ratio
Fig.	Figure
Fe	Iron
g	gram
g/d	gram/day
Hb	Haemoglobin
HL	Hemicellulose
i.e.	That is to say

IU	International unit
kcal	Kilo calorie
kg	Kilogram
mg	Milligram
M	Maize
M_0	Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm)
M_1	Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm)
M_2	Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm)
M_3	Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm)
mm	Millimeter
MIN	Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm)
MT	Metabolic trial
MUMMB	Medicated urea molasses mineral block
MCH	Mean corpuscular haemoglobin
MCHC	Mean corpuscular haemoglobin concentration
N	Nitrogen
NC	Negative control
NDF	Neutral detergent fiber
NFE	Nitrogen free extract
No.	Number
NRC	National research council
NS	Not significance
NC	Negative control
$p<0.05$	Significant at 5% level
P	Phosphorus
PCV	Packed cell volume
ppm	Parts per million
PC	Positive control
PGADG	Pregnancy average daily gain
Ref.	Reference
Rs.	Rupees
SA	Serum albumin
Se	Selenium
SEM	Mean of standard error
SG	Serum globulin

Sig.	Significance
SDC	Soy deoiled cake
TA	Total Ash
Tab.	Table
TDN	Total digestible nutrients
TEC	Total erythrocyte count
TP	Total protein
UMMB	Urea molasses mineral block
viz	Namely
$W^{0.75}$	Metabolic body weight
Zn	Zinc

CHAPTER-I
INTRODUCTION

The world currently produces more food per head than ever before and the global rate of increase in food production is still greater than the increasing rate of population. However, a demand for animal food (milk and meat) has been roughly estimated that global population growth will demand a three-fold increase in food production by 2050 and by then consumption of livestock products may increase five fold in Asian countries including India (DAHD, 2005). India accounts for 20% of the world's goat population with annual growth rate of 1.6% (DAHD, 2005) and contributes nearly 7% towards its national income (Jagannath *et al*., 2000). About 75% of the total world production of goat meat is produced in tropical and sub-tropical countries. India contributes about 50% of the total production and nearly 35% of the meat consumed in the country comes from the goat alone. A substantial contribution amounting to nearly Rs 562.3 million per annum to national income is being made by livestock and their products. There exists a scope for its further enhancement by nearly 30% through improved nutrition, scientific management and strategic reduction *in situ* worm load (Sharma, 2001). Such heightened demand will consequently need increase in sustainable livestock productivity. Goats add Rs. 12000 million to Indian economy every year (Deshpande and Kulkarni, 2000). These animals are known to provide a cost: benefit ratio of 1:11.7 with an investment return rate (IRR) value for over 30.

The goat is one of the most important species of livestock in India. It has short generation interval, high prolificacy and is easily adaptable to a wide range of climatic conditions. These characteristics give it a greater relevance in the household economy of the poor. The goat is capable of surviving on sparse vegetation and extreme climates. Goat meat is the most preferred meat in the country. Almost 95% of the goat meat produced in the country is consumed locally, though per capita availability is far below the requirement. Goats provide a dependable source of income to about 40% of rural population below the poverty line in India (Banerjee, 1991). Illiteracy and lack of knowledge regarding animal nutrition, health management and breeding have resulted in non-exploitation of the potential of every local breed. Goats are popularly known as poor man's cow.

The Chhattisgarh state is rich in livestock wealth. The total livestock population is 1, 28, 18,099 and goat contributes 16% of Chhattisgarh livestock population (IGKV, *deca,* plan, 2001). In Chhattisgarh there is no recognized breed of goat and all the available goats are non-descript. Goat rearing is the main subsidiary occupation of tribals in Chhattisgarh. The majority of population in our country is shifting towards the non-vegetarian diets due to their coward in nature. Pulses being costly items in the diet, perhaps the small ruminants may be the only substitute. Sheep and goats provide supplementary high quality protein both through meat and milk. Grazing ruminants are the most likely species to suffer from a condition of under nutrition due to insufficient supply of nutrients through the forage they graze upon. In the tropics under-nutrition is cited to be one of the major constraints towards efficient animal production and inadequate mineral

nutrition is perhaps a more limiting factor in this regard compared to the deficiency of energy and protein. Grazing livestock usually does not receive mineral supplementation except common salt and must depend largely on forages to supply their mineral requirements and thus deserve greater attention at both the micro and macro level.

Molasses, a major by-product of the sugar industry is a good, palatable and cheap source of energy for ruminants. Use of liquid molasses by small farmers, however, is very limited due to problems related to transport, storage and legislation. One strategy to get over this obstacle and increase the use of molasses is through the manufacture of urea-molasses multinutrient blocks (UMMB). The technique is to mix the different ingredients in a container and to pour the mixture in moulds to solidify into blocks. Major advantages of using the blocks are convenience in terms of packaging, storage, transport and ease of feeding. Blocks can thus provide an avenue to maximize the use of locally available feed materials such as molasses and bran for feeding ruminants, thereby reducing the use of high cost concentrate feeds.

Ruminant livestock production is almost entirely dependent on feeds consisting of fodder and crop residues. These feeds are often of poor quality, usually deficient in protein and minerals. To improve production, the efficiency of utilization of the available feed resources can be optimized by the use of supplements that provide the deficient nutrients. Generally for such purpose, concentrates such as maize, deoiled soy cake and UMMB which are high in protein used as supplements. The purpose of supplements is to provide nutrients that are deficient in the basal diet and nutrients needed for production. Some of

these supplements can sometimes be manufactured using locally available ingredients and agro-industrial by-products.

Goats in the villages are reared traditionally on a forage-based diets and the practice of supplementation is not common. This traditional feeding system is insufficient to satisfy the nutritional needs of the goats, particularly during high production periods like late pregnancy, lactation and growth. It results in poor growth performance of the kids, particularly in multiple litters, giving low live weights at 90 days of age with wide variations from 5 kg to10kg for the local breed, as well as a high kid mortality of 16% during the first three months of life (Saddul *et al.*, 1999). Urea molasses multinutrient blocks (UMMB) provide a readily available source of energy in the form of molasses, nitrogen (both from protein and non-protein sources), fiber and minerals. Hadjipanayiotou (1996) reported that molasses-urea blocks have been successfully used in different parts of the world.

Trivalent Cr is an essential trace mineral that is involved in carbohydrate, lipid and protein metabolism. Mertz (1992) showed that Cr potentiates the effects of insulin and, therefore, improves carbohydrate metabolism. Its supplementation also improved growth and survival rate.

Loss of appetite is usually the earliest clinical sign of zinc deficiency. McDowell (1992) reported that zinc is necessary for health in rats and mice shortly there after zinc deficiency was found in lambs, kids, pigs and calves. The deficiency was associated in all species with severe inappetence and growth depression, impaired productive performance and abnormalities of skin and its appendages.

Selenium is an essential trace element present in numerous enzymes (glutathion peroxidase, iodothyronin deiodinase, thioredoxin reductase, etc.) and selenium proteins. It helps to protect the organism against oxidative stress, participates in the synthesis and metabolism of thyroid hormones, proteosynthesis and reproductive performance (Schrauzer 2000). Selenium is known primarily for its anti-oxidative activity, and together with other antioxidants such as vitamins E, C, β-carotene, zinc and copper it ensures low concentrations of reactive oxygen forms in tissues. In adults, abortions, stillbirths, retained placenta or inability to conceive may result from selenium deficiency. Some researchers have shown that selenium may play an important role in arsenic detoxification from living cells (Amirez *et al.* 2005). Dietary supplementation with sodium selenite significantly reduced the clastogenic and genotoxic effects of arsenic.

The present experiment was conducted to study the effects of supplemental mineral (Cr, Zn and Se), un-medicated UMMB and medicated UMMB on growth performance, nutrient utilization, blood biochemical constituents, and hematological and mineral profile of growing, adult and pregnant goats. The study is planed with the following objectives:

OBJECTIVES

1) To study the nutritional status of growing, pregnant and non-pregnant adult goats fed on diet supplemented with Cr, Zn and Se.
2) To study the nutritional status of kids and non pregnant adult goats fed on diet supplemented with medicated and un-medicated UMMB.
3) To study the nutritional status of pregnant goats fed on diet supplemented with un-medicated UMMB.

4) To study the effect of dietary supplementation of Cr, Zn and Se and UMMB on blood biochemical, hematological, and mineral profile in goats.

5) To work out the economics of raising kids on above diets under stall-fed condition.

CHAPTER-II
REVIEW OF LITERATURE

Effect of urea molasses mineral block (UMMB) and mineral supplementations (Zn, Cr and Se) on live weight gain, feed consumption, haemato-biochemical and mineral profiles in kids and adult (non pregnant and pregnant) goats has been studied by various authors, some of which has been cited below:

2. 1 Locally available roughages

2.1.1 ***Acacia leucophloea*** (syn. *Mimosa leucophloea)*

Acacia leucophloea (Roxb.) Wild. (Leguminosae Mimosoideae) is a large thorny tree attaining heights of 35 m and diameters at breast height of 100 cm (Nielsen 1992; Heyne, 1950). Native to arid areas in South and Southeast Asia, *Acacia leucophloea* is easily identified by its white bark and large wide spreading limbs. In harsh environments and on poor soils this species remains a shrub or small malformed tree. Flowering can be seen from July to November in India (Troup, 1983) and December to March in Indonesia (Djogo, 1992). The pods are yellow, green or brown in color, flat and fairly straight. They measure 10-20 cm long, 5-10 mm wide and ripe from February to June in India (Troup, 1983) and July to September in Timor (Djogo, 1992). Pods are collected before it disperses seeds. Healthy pods contain 10-20 smooth, dark brown oblong seeds with an average size of 6x4 mm (Kumar and Bhanja, 1992).

The largest continuous distribution of *Acacia leucophloea* is in arid India, Sri Lanka, Bangladesh, Burma and much of Thailand. Other populations occur in

southern Vietnam, Java and Bali of Central Indonesia, and Timor of Eastern Indonesia (Nielsen, 1992; Troup, 1983). This species has not been widely introduced to other regions. *Acacia leucophloea* is an important dry-season fodder and pasture tree throughout its range. Leaves, tender shoots and pods are eagerly eaten by goats, sheep and cattle. Singh (1982) and Tiwari *et. al*.(1998) reported that leaves contain 15% crude protein and 19% crude fiber. Hydrocyanic acid content is a major constraint to use it as sole fodder (Bhadoria and Gupta, 1981). Grass beneath the trees remains succulent while exposed grass becomes dry and unpalatable. During dry season, this tree protects livestock and under story pasture from excessive temperature.

Acacia leucophloea grows well on alluvial or infertile soils and it also has great potential as a reforestation species for degraded sites though it is not commonly planted for this purpose in current-days. Common names for this species often refer to its light color; white-bark acacia (English), safed kikkar, reonja (Hindi), safed babul (Bengali), goira (Oriya), sarai, velvelam (Tamil). Other common names include pilang and besok (Indonesian).

2.1.2 *Aeschynomene indica*

There are some 100 species in the genus *Aeschynomene* in Africa (Lock, 1989), 50 in East Africa (Gillett *et al*., 1971), 20 in West Africa (Hutchinson *et al*., 1958) and 6 or 8 in the Sahel (Andrews, 1952, Berhaut, 1976), most are unpalatable annuals growing on deep alluvial clay soils subject to flooding or to water-logging. One single species is reported as good fodder to ruminants, although toxic to equines (Berhaut, 1976) and similar reports are also available in India.

It is an erect, sub-shrubby, generally annual but sometimes perennial herb, 0.3 to 2.5 m tall with a low to moderate palatability and not readily eaten by the animals but is generally considered a useful legume where it grows. The *sola hay* contains 12.20, 1.19, 61.06, 44.76, 1.41 and 0.12 percentage CP, EE, NDF, ADF, Ca and P respectively (Jain *et al*., 2000). *A. indica* possess many medicinal uses *i.e.* spermicidal because it contains an unidentified alkaloid.

It normally grows up to an altitude of 1500 m., in wet and muddy places, in seasonal swamps and around the margins of more permanent swamps in tropical country like India. It is found throughout India as weed in paddy field and water logged pasture. It often grows together with *Sesbania* spp. and *Acacia nilotica* ssp. *tomentosa*. It is widespread in tropical Africa, tropical and subtropical Asia, Australia and North America. It could be utilized as a fodder crop in rotation with rice, or to make use of water logged depressions for biomass production of green manure.

There is some suspicion of occasional toxicity. Boyland (1974) indicated strong field evidence of toxicity in western Queensland and Australia, and Bogdan (1977) reported the death of animals in Malawi. Stock deaths implicating *A. indica* had been reported also from Papua New Guinea.

2.2 Urea molasses mineral block

Traditionally in villages goats are reared mainly on a forage-based diet and the practice of supplementation is not common. This traditional feeding system is insufficient to meet the nutritional requirement particularly during high production periods like growth, late pregnancy and lactation. This reflects on growth performance of the kids, particularly in multiple litters, giving low live

weights at 90 days of age with wide variations from 5kg to 10kg for the local breed, as well as a high kid mortality of 16% during the first three months of life (Saddul *et al.,* 1999). Urea molasses multi-nutrient blocks (UMMB) provide a readily available source of energy in the form of molasses, nitrogen (from protein and non-protein sources), fibre and minerals. Hadjipanayiotou (1996) reported that molasses-urea blocks have been successfully used in different parts of the world.

2.2.1 Formulation and preparation of UMMB

UMMB use in India dates back to its introduction in 1983 by the National Dairy Development Board (NDDB), Anand. Initially, it was produced by a "hot process" using various formulations, equipment and procedures (Gupta and Malik, 1991; Malik *et al*., 1993; Garg *et al.,* 1998).

2.2.2 Optimum UMMB urea level

The urea level in feed blocks is important as it influences the rumen ammonia level, affecting fiber digestion. UMMB with 2, 10, 15 and 20 percent urea are prepared and being fed to ruminant. *In sacco* DM digestibility of wheat straw increased from 31.3 per cent with 2 per cent urea and 35.9 percent with 10 percent urea in the blocks (Tripathi, 1997; Garg *et. al*., 1998). Further, increases in urea level in UMMB do not change the digestibility. However, ammonia concentrations in the rumen progressively increase with increasing levels of urea. The negative effect of high urea levels on block intake may be related to either low palatability or excessive ammonia concentrations in the rumen.

Tripathi (1997) and Garg *et al*. (1998) suggested 10 percent urea as optimum level in the feed blocks.

2.2.3 UMMB preparation by the hot process

Blocks produced by hot procedure (Malik *et al*., 1993) is of a highly hygroscopic nature and lead to poor shelf life (Tripathi, 1997; Garg *et al*., 1998). The feed block technology could be used for easy and reliable drug administration in several health conditions (Sanyal and Singh, 1995a) and has been adopted by a few commercial firms.

2.3 Medicated urea-molasses mineral block

Pharmacokinetics studies with UMMBs in dairy cattle and buffalos were carried out to select proper daily dose of anthelmintics. Fenbendazole (FBZ) has been found most suitable as it is stable in blocks, does not require a milk withholding period and has a safety index of 67 in cattle and 1000 in small ruminants. Moreover, as the drug is not patent protected it can be procured in bulk from the open market. An effective concentration of anthelmintically active principal metabolite of FBZ (oxfendazole; OFZ) in plasma could be achieved by daily intra ruminal administration @ 0.5 mg/kg body weight (Sanyal, 1993). The effective level is achieved in 4 to 6 days of drug administration and a plateau is maintained thereafter. The OFZ disposition profile reveals typical zero order absorption-elimination from day 4 to 6 (Sanyal, 1993). Thus by daily low level dosing the parasites would be exposed to the toxic concentration for much longer periods without additional use of the drug. Solid phase extraction and reverse phase high performance liquid chromatography (HPLC) study shows a successful result after incorporation of FBZ @ 0.5 g/kg block material. Medicated blocks may be used at the onset of monsoon rains for strategic and sustainable parasite control in dairy animals (Sanyal, 1993; Sanyal and Singh, 1993; Sanyal and Singh 1995a).

2.4 Chromium

The essentiality of Cr mineral was first demonstrated by Schwarz and Mertz (1992) in rats. Trivalent Cr is an essential trace mineral that is involved in carbohydrate, lipid, and protein metabolism (Mertz *el al*., 1974). In 1990s Cr was studied intensively as an essential mineral in livestock animals (cattle, sheep, goat, horses, pigs and poultry). Schwarz and Mertz (1992) showed that chromium increased serum glucose and later research established chromium as a cofactor with insulin, necessary for normal glucose utilization and for animal growth (Rosebrough and Stowle, 1981, Uusitupa *et al*., 1992). In rats and calves, chromium supplementation increased serum insulin, glucose, total protein and albumin (Holdsworth and Neville, 1990; Uusitupa, 1992; Chang and Mowat, (1992).

2.4.1 Sources of dietary chromium

Generally, forages and byproducts contain more Cr than grains. The basal Cr concentrations reported for experimental diets for ruminants (range: 0.3 to 1.6 ppm) is usually higher than the supplemental Cr added to these diets (0.25 to 0.5 ppm). There is little information on the biological activity/availability of Cr in feedstuffs for livestock. Generally, the Cr in most ruminant feedstuffs should be considered poorly available.

Table 1: The chromium content of feedstuffs is given as below:

S. No.	Feedstuff	Cr, ppm
1.	Dehydrated alfalfa	0.20
2.	Corn silage	2.03
3.	Ryegrass	0.44
4.	Barley	0.83
5.	Corn	0.91
6.	Wheat bran	0.63
7.	Meat meal	0.80
8.	Fish meal	0.63
9.	Soybean meal	0.15
10.	Brewers yeast	1.00
11.	Brewers grain	0.23

(Subiyatno, 1994)

2.4.2 Chemical properties of chromium

Elemental chromium is not naturally present in the earth crust and is biologically inert. Almost all naturally found Cr is trivalent while hexavalent Cr is mostly of industrial origin. Most Cr compounds are halides, oxides or sulphides.

2.4.2.1 Divalent chromium (Cr^{2+})

Divalent chromium is a strong reductant; the form is readily oxidised when in contact with air, producing $Cr3^{+}$. This explains why divalent Cr is not available in biological systems.

2.4.2.2 Hexavalent chromium (Cr^{6+})

Hexavalent chromium is the second most stable form and a strong oxidising agent, especially in acidic media. Hexavalent chromium is bound to oxygen as chromate (CrO^{42-}) or dichromate ($Cr2O^{72-}$) with a strong oxidative capacity. This form of Cr crosses biological membranes easily, reacting with protein components and nucleic acids inside the cell while being deoxygenated to Cr^{3+}. The reaction with genetic matter provides for the carcinogenic properties of Cr^{6+}.

2.4.2.3 Trivalent chromium (Cr^{3+})

Trivalent chromium is the most stable oxidation state in which Cr is found in living organisms. It does not have the capacity to cross cell membranes easily (Mertz, 1992) and has a low reactivity, which is the most significant biological feature distinguishing it from Cr^{6+}. Trivalent Cr forms a number of coordination complexes, hexadentate ligands being the basic form. Some forms of Cr^{3+} (e.g. Cr2O3) are, due to their low reactivity and absorption from the gastrointestinal

system, used as markers in the study of digestion processes (Furnival *et al*., 1990 a, b).

2.4.3 Chromium absorption

Chromium may be present in diets in the form of inorganic compounds or organic complexes. Elemental Cr is not absorbed and has no nutritional value (Ducros, 1992).

Cr is supplemented orally; most Cr^{6+} seems to be reduced to Cr^{3+} before reaching the site of absorption in the small intestine (Doisy *et al*., 1976). The main path for Cr^{3+} to get into the organism is through the digestive system. The most active absorption site in rats is the jejunum; absorption is less efficient in the ileum and the duodenum (Chen *et al*., 1973).

The mechanism of Cr intestinal absorption is not fully known yet. Some papers give evidence of passive diffusion (Stoecker, 1999). Absorption of inorganic Cr^{3+} is indirectly proportional to dietary content. The percentage of Cr absorbed from diet decreases until it reaches 40 μg/day after which the absorption stabilises at 0.5% (Anderson and Kozlowski, 1985; Bunker *et al*., 1984). Lyons (1994) claims that the bioavailability of inorganic Cr is < 3% while organic Cr is over ten times more available. The causes of the low bioavailability of inorganic Cr are numerous and they are likely to be in connection with the formation of non-soluble Cr oxides, Cr binding to natural chelate-forming compounds in fodders, interference with ion forms of other minerals (Zn, Fe, V) (Borel and Anderson, 1984). Suboptimal level of dietary niacin lowers the conversion of inorganic Cr to the bioactive Cr (Ranhotra and Gelroth, 1986).

Cr absorption from food is enhanced by the presence of amino acids, the ascorbic acid, high carbohydrate, oxalate and aspirin levels in the diet, while phytates and antacids reduce Cr concentrations in blood and tissues (Hunt and Stoecker, 1996).

2.4.4 Excretion of chromium

Absorbed Cr is excreted primarily in urine by glomerular filtration, or bound to a low-molecular organic transporter (Ducros, 1992). A small amount is nevertheless eliminated in hair, perspiration and bile. Urinary excretion of Cr also heavily depends on the form of Cr supplementation.

2.4.5 Chromium deficiency

References of Cr deficiency are relatively scarce and most of the existing ones quote results of experiments on laboratory animals. Frank *et al*. (2000a, b) have studied experimentally induced Cr deficiency in goats. The population with a Cr deficiency showed higher weight gains (31.1 ± 11.7 vs. 20.0 ± 7.3 kg) for the period of monitoring (84 weeks) compared with the control group. The authors explain this unexpected effect by the possibility that Cr deficiency has impaired glucose tolerance and increased insulin release subsequently leading to hyperinsulinemia. Cr deficiency has also led to an increase in haematological parameters (haemoglobin, haematocrit, erythrocytes, leucocytes and mean erythrocyte volume); increased total protein concentrations and hyperinsulinemia were observed compared with the group of controls as well.

2.4.6 Chromium toxicity

Cr toxicity is associated mainly with hexavalent chromium, whole trivalent Cr is believed to be a highly safe mineral. Hexavalent Cr is more soluble than trivalent Cr and at least five times as toxic (Barceloux, 1999). The safety limit for Cr^{3+} is approximately 1:10000. Cr^{3+} toxicity is in fact lower than the toxicity of all other essential elements such as Cu, I, Zn, Mn and especially Se (Lindemann, 1996). The details of Cr^{6+} toxic activity are, however, not known. The main protection mechanism against Cr^{6}+ activity in the lungs and the stomach is the reduction of Cr^{6+} to Cr^{3+} by an NADPH-dependent mechanism involving ascorbate.

2.5 Zinc

Zinc participates in the structural, catalytic, and regulatory actions of metalloenzymes (Brandao-Neto *et al*., 1995). Some of the more important Zn-dependent enzymes include carbonic anhydrase, alcohol dehydrogenase, glutamic dehydrogenase, lactic dehydrogenase, alkaline phosphatase, and carboxypeptidase A and B (McDowell, 1992). In addition to its role in these enzymes, Zn has also been associated with DNA, RNA and protein; cellular division, growth, and repair (Miller *et al*., 1968); and immune function (Keen and Gershwin, 1990).

With such a vast biological significance, ensuring that animals consume adequate quantities of Zn is vital to maintaining a healthy, productive animal. In many instances, it is necessary to provide some form of supplemental Zn to animals in order to meet production goals.

2.5.1 Sources of dietary zinc

The NRC (1996) set the Zn requirement for growing goats at 30 mg/kg of the dietary dry matter (DM). Traditionally, the major forms of supplemental Zn used to meet these requirements have been the inorganic form, including oxides, sulfates, chlorides, and carbonates. However in animal tissues, micro minerals are often chelated to specific binding proteins, which serve as transport proteins, storage proteins, active enzymes, and a host of other functions (Greene, 1995).

The amine and carboxyl groups of peptides and amino acids readily bind to metal ions via coordinate-covalent bonds (Spears, 1988; Hutcheson, 1989). The strength of these bonds varies as a result of the specific nature of the metal and the organic constituent (Kratzer and Vohra, 1986, Spears, 1988; Kropp, 1990; Chirase *et al*., 1991). The stability of chelates (e.g., the relative strength or weakness of the bonds formed) determines the true value of the chelated mineral as a supplement. The strength of the bonds formed depends largely on the binding affinity between the organic molecule and the metal, and the ability of the dietary chelates to stay bound within the gastrointestinal tract depends on pH and other digestive components (Kratzer and Vohra, 1986). Therefore, chelates used by the feed industry must be strong enough to survive the digestive environment of the animal, yet not so strong that they are rendered unavailable after absorption.

2.5.2 Zinc absorption

The small intestine is generally regarded as the main site of Zn absorption (Miller, 1970; Hampton *et al*., 1976a). For many years, the duodenum, or proximal portion of the small intestine was considered to be a much more active site of absorption than more distal portions; however, later research showed that

true Zn absorption per unit of small intestinal length was fairly uniform, and that relative Zn absorption is not affected by Zn status (Hampton *et al*., 1976a, 1976b). Although the small intestine is the primary site of Zn absorption, an appreciable quantity of Zn also is absorbed from the rumen and abomasum of both cattle (Miller and Cragle, 1965) and sheep (Arora *et al*., 1969).

2.5.3 Excretion of zinc

It has been well established that under normal dietary circumstances, the faeces is the major route of Zn excretion in ruminants, as well as other animals (Miller, 1969).

Zinc found in the faeces is not limited to excretion of unabsorbed dietary Zn (normally a large proportion) but also consists of excretion of endogenous Zn (Hambidge *et al*., 1986). Endogenous Zn can be found in almost all segments of the digestive tract including the rumen and reticulum. The proximal portion of the small intestine, however, is probably the most important site of endogenous excretion (Stake *et al*., 1974; Miller *et al*., 1991). The quantity of Zn reabsorbed from the small intestine depends, in part, on the Zn status of the animal. Miller *et al*. (1991) studied Zn absorption, metabolism, and endogenous excretion in both Zn-deficient and normal calves, and found that Zn-deficient animals had a higher endogenous Zn excretion into the upper portions of the intestinal tract.

Urinary excretion of Zn by calves and lambs is generally low (< 1 mg/d), with little effect as a result of dietary Zn supply (Hambidge *et al*., 1986).

2.5.4 Factors affecting zinc absorption

There are a number of factors that affect absorption of Zn from the gastrointestinal tract. The single most important of these factors is the Zn content

of the diet itself (Miller, 1970). It has been shown that Zn-deficient calves can absorb as much as 80% of an oral Zn dose (Miller, 1970). Although, low Zn or Zn deficient diets increase Zn absorption.

Animal maturity is another factor that seems to have an effect on Zn absorption. Younger calves absorb a greater percentage of dietary Zn than older animals (Miller, 1970). However, in the same study, it also was discovered that when a Zn-deficient diet was fed, absorption was not affected by age of the animal (Miller *et al*., 1968).

Other factors that can greatly affect Zn absorption are related to components of the diet itself. Mineral interactions often occur and can be either advantageous or deleterious to absorption. Metal ion interactions are positive when one ion enhances the bioavailability of another, and negative interactions occur when one ion decreases the bioavailability of another (O'Dell, 1989).

2.5.5 Zinc deficiency

As noted previously, Zn has been well established as an essential nutrient for the health and normal functioning of all animals, including ruminants

Miller (1970) described clinical signs of Zn deficiency in ruminants to include: (a) inflammation of the nose and mouth with submucous hemorrhages; (b) unthrifty appearance; (c) rough hair coat; (d) stiffness of the joints, with soft edematous swelling of the feet in front of the fetlocks; (e) cracks in the skin of the coronary bands around the hooves that later become deep fissures; (f) dry, scaly skin on the ears; (g) thickening and cracking of the skin around the nostrils; (h) development of horny overgrowths of the mucosa of the lips and dental pads; (i) gnashing of the teeth; (j) excessive salivation; (k) alopecia; (l) red, scabby, and

wrinkled scrotal skin; and (m) bowing of the hind legs. Decreased feed intake, growth rate, and feed efficiency are often early signs of Zn deficiency (McDowell, 1992). The signs of Zn deficiency, however, are not always overt.

A borderline Zn deficiency is difficult to diagnose clinically, but it might be of more economic importance than a severe Zn deficiency (McDowell, 1992).

2.5.6 Zinc toxicity

Just as Zn deficiency can result in poor production by animals, excess dietary Zn also can be problematic for producers. For most species, overt toxicosis of Zn first appears when the levels of dietary Zn approach 1,000 mg/kg (NRC, 1980). Some of the problems observed with Zn toxicity include decreased weight gains, anemia, and reduced bone ash, decreased tissue concentrations of Fe, Cu, and Mn, and diminished utilization of Ca and P (NRC, 1980).

Ott *et al*. (1966) conducted a study to evaluate the effects of high dietary Zn on performance by lambs. Dietary levels of supplemental Zn in this study were 0, 0.5, 1.0, 2.0, and 4.0 g/kg of diet. Results showed that as level of dietary Zn increased, feed consumption decreased, weight gain decreased, and feed efficiency (reported as feed: gain) increased.

In most studies in which dietary Zn concentrations were less than 600 mg/kg, no adverse physiological effects were observed (NRC, 1980).

Campbell and Mills (1979) showed that pregnant ewes fed 750 mg/kg zinc produced no viable lambs compared with lambs supplemented with 30 and 150 mg of Zn/kg. Other studies have shown that sheep given intraruminal doses of zinc sulfate displayed diarrhea, weight loss, and death (McDowell, 1992).

2.5.7 Bioavailability of zinc

Many studies have been conducted to evaluate the bioavailability of organic minerals. The term bioavailability refers to the proportion of an ingested nutrient that is absorbed and utilized (O'Dell, 1989).

Spears (1989) conducted two balance trials to evaluate the influence of Zn source on the bioavailability and metabolism of Zn. In the first experiment, lambs were fed a semi-purified diet deficient in Zn, and treatments consisted of Zn oxide and Zn methionine added to the basal diet to provide 15 mg of Zn/kg of diet. Results showed that lambs fed Zn methionine had a lower fecal excretion of Zn than lambs fed Zn oxide, but apparent Zn absorption did not differ between the two Zn sources. In addition, urinary excretion of Zn tended to be less by lambs receiving Zn methionine, which resulted in a greater retention of Zn by lambs fed Zn methionine than by lambs fed Zn oxide. In the second experiment, lambs were fed an orchard grass hay-based diet containing 30 mg of Zn/kg and a supplement formulated to supply 20 mg Zn/kg from either Zn oxide or Zn methionine. In this experiment, apparent absorption and retention of Zn did not differ between the two sources. Urinary Zn excretion tended to be less by lambs receiving Zn methionine, but the difference was not significant. Results of these two experiments suggest that Zn methionine might be a more bioavailability source of Zn than Zn oxide.

2.6 Selenium

Selenium is an essential trace element present in numerous enzymes (glutathione peroxidase, iodothyronin deiodinase, thioredoxin reductase, etc.) and proteins. It helps to protect the organism against oxidative stress, participates in

the synthesis and metabolism of thyroid hormones, proteo-synthesis (Schrauzer, 2000). It is also important for reproduction and its anti-carcinogenic effect play an important role as well (Schrauzer, 2000). Proper selenium levels are necessary for various physiological functions of goats like reproduction, lactation and proper functioning of muscles. Apart from natural selenium content in feeds, numerous trace elements are currently supplemented in the form of mineral feed additives for ruminants. Supplementation of selenium in ruminant feed is traditionally monitored in relation to animal health, reproduction and production. In recent years, attention has also been diverted to selenium supplementation with the aim to increase the nutritive value of food. These on-farm methods represent an important path to increased nutrition value of food. Most trials with the supplementation of selenium were carried out in cattle, while less attention has been paid to this issue in other ruminants, probably because of their less serious health problems due to deficiency diseases.

2.6.1 Distribution of selenium

Selenium is a trace mineral present in varying amounts in the soil around the world. Soil containing less than 0.5 mg of selenium per kg is considered "selenium deficient".

Soil Se is rarely detected in concentrations greater than 500 ppm (Wilber, 1980). Part of the Se in the soil is available to the vegetation it produces and absorption of selenium by growing plants is dependent on soil selenium levels. Thus pasture on Se deficient soil produce deficiency in goats.

Several forms of Se found in soils, which include: selenides, elemental selenium, selenites, selenates, and organic selenium. Selenates and selenites are

the most available forms and consequentially are the forms absorbed by plants and are generally found in alkaline, well-aerated soils. The insoluble selenides and elemental selenium are the least available and are found in acidic, poorly aerated soils (NRC, 1983). Soils supplying an abundance of Se are referred to as seleniferous soils and thus produce toxic plants (NRC, 1983).

2.6.2 Selenium absorption

The most prevalent forms of Se consumed by dairy cows are selenate and selenite (from inorganic Se supplements), and Se-met and Se-cys (from Se-yeast and basal feedstuffs). Ruminal metabolism and intestinal absorption of these Se compounds differ. Most of the selenate (SeO_4) consumed by a cow is reduced to selenite (SeO_3) in the rumen and residual selenate is absorbed as selenate in the small intestine probably via passive mechanism (Aspila, 1988). Some of the selenite is used to synthesize seleno-amino acids (predominantly Se-cys) that are incorporated into microbial protein. In the rumen, selenite (either that consumed in the diet or produced from selenate) can be converted to low molecular weight insoluble forms of selenium and these compounds have not been chemically identified but most likely are not well absorbed or utilized by the host (Koenig *et al*., 1997). Because it is so difficult to quantify the various Se compounds, reliable data on distribution of Se in ruminal contents are limited. When selenite is fed 30 to 40% is converted to insoluble forms, 10 to 15% is found in microbial protein, and 40 to 60% remains as selenite (Serra *et al*., 1994). An *in vitro* experiment shows about 60% of Se-met (not Se-yeast) was incorporated directly into bacterial protein as Se-met (Paulson *et al*., 1968). Although data are limited, a much higher percentage of Se leaving the rumen is in the form of seleno-amino acids

(predominantly Se-met) when cows are fed Se-yeast than fed with selenite or selenate. Seleno-methionine is absorbable from the intestine by the same mechanism as methionine and is quite efficient (>80%) (Ivancic and Weiss 1999). Se-met and met use the same intestinal absorption system, increasing the intestinal flow of met will decrease absorption of Se-met by competitive inhibition.

Selenium balance studies showed true absorption of Se from diets containing supplemented inorganic Se is about 50% in dairy cows, goats, and sheep (Harrison and Conrad, 1984; Aspila, 1988; Koenig *et al*., 1997; Ivancic and Weiss, 2001). Feed containing appreciable quantities of antagonists inhibits true absorption of selenium. Data on the true digestibility of Se from Se-met or Se-yeast are very limited and variable. True digestibility of Se from Se-met in goats was 65% (Aspila, 1988), and calculated true digestibility of Se from Se-yeast in sheep was 44% (Koenig *et al*., 1997). Se-yeast has 60% and 55% escape value from the rumen in the form of Se-met reported on the basis of *in vitro* and *in vivo* studies respectively (Aspila, 1988).

2.6.3 Selenium metabolism

Se is an essential nutrient for animals because selenoenzymes contain a Se-cys residue in their active sites. Glutathione peroxidase (GSH-px) is the most important selenoenzyme and is an important component in cellular antioxidant systems. Cells precisely insert Se-cys in enzymes. Absorbed Selenite incorporated in the cells and reduced to selenide; selenide then induce synthesis of Se-met from a serine molecule linked to a specific tRNA (UGA codon). The synthesized Se-cys-$tRNA_{UGA}$ complex is then incorporated to right place during protein synthesis. Absorbed Se-cys cannot be inserted directly into the active site

of the enzyme during protein synthesis because it does not have the correct tRNA. Dietary Se-cys must be catabolized, and then the Se can be reduced to selenide and a Se-cys-$tRNA_{UGA}$ is synthesized. Absorbed dietary Se-met can be used in place of met in protein synthesis because cell does not able to differentiate between regular methionine and Se-met. Therefore, Se-met can be found in all proteins along with methionine proportionate to the relative pool sizes of regular methionine and Se-met. Se-met can also be catabolized and its Se may be converted to selenide and then incorporate into Se-cys-$tRNA_{UGA}$. The bottom line difference between inorganic (selenite) and organic Se (Se-met) is that inorganic Se is used almost exclusively to produce selenoenzymes, but organic Se can be used to produce selenoenzymes and also result in general labeling of all proteins that contain methionine. This difference has implications when interpreting Se concentration data.

2.6.4 Selenium deficiency

When livestock are deficient in selenium, glutathione peroxidase cannot be synthesized. If the animal is also deficient in vitamin E they develop nutritional muscular dystrophy due to the damage of the cell membranes of the skeletal and cardiac muscles. Calcium salts accumulate in the defective and dying membranes resulting in the appearance of white areas in the muscles which is named as "white muscle disease in lamb"

White muscle disease occurs in farm animals including fast growing goat kids. Newborns usually are not affected because selenium readily crosses the placenta and stored in the fetal liver and kidney. Milk is generally very low in selenium so the newborn requires this store until it is able to begin feeding on

forages. The kids from selenium deficient mother are born with selenium deficiency and unable to stand and suck due to muscular weakness. The heart and respiratory rates are also elevated due to the damaged heart muscle. Mild deficiencies can result in chronic health problems.

Additional problems encountered from selenium deficiency in adult animals are impaired immunity, thyroid function and retained placentas. The signs of selenium deficiency diseases often do not appear until animals have been raised through several generations. First generation deficient animals are more sensitive to stresses and vitamins E deficiency along are more prone to toxicity of certain chemicals and heavy metals such as mercury. If animals receive an adequate amount of vitamin E but are deficient in selenium signs include hair loss, slow growth, and reproductive failure.

2.6.5 Selenium toxicity

Selenium has a very narrow margin of safety. Goats require 0.2 ppm of selenium, and the toxic level is 3 ppm. Some symptoms of selenium deficiency are identical to those of selenium toxicity. Selenium deficiency and toxicity both may cause reproductive failure in goats. Kidney failure, stillbirth, and abortions also may be attributable to either end of this spectrum. By contrast, hair loss in the beard and flank regions and cracks and deformities in horns and hooves may reveal an over abundance of selenium in the goat's diet. Certain "indicator" plants reveal a toxic level of selenium in the soil. Some species of *Astragalus* (locoweed) indicate the presence of high levels of soil-based selenium and goats become addict to these plants.

Symptoms of severe selenium toxicity include impaired vision and staggering ("blind staggers"), rear legs, followed by muscular weakness of front legs, and progressive weight loss. Once a goat suffers from severe selenium toxicity, there is no effective treatment. Removal of the affected animals from the pasture where the problem occurred and supportive therapy is the best chance of saving the goats. Goats affected by selenium toxicity remain bright, alert, and are eating well up to the time of death.

2.6.6 Selenium supplementation

Selenium has been recognized for several decades as an essential trace mineral required by all animals (Chase, 1980; Phillips *et al*., 1989). Forages and grains in ration are the main source of Se to the animals. However, the Se content of a feedstuff is somewhat dependent on the Se content of soil.

Selenium is not required by plants; however, it is an essential trace mineral required for adequate nutrition and health of animals, birds, fishes and human (Mayland, 1994). In general diets containing 0.1 to 0.3 ppm Se will supply an adequate amount of Se for all the species. The availability of Se is dependent on chemical form of selenium in soil, which is largely dependent on the pH and oxidation-reduction potential of the soil (Ylaranta, 1993; Mayland, 1986). In acidic and poorly aerated soils, Se is found as insoluble selenide (-2) or elemental Se (0) which are unavailable to plants. Selenium is more readily available in aerated acidic and neutral soils as selenites and in alkaline soils as selenates (Mayland, 1986).

Plants absorb large amounts of selenate, moderate amounts of selenite and trace amounts of selenide or organic Se (McDowell, 1992). Both inorganic and

organic forms of Se are found in plants. Selenate is the major inorganic form of Se found in plants and the organic form of Se predominantly found in plants is in the form of seleno-amino acids (McDowell, 1992). Generally Se is supplemented in diets as sodium selenite, where as selenomethionine is the predominant form of Se found in most feedstuffs (NRC, 1996). Diets containing high (Ca 1.3%) or low (Ca 0.5%) calcium apparently reduced Se absorption in cattle (Harrison and Conrad, 1984). Increased sulfur consumption has been documented to increase the Se requirements and in some incidences it decreased absorption of Se in sheep (Pope *et al*,1979) and dairy cattle (Ivancic and Weiss, 2001).

Different methods have been used to improve Se status of farm animals. When Se supplementation is required, there are several approaches that can be taken to administer the trace mineral. Primarily, Se is supplemented into a premix, or long lasting Se compounds are administered parentally or via a sustained-released bolus (Chase, 1980; McDowell, 1992).

Many manufacturers offer premixes that contain Se. However, the amount of Se that can be added to the total dry matter ration is limited to 0.3 ppm for beef and dairy cattle (NRC, 1996; 2001). Considering economics, regulatory issues, and ease of use, sodium selenite (inorganic Se source) is the most common form of Se added to feed and mineral premixes (Chase, 1980).

2.7 Effect of UMMB, MUMMB, Cr, Zinc and Se on feed consumption

Moonsie and Mowat (1993) did show improved ADG and DMI in calves supplemented with high-Cr yeast in a corn-silage diet. Whereas Boleman *et al*. (1995) reported reduced ADG and DMI in pigs fed Cr tripicolinate from the growing to the finishing phase. There was no effect of Cr supplementation on,

DMI, and gain:feed ratio in beef steers during the 21 to 23 day feeding period reported by Kegly *et al*.(2000).

Mean DMI were not affected by Cr-Picolinate supplementation. Supplemental Cr-Picolinate did not influence any measure of N balance during week 3 or 11. During week 3, the wether lambs had an average N intake of 28.3 g/d, with an average daily absorption of 18.5 g, resulting in 7.69 g of N retained per day. During wk 11, the wether lambs had an average N intake of 34 g/d, with 21.7 g of N absorbed daily, and an average of 7.67 g of N retained. This resulted in an average of 65.3 and 63.7% of the N intake being absorbed, and 27 and 22.6% of the N intake being retained during week 3 and 11, respectively. (Kitchalong *et al*.,1995).

Chromium with CP interaction was observed for ADG, DMI, and gain:feed ratio; Cr increased all three variables in lambs fed high protein and decreased all three variables in lambs fed low protein. (Gentry *et al*., 1999).

Paul *et al*. ((2005) reported that the Intake of DM, CP and NDF was higher in the Cr supplemented bucks compared to the control ones though the difference between the 0.2 and 0.4 mg Cr supplemented bucks was not significant ($p > 0.05$). The higher intake of Cr and other trace elements from the basal diet in the Cr supplemented bucks, it is due to the difference in DM intake among the treatment groups. DM intake in the Cr supplemented bucks was higher resulting more Cr intake in these animals compared to the control ones.

Paul *et al*. ((2005) found that the Intake of OM and ADF, on the other hand, was higher in the 0.4 mg Cr supplemented group only. The apparent total tract digestibility of DM, OM, CP and ADF increased and that of NDF showed an

increasing trend ($P < 0.1$) when the diet was supplemented with Cr. However, the effect of increasing the level of supplemental Cr beyond 0.2 mg on the apparent digestibility of nutrients was not evidenced ($P > 0.05$) in this study.

Wagner *et al*. (1999) reported that, there was not significant source of variation for dry matter intake between zinc supplemented group and control group. Treatment had no effect on feed to gain ($P > 0.94$) or gain to feed ($P > 0.73$) ratio.

Malcolm-Callis *et al*. (2000) observed that, there was a linear ($P < 0.10$) decrease in daily DM intake with increasing zinc concentration, suggesting that higher concentration of ZnSO4 may have a negative influence on palatability. Feed efficiency of steers for d 56 to 84 exhibited a linear ($P < 0.10$) increase and a positive quadratic ($P < 0.10$) response with supplemental zinc.

Nunnery (2002) observed during the first collection period, there were no differences in DMI or fecal DM excretion between treatments groups and control group in lambs; however, DM digestibility was lower for the control treatment than for the average of the other three treatments. Dry matter intake did not differ among treatments during the second collection period. Lambs supplemented with Zn sulfate had a greater fecal DM excretion than lambs in the Zn methionine and Zn propionate treatments during the second collection period, and DM digestibility was lower for the Zn sulfate-supplemented lambs than for the Zn methionine- and Zn propionate-supplemented Iambs. There were no differences among treatments for the following measurements; N intake, fecal N (g/d), urinary N (g/d), urinary N (% of intake), N absorption (g/d), and N retained (% of absorbed).

Garg *et al*. (2003) reported that, intake of dry matter, organic matter, crude protein, digestible CP and total digestible nutrients and digestibility of DM, OM, CP, ether extract, neutral detergent fiber and hemi cellulose were significantly higher in Zn-methionine group as compared to control group lambs. However, digestibility of cellulose and acid detergent fiber was significantly higher in Zn-methionine group as compared to control group.

Aliarabi and Chhabra (2005) reported that the average intake concentrate mixture, maize hay, milk and skimmed milk on DM basis was similar in Zn supplemented groups and control group. Average TDN and CP intake of different treatment groups were also similar in all groups. The result indicated that zinc supplementation did not have any significant effect on intake of DM and other nutrients in cross bred calves.

Ivancic and Weiss (2001) investigated the effects of dietary selenium concentrations on selenium balance in dairy cows. Mid lactation Holstein cow (n=30) were fed diets containing 0.3 mg of supplemental Se (from sodium selenite) /kg of dry matter. The experiment lasted for 112 days. They concluded that dry matter intake was not affected by supplementation of 0.3 ppm Se.

Lawler *et al.* (2004) did not find any effect on DMI on supplementation of 0.38 ppm Se in crossbred steers.

Mudgal *et al*. (2007) conducted an experiment in which they divided twenty male buffaloes calves into four treatment groups (n=5/group). Among the four groups one group was supplemented with 0.3 ppm Se supplementation did not affect the dry matter intake in buffalo calves.

Shinde *et al.* (2008) studied the effect of selenium supplementation on dry matter intake in twenty male buffalo calves (10-12 months, 75.30±2.20 kg) and divided them into four groups(n=5/group).. Treatments were group I control (without any supplementation), whereas group II, III, and IV were supplemented with 0.3 ppm selenium, 300IU of DL alpha tocopherylacetate and both 300 IU DL –alpha tocopheryl acetate and 0.3 ppm selenium, respectively. Experiment feeding lasted for a period of 196 days. They concluded that supplementation of vitamin E and Se had no effect on the nutrient utilization in male buffalo calves.

Kumar *et al*. (2009) conducted an experiment in male lamb for 90 days and found that the level of selenium 0.15 and 0.30 ppm had no significant effect on intake of dry matter, organic matter, crude protein (CP), ether extract, neutral detergent fibber, acid detergent fiber and hemicellulose, balances of calcium and phosphorus; and levels and intake of digestible CP and total digestible nutrients.

2.8 Effect of UMMB, MUMMB, Cr, Zinc and Se on nutrient utilization

Nicholson *et al*. (1991) did not find any effect on dry matter and organic matter digestibility due to selenium supplementation at rate the 1 ppm. Ivanic and Weiss (2001) did not observe any effect on DM digestibly in Holstein cows due to Se supplementation @ 0.3 ppm. Mudgal *et al*. (2007) studied the effect of 0.3 ppm selenium supplementation on digestibility of DM, CP, EE, ADF and NDF in buffalo calves. They concluded that selenium supplementation of DM, CP, EE, ADF and NDF in buffalo calves. They concluded that selenium supplementation did not affect the digestibility of DM, CP, EE and NDF. However, digestibility of ADF and cellulose was significantly increased in the animals supplemented with 0.3 ppm selenium.

Shinde *et al*. (2008) conducted an experiment in twenty male buffalo calves (n=5/group) for 196 days to study the effect of vitamin E and Se supplementation on digestibility of proximate principles, fiber fractions and balance of nitrogen, calcium and phosphorus. Groups were supplemented with 0.3 Se, 300 IU of DL- alpha tocopheryl acetate and both 300 IU DL- alpha tocopheryl actate and 0.3 ppm selenium. They found that the digestibility of DM, OM, CP, EE, NDF, ADF, cellulose and hemicellulose were statistically comparable in the different groups. The intake, excretion and balance of nitrogen, calcium and phosphorus were also found to be similar in the four groups. They concluded that supplementation of vitamin E and Se had no effect on the nutrient utilization in male buffalo calves.

Kumar *et al*. (2009) found that supplementation of Se both at 0.15 and 0.30 ppm levels had no significant effect on digestibility of dry matter, organic matter, crude matter(CP), ether extract, neutral detergent fiber, acid detergent fiber and hemicellulose; balances of calcium and phosphorus; and level and intake of digestible CP and TDN in lamb.

2.9 Effect of UMMB, MUMMB, Cr, Zinc and Se on live weight gain

Use of UMMB increased live weight gain of buffalo heifers (Akbar *et al.*, 1991). UMMB supplementation with straw-based diets for indigenous cows resulted in 4.8 percent increased liveweight gain after calving (Ghosh *et al*., 1993).

Xu *et al*. (1994) observed increased feed intake and improved daily gain (23 percent) in sheep having access to lick blocks, compared with controls. Similar results were observed by Jia *et al*. (1995) and Yang *et al*. (1996). When

hybrid goats had access to urea-molasses blocks, average block intake was 80 g/day (Guan *et al*., 2001b). During the last three months of the experiment, daily weight gains were 67 g and 43 g for goats with and without access to the blocks, respectively. Effects of multinutrient lick blocks on performance of growing goats were investigated by Zhang *et al*. (1999), where goats with access to lick blocks had a live weight gain 38.3 percent higher than those without the blocks.

When the multinutrient lick blocks were provided as a supplement to grazing goats and sheep, the effect on productive performance was significant with much higher weight gain in the block supplemented animals than in the control group without blocks (Zhang *et al*., 1999). Liu *et al*. (1995) reported their results with two groups of goats, which grazed together on hill pasture during the day and were offered rice straw *ad lib* in stalls at night. One group had free access to the urea-mineral lick blocks along with rice straw at night. Goats with access to the blocks performed better than those in the control group. Live weight gains were significantly higher in animals with blocks compared with those without blocks (95 vs73 g/day).

Sanyal and Singh (1995a) reported that the heifers treated with Med-UMMB gained more weight from the second month with a net gain of 60g per day. Waruiru and Onyando (2001) found higher cumulative live weight response in heifer treated with Med-UMMB and UMMB compared to control group. Sheep consuming UMMB gained more weight than sheep fed a conventional mineral block or without supplementation (Forsberg *et al.*, 2002). Roy (2007) found non significant difference in live weight gain of goat consuming UMMB and medicated UMMB compared to control group.

In cattle, a positive effect of Cr supplementation on weight gain has been recorded by Chang and Mowat (1992). Cr supplementation during periods of increased stress has a positive effect on weight gain.

Page *et al*. (1993) reported a linear reduction in daily feed intake and an increase in daily gain for pigs supplemented with 50, 100 and 200 parts per billion (ppb) chromium picolinate. Other studies (Mooney and Cromwell, 1997) have confirmed the positive effect of supplementing 0.2 mg/kg of Cr on weight growth, but not on nutrient conversion.

Harris *et al*. (1995) reported no differences in daily gain, daily feed intake, gain:feed ratio and loin muscle area for pigs when supplemented with chromium picolinate. Supplemental chromium did not affect the average daily gain and dry matter intake of weaned growing rabbits observed by Shain *et al*. (2001).

Kitchalong *et al*. (1995) reported that the mean ADG (average 272 g/lamb) and DMI (average 1.92 kg lamb) were not affected (P>.l0) by Cr-Picolinate supplementation. There was no effect of Cr supplementation on, ADG in beef steers during the 21 to 23 day feeding period reported by Kegly *et al*. (2000).

Green (1997) observed that chromium had no significant effect on any growth, carcass, or muscle quality characteristics, although chromium-fed pigs were slightly fatter. Barrows gained faster ($P < .001$) and consumed more feed ($P< .001$) than gilts, yielding heavier ($P < .001$) carcasses, and heavier ($P < .05$) wholesale cuts.

Uyanik (2001) reported that, chromium supplementation had no significant effect on live weight in sheep, but subcutaneous fat was reduced significantly in both chromium groups.

Pechova *et al.* (2002) demonstrated favorable effects of chromium supplementation on growth rate in bulls. The difference in weight gains between the experimental and the control bulls was highly significant in the first phase of the fattening period, but diminished to become no significant in the second phase.

Paul *et al*. ((2005) reported that the total body weight gain and live weight gain to DM intake ratio was higher ($P < 0.001$) in the Cr supplemented goats. However, similar performance of the 0.2 and 0.4 mg Cr supplemented bucks suggested that there was not much benefit of supplementing these animals with Cr above the level of 0.2 mg.

The goats gained body weight during the experiment but neither the ADG nor the final body weight was affected by dietary treatments observed by Haldar *et al.* (2007). Supplemental organic chromium can increase rate of gain anywhere from 0 to 30% depending upon level of stress and/or disease challenge.

Pond (1983) reported that, feeding of 0.5% Ca and19 to 26 ppm Zn is adequate for normal weight gain in Columbia and Suffolk lambs.

Spears (1989) observed that daily gain and efficiency of feed use were significantly lower in lamb fed the control diet. Growth and performance of lamb fed ZnO was similar to lamb fed Zn-Methionine.

Feeding trials showed a significant 3.26% increase in daily gain and a 4.05% improvement in feed conversion when zinc methionine was added to the control diet (Spears and Kegley, 1991). Kegley and Spears (1994) reported that steers fed a finishing diet supplemented 25 mg/kg Zn with Zn protein tended to gain faster and more efficiently than steers supplemented with ZnO or unsupplemented controls. Spears (1989) reported supplementation of growing

cattle with Zn methionine has positive effect on ADG and gain:feed relative to controls group or supplemented with inorganic Zn.

The Zn supplemented lambs gain weight significantly higher than control group. Subsequent weight gains by the lambs receiving 15 mg of zinc/kg of diet were below those of the lambs fed at the 2 higher zinc levels. Hatfield *et al*. (1993) reported no effect of zinc methionine added to a basal diet when lamb average daily gain was measured as compare to control group.

Puchala *et al*. (1999) reported that, supplementation of the diet with Zn-Met (1, 3 and 5 g/day of Zn-Met) increased ADG (65.5 versus 55.9 g/day for control) of goats as compare to control group. ADG for goats receiving ZnO was lower than for goats receiving a similar amount of Zn from Zn- Met but it is not significantly differ .

Malcolm-Callis *et al*. (2000) found that, no significant differences in body weight were observed among steers across all zinc treatments. A linear decrease in ADG was observed among steers receiving increasing zinc concentrations on day 28 to day56. Overall, no differences were noted among treatments for ADG.

Nunnery (2002) found that the heifers fed the control diet had a greater body weight on day 35 than heifers in any of the other three Zn supplemental groups. This increased final body weight was reflected in a tendency for control heifers to have an increased ADG compared with the other three treatments for the 35 day receiving period. Average daily gain by heifers in all treatments did not differ from day 0 through 14 or from day 0 through 28. Average daily feed intake, ADG, and gain: feed were not affected by dietary Zn treatment.

Garg *et al.* (2003) reported that, average daily gain of the lambs and feed conversion efficiency were also significantly higher in Zn-methionine group as compared to control and ZnSO4 groups, suggesting a positive role of organic zinc supplementation on the performance of lambs.

Wang *et al.* (2006) reported that, there was no significant difference in body weight gain and feed/gain between zinc supplemented group and control group.

Zali *et al.* (2008) reported that the ewe body weight gain and ADG at the end of the study and ewe body weight gain and ADG change from beginning to end of the study did not differ between ewes supplemented with sulfate zinc and control ewes.

Castellan *et al.* (1999) determined that calves that received Se injections showed an improved ADG over calves that did not receive any supplemental Se injections. Similar results were detected by Wichtel *et al*. (1996) who reported positive effects in weight gain of young cattle. However not all experiments involving Se supplementation resulted in improved weight gains.

Perry *et al*. (1976) studied the effect of supplemental selenium at levels of 0, 0.1, 0.2, or 0.4 mg/kg to a finishing beef cattle diet containing 0.08 mg/kg. In one experiment, an increase in gain in body weight was obtained from adding 0.1 mg selenium per kilogram diet. However, in a second experiment, no benefit was obtained from adding 0.1 mg/kg and supplemental levels of either 0.2 or 0.4 mg/kg resulted in a significant depression in rate of gain in body weight, indicating the range between suboptimal and possible growth- depressing levels of dietary selenium for beef cattle may be quite narrow.

Byers and Moxon (1980) correlated protein and selenium levels for growing and finishing beef cattle and found that growing cattle fed each diet responded positively to selenium in rate and efficiency of gain, with the greatest response observed for those fed the lowest protein diet. However, during the increasing phase, supplemental selenium as sodium selenite in linseed did not after performance. So they concluded that selenium levels are most critical during early stages of growth and when cattle are fed diets marginal or deficient in protein.

Ellis *et al*. (1987) treated Poll-Dorset cross lambs of 4-6 weeks of age with no selenium or cobalt treatment. Selenium orally 1 mg; 2 mg; vitamin B_{12} subcutaneously ; both oral selenium and vitamin B_{12} injection and glass bullet one soluble 17 glass bullet given orally containing 5 g/kg cobalt as cobalt oxide 3 g/kg selenium and 134 g/kg copper oxide. At 5-7 week intervals lambs were weighted and they concluded that a significant bodyweight response was obtained to vitamin B_{12} and glass bullet treatment but not to selenium.

Wichtel *et al*. (1996) studied the effects of selenium and iodine supplementation on growth rate and on thyroid function in heifer calves form 2 herds at pasture. Supplementation of calves with intraruminal Se pellets (designed to release SE about 3 mg/day) increased body weight gain and tended to increase the plasma concentration of insulin like growth factor I.

Wichtel (1998) suggested that selenium supplementation of ruminants grazing pastures deficient in selenium may improve growth rate in cattle and sheep.

Gabryszuk and Klewiec (2002) studied the effect of injecting 2 and 3 year old ewes with selenium and selenium –vitamin E and concluded that two consecutive injections of SE (before mating and lambing) significantly increased lamb body weight at day 28(10.9kg) and daily weight gain for 28 days (241.8g) in 3 year old ewes compared with controls (9.4 kg, 197.7g, respectively). Administration of Se also significantly increased daily weight gain in first 4 weeks of life (220.1g) in lambs of 2 year old dams (186.1g for controls).

Grace and Knowles (2002) collected data form 24 Se- supplementation growth- response trials and analyzed it. Supplemented groups received 5 mg Se/month as Na_2SeO_3 in 20 trials and 1 mgSe/kg live weight as $BaSeO_4$ in 4 trials. Among 24 trials, growth rate of supplemented lambs was 3 to 63 g/day higher than that of untreated lambs. The relationship between blood Se concentration (X) and growth response (Y) was described by the following hyperbolic-decay equation; Y=2.6(SE 3.6)+1850(SE 230)/X(R2=0.74).

Mudgal *et al*. (2007) did not observed any significant effect on growth rate of buffalo calves supplemented with 0.3 ppm Se in their diet.

Shinde *et al*. (2008) divided twenty male buffalo calves (10-12 months, 75.30 2.20 kg) into four groups of five animals and groups diet was supplemented with 0.3 ppm selenium , 300 IU of DL-alpha tocopheryl acetate, and both 300 IU DL-alpha tocopheryl acetate and 0.3 ppm selenium except control group. Experimental feeding lasted for a period of 196 days during which fortnightly body weights was recorded. The ADG was 423.47 to 462.85g and they concluded that supplementation of vitamin E and Se had non effect on the growth performance in male buffalo calves.

Kumar *et al.* (2009) studied the effect of inorganic and organic Se supplementation on growth rate of lambs for 90 days with 18 lambs into three groups and groups were additionally supplemented with 0.15 and 0.15 mg Se/kg of diet through sodium selenite (inorganic Se) and Jevsel-101 (organic Se). They concluded that supplementation of organic as well as inorganic Se was found to improve the growth rate humoral immune response and antioxidant status of the lambs.

2.10 Effect of UMMB, MUMMB, Cr, Zinc and Se on haematological parameters

Numbers of red and white blood cells, concentrations of alkaline phosphatase, lactate dehydrogenase and serum levels of total protein, albumin, globulin and haemoglobin were significantly higher in goats supplemented with multinutrient blocks than in goats without blocks (Zhang *et al*., 1999). Compared with the controls, contents of all minerals except copper were higher in serum of goats supplemented with multinutrient blocks.

There was no re-infection by nematodes in the MUMMB supplementation group, with faecal egg counts at zero at all counts (30, 60, 90 and 120 days). Heifers in the UMMB group showed lower egg counts than control heifers. Packed cell volume (PCV) in the MUMMB group increased from 27.4 ±5.4 to 31.5 ±2.9 at 60 days, and it was higher than in the UMMB and control groups ($P < 0.05$), which were similar ($P > 0.05$). PCV was not significantly different at 30, 90 and 120 days ($P > 0.05$). (Sanyal, and Singh,1993b)

Gentry *et al*. (1999) reported that dietary treatment of chromium did not affect white blood cell count (WBC), hemoglobin (Hb), mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean corpuscular hemoglobin

concentration (MCHC), packed-cell volume (PCV) or percentage neutrophils, lymphocytes, monocytes and eosinophils. Lambs fed high protein diets had higher red blood cell count (RBC) when they were also fed supplemental Cr; however, lambs fed low protein diets had lower RBC when they were fed supplemental Cr. Platelets and heat-precipitable protein (HPP) were higher in lambs fed supplemental Cr than in lambs fed diets without Cr supplementation.

Kumar (2008) observed total erythrocyte count, Hb concentration and PCV were significantly ($P<0.05$) higher in mineral supplemented groups than control.

Stowle *et al*. (1988) conducted an 8 weeks trial with 24 cows supplemented with Se at 0, 2.5, 5 an d10 mg/day and found that maximum serum Se (week 4) wer4e 23, 56, 71 and 79 ng/ml which indicated that Se supplementation at 2-2.5 mg/day is inadequate to obtain desirable serum Se concentration.

Gerloff (1992) reported that 70 to 100 ng of Se/ml of serum is an acceptable target concentration, which can be attained most often by providing >6 mg of supplemental Se per animal per day.

Alonso *et al*. (1998) evaluated Se status in 20 sheep from a selenium deficient region. 10 sheep were pregnant and /or lactating and 10 were control, non pregnant sheep. The serum concentration of selenium was found to decrease significantly in ewes at the beginning of lactation. In the second half of the pregnancy, GSH-Px activity was below normal but no pathology was associated with selenium deficiency. The lambs had no symptoms of nutritional myopathy

and they suggested that the low selenium levels in the ewes did not affect their offspring's development.

Mudgal *et al*. (2008) did not find any effect of 0.3 ppm Se supplementation on serum cholesterol, blood urea nitrogen, creatinine, total protein and serum enzymes SGOT and SGPT.

Kumar *et al.* (2009) conducted an experiment in 18 male lambs into a three groups (n-6) for 90 days. Groups were additionally supplemented with 0.15 mg Se/kg of diet through sodium selenite (inorganic Se) an dJevsel-101(organic Se) except control. They concluded that supplementation of Se had no effect on serum total cholesterol, total protein, albumin, globulin and albumin globulin ratio. However, there was a significant increase in serum Se level and RBC in both the Se supplemented groups as compared to control group.

2.11 Effect of UMMB, MUMMB, Cr, Zinc and Se on biochemical parameters

Jain *et al.* (2005) reported that feeding of urea molasses mineral block increased the blood glucose, plasma calcium, inorganic phosphorus, total protein, albumin, globulin and albumin globulin ratio in kids.

Higher values ($P<0.01$) of Hb, PCV and TEC were recorded in Med-UMMB treated calves in comparison to untreated infected controls from day 32 post infection of *Haemonchos sp*.(Sanyal and Singh, 1993)

Supplemental Cr altered lipid metabolism. Reductions in circulating concentrations of cholesterol and (or) nonesterified fatty acids (NEFA) are frequently reported in ruminants (Bunting *et al*., 1994; De Pew *et al*., 1998; Kitchalong *et al*., 1995; Yang *et al*., 1996). It is likely that the more dramatic

hypolipidemic effects of organic Cr may be attributable simply to increased glucose tolerance with corresponding reductions in lipolysis.

Kitchalong *et al*. (1995) reported that overall, mean total cholesterol (average 44.6 mg/dL) was not affected by Cr-Picolinate; however, during week 2, total cholesterol was 16.7% lower in the Cr-Picolinate supplemented lambs. Moreover, plasma cholesterol exhibited a quadratic effect with time. Plasma albumin and total protein concentrations (average 33.8 and 59 g/L, respectively) were not affected by treatment, but circulating albumin concentrations exhibited a quadratic response over week independent of dietary treatment (diet x week). Mean plasma glucose did not differ between the dietary treatments (average 3.68 mmol/l).

Hayirli *et al*. (2001) is demonstrated that Plasma glucose and serum glucagon concentrations and molar ratio of serum insulin to plasma glucose were similar across all levels of Cr-methionine supplementation.

Uyanik (2001) reported that, there was a slight decrease in glucose concentrations in the 200-ppb chromium group, although only the differences on day 55 were significant. No significant differences were found in total protein, albumin, ALT, AST, and GGT levels.

Pechova *et al*. (2002) demonstrate a significantly higher concentration of total blood plasma proteins found in chromium supplemented bulls. A significance between-group difference was also found in the concentration of total cholesterol, which was lower in the control than in the experimental group on day 136.

Paul *et al*. ((2005) found that the preprandial and postprandial plasma glucose on days 0 and 65 was in all the experimental groups. However, a day x dose interaction suggested that as supplementation progressed plasma glucose concentration got elevated especially in the bucks supplemented with 0.4 mg Cr. The elevated plasma glucose in the 0.4mg Cr supplemented bucks apparently contradicted the general hypothesis governing the mode of Cr action. Taking into account the effect of Cr on the potentiation of insulin action a lower plasma glucose concentration in this group was expected. However, in Cr supplemented ruminants, an enhanced gluconeogenesis from propionate was reported (Subiyatno *et al*., 1996), which at the dose level of 0.4 mg, might have had overridden the effect of insulin on the cellular uptake of glucose and resulted an elevated plasma glucose concentration.

Paul *et al*. ((2005) found that the higher alkaline phosphatase activity in the chromium supplemented bucks because, Cr augmented new bone crystal formation by enhancing the uptake of circulatory Ca into the bone matrix. This was supported by the lower concentration of Ca in the serum of the Cr supplemented bucks (2.18 and 2.17 mmol/ L respectively in the 0.2 and 0.4 mg groups respectively) compared to the control group of bucks (2.34 mmol/L).

Haldar *et al.* (2007) found in goats fed added dietary Cr from Cr chloride and Cr yeast relative to the control group of goats that serum glucose in the control group of goats increased while that in both the Cr supplemented groups decreased. Dietary Cr supplementation improved post-prandial utilization of glucose with lower serum level of glucose being detected in the Cr chloride and

Cr yeast dietary groups than in the control group. Dietary treatment had no effect on the post-prandial changes in serum total protein.

Pond (1983) reported that, feeding of 0.5% Ca and19 to 26 ppm Zn is adequate for normal plasma concentrations of total protein, albumin and alkaline phosphatase in Columbia and Suffolk lambs.

Malcolm-Callis *et al*.(2000) found that, serum cholesterol concentrations were not affected significantly by added zinc (0.26, 0.25, and 0.27 mg/ml) for 20, 100, and 200 mg of added zinc/kg, respectively. In addition, no differences ($P > 0.10$) were observed in fatty acids.

Ozcel *et al*. (2001) observed that supplementing the lamb diets with 30 ppm of zinc bacitracin, the total serum protein and albumin, level was not significantly effected to control group.

Spears *et al*. (2004) reported that, plasma alkaline phosphatase activity was not affected by dietary Zn concentration or source. Alkaline phosphatase activity, across sampling days, averaged 49.6, 57.5, 53.8, and 54.1 Units/l for steers fed the control, ZnSO4, Zn-methionine, and Zn-glycine treatments, respectively.

Wang *et al*. (2006) reported that, no significant difference was observed in biochemical values between the control, the low, and the medium-Zn supplemented groups. Plasma folate concentration and glucose were not influenced by dietary zinc level.

Zali *et al*. (2008) reported that the serum alkaline phosphatase activity was differ ($P<0.05$) between control and supplemented ewes and alkaline phosphatase activity tended to be greater in supplemented ewes than control group.

Kumar (2008) reported that supplementation of zinc in the diet of kid results in increase alkaline phosphatase activity, total protein, albumin and globulin levels in serum. However blood glucose and total cholesterol, triglyceride, HDL and LDL cholesterol in serum were significantly reduced due to mineral supplementation.

2.12 Effect of UMMB, MUMMB, Cr, Zinc and Se on mineral profiles

Uyanik (2001) reported that, Serum Cr concentrations slightly but not significantly increased in both chromium groups as compare to control group.

Paul *et al*. ((2005) found that the intake and apparent absorption of Cr in the bucks increased in almost a parallel fashion as the level of supplemental Cr increased in the treatment groups. The intake of Cu, Zn, Fe and Mn and the apparent absorption of Cu and Zn increased due to Cr supplementation though the increment in the dose level from 0.2 to 0.4 mg did not appreciably affect their apparent absorption. Apparent absorption of Mn was similar among the treatment groups. Neither the intake nor the apparent absorption of Fe in the bucks was affected by Cr supplementation.

Paul *et al*. ((2005) observed that the plasma Cr concentration increased in the Cr supplemented bucks. The difference between the 0.2 and 0.4 mg Cr supplemented animals was not conspicuous, however. Concentration of Cu, Zn and Mn in plasma was similar in all the treatment groups prior to the start of the experiment. Though Cr supplementation had no apparent effect on the plasma Cu concentration, levels of plasma Zn and Mn were elevated due to Cr supplementation. No definite effect of supplemental Cr feeding on plasma Fe

concentration could be ascertained though on day 65 it was found to be higher in the 0.4 mg Cr group of bucks.

Pechova *et al.* (2002) demonstrate that the Cr supplementation had no significant effect on whole blood concentration of Cr in Dairy Cows. Compared with controls, the experimental group showed significantly lower concentrations of phosphorus and copper, and Zinc concentration remained constant during the experimental period. Supplemental chromium protects the stress-induced urinary losses of zinc, copper, iron and manganese in ruminants.

A decreased loss of some micro elements (Zn, Fe, Cu and Mn) during stress after Cr supplementation to mice has been reported by Schrauzer *et al*. (1986). Interaction between Cr and Cu was studied by Stahlhut *et al*. (2006), Cr supplementation had no effect on the liver or plasma Cu concentrations in cows, although, supplemental Cr resulted in higher plasma Cu concentrations in calves on Day 279. The relation between Cr and Fe has been investigated most since both these minerals are transported as transferrin-bound. At low Fe saturation, Cr and Fe bind preferentially to different binding sites. When, however, the Fe concentration is higher, the two minerals compete for the same binding sites. (Sargeant *et al*., 1979).

Pond (1983) reported that, feeding of 0.5% Ca and19 to 26 ppm Zn is adequate for normal blood plasma concentrations of Ca, P and Zn in Columbia and Suffolk lambs.

Puchala *et al.* (1999) reported that supplementation of the diet with Zn-methionine increased plasma Zn concentration (0.92 versus 0.72 mg/l for control) and there were no differences in plasma Zn concentration between goats receiving

the ZnO supplement and goats receiving a similar amount of Zn from Zn-methionine (0.87 versus 0.92 mg/l; P > 0.56).

Eryavuz *et al.* (2002) reported that, the plasma Cu concentration in the defaunated+zinc supplemented group was significantly lower than other groups in goats. Plasma zinc level in the faunated + Zn and defaunated +Zn groups was higher than other groups. There were no significant differences in the plasma Mg, Ca, inorganic P and K levels among the groups.

Ozcel *et al.* (2001) observed that supplementing the Kıvırcık lamb diets with 30 ppm of zinc bacitracin raised the blood serum inorganic phosphorus (Pi) level and especially Cu level of liver and kidney tissues. Total serum Ca, Mg, Cu and Zn level was not affected by zinc bacitracin supplementation.

Garg *et al*. (2003) reported that, though the balance of calcium was adversely affected in both the Zn supplemented groups, but it was significantly higher in Zn-methionine group compared to ZnSO4 group. While apparent absorption and retention of nitrogen, phosphorus, copper, iron and manganese were similar among different groups, retention of Zn as well as its concentration in the serum was highest in Zn-methionine group, followed by ZnSO4 group and lowest in the control group, suggesting higher bioavailability of Zn from Zn-methionine as compared to ZnSO4.

Kumar *et al.* (2003) reported that significantly higher plasma zinc level in zinc supplemented kids. The Ca intake was similar in treatment group and control group but its balance and retention was maximum in treatment group probably due to its better utilization as a result of zinc supplementation.

Spears *et al*. (2004) reported that, plasma Zn concentrations were significantly higher for the Zn-glycine and Zn-methionine treatments compared to the control group.

Aliarabi and Chhabra (2005) reported that after supplementing zinc, significant difference was observed in plasma zinc concentration at 2nd fortnight among the treatments with a significantly lower value in control group. Zinc plasma level of calves increased sharply and this increase in zinc content continued till 4th fortnight of the experiment and after that it become almost constant. However, no significant difference was observed in treatment groups, while animals in chelated zinc supplementation, tended to have a higher value of plasma zinc. This shows the bioavailability of chelated zinc is higher than that of inorganic zinc.

Zali *et al* (2008) reported that the blood Zn concentration was higher in Zn supplemented than control ewes although this increase was not significant ($p>0.05$). Blood Cu, Fe, Na, K and Ca concentration did not differ ($p>0.05$) between ewes supplemented with sulfate zinc and control ewes.

Kumar (2008) reported in kids that serum levels of Zn, Cr and Mn were significantly ($P<0.05$) higher in mineral supplemented groups than control however they did not differ significantly among themselves.

2.13 Effect of UMMB, MUMMB, Cr, Zinc and Se on reproductive performance

Se administration to ewes has been shown to increase uterine contractions, thereby increasing the chance of fertilization and reducing the incidence of infertility in ewes (Hansen and Deguchi, 1996).Lacetera *et al.* (1996) reported no

improvement in growth of offspring when Se and vitamin E were administered during the late stages of pregnancy.

Spears *et al*. (1986) used seventy two Hereford x Simmental cows, averaging 498 kg in body weight and 5.2 year of age, in a 2 year study to ascertain if selenium – vitamin E injections and winter protein supplementation would affect growth, reproduction and health of beef cattle maintained year round on feedstuffs marginally deficient in Se (0.03 to 0.05 mg/kg). He found that Selenium- E injections reduced calf death losses form 15.3 % 4.2 %, respectively.

Gerloff (1992) concluded that the major benefits, observed experimentally of maintaining optimal Se intakes include minimizing the incidence of mastitis and preventing calf losses associated with mayopathy and /or respiratory disease. Wichtel (1998) suggested that selenium supplementation in ruminants grazing pastures deficient in selenium may improve milk production and fertility in sheep.

Satter *et al.* (2007) carried out a study on forty exotic cows in their last trimester of pregnancy and concluded that administration of vitamin E- selenium before calving may be beneficial in improving the reproductive parameters in exotic cows.

Akhtar *et al*. (2009) determined serum micro-mineral status (copper, iron , zinc, selenium) in normal she buffaloes and found that mean serum concentrations of copper, iron, zinc and selenium values were 70.59 µg/dl, 181.4 µg/dl and 0.10 µg/ml, respectively. They concluded that deficiencies of copper, iron, zinc and selenium either singly or in combination could be responsible for reproductive failures in Nilli- Ravi buffaloes.

CHAPTER–III
MATERIALS AND METHODS

3.1 Location

The study was carried out in the Department of Animal Nutrition, College of Veterinary Science and Animal Husbandry, Anjora, Durg (C.G.).

3.2 Selection of experimental animals

Experiment was conducted in three phases in kid, adult non pregnant and adult pregnant goats. Animals were selected from Animal Nutrition goat shed for the study. First phase of the experiment was conducted in forty eight growing kids of 6-9 months selected randomly on body weight basis and divided into 12 groups of four in each following 3x4 factorial scheme. For the second experiment twenty four adult non pregnant goats of 12-14 months age divided into six groups having 4 goats in each and for third experiment twenty four pregnant goats of 20-24 months of age divided into six groups having four goats in each were selected. Animals were selected from Animal Nutrition goat shed for the study.

3.3 Housing and management

Goats during all the phases of the experiments were housed in a well – ventilated goat shed with facilities for individual feeding under hygienic and uniform management conditions. All goats were sprayed with Butox (Deltalmethrin, Hoeschst Rousse, Vet India) @ 3 ml/l water at weekly interval for three weeks before start of experiment to control the ectoparasites (ticks, mites and flies).

3.4 Deworming

All goats were dewormed by Albendazole (Albendos, 2.5% w/v albendazole suspension, Dosch Pharmaceuticals Pvt. Ltd., Mumbai, India) at the rate of 7.5 mg/kg body weight orally. The elimination of parasitic infection was confirmed by faecal examination.

3.5 Identification of goats

All goats were ear tagged with metallic tags having identification numbers using ear tag machine.

3.6 Collection of roughages

Locally available sola grasses (*Aeschynomene indica*) and rhea leaf (*Accacia leucophloea*) were collected from college campus and were dried and stored for feeding of goats during experiments.

3.7. Preparation of UMMB and Med-UMMB

A technology was employed for the preparation of urea molasses mineral block and medicated urea molasses mineral block by using locally available feed ingredients as detailed in table 2. Known quantity of molasses were taken in a container and heated at 60ºC for removal of excess moisture. After that the ingredients were mixed with molasses in order of urea, mineral mixture, common salt, quick lime, soybean cake (deoiled), bentonite, rice bran (deoiled) and maize. The mixture was set in a wooden mould (9’’x 6’’). After removal of the moulds, the blocks were arranged in the drying area where the blocks so prepared would not be exposed to direct sunlight rather under shade with good ventilation for 24 to 72 hours.

Medicated UMMB: In above mixture (as in un-medicated UMMB) fenbendazole @ 0.5g/kg feed block were added for preparation of medicated UMMB.

3.8 Composition of urea molasses mineral block

Ingredient like molasses, maize, deoiled rice bran, deoiled soy cake, quick lime, bentonite, mineral mixture and common salt were used for preparation of UMMB in the proportion shown in the table 2.

Table 2: Composition of urea molasses mineral block

Ingredient	Parts (kg)
Molasses	44
Maize	10
Deoiled rice bran	11
Soybean cake (deoiled)	11
Urea	10
Lime (quick lime)	5
Bentonite	5
Mineral mixture	3
Common salt	1

3.9 Preparation of Diet

Roughage consisted of sola grass (*Aeschynomene indica*) and rhea leaf(*Accacia leucophloea*) in equal proportions (sola grass + rhea leaf meal 50:50) and concentrate mixture of deoiled rice bran (25%), maize (42%), deoiled soy bean cake (30%), premixes (2%) and common salt (1%).The nutritive value of diet were adjusted to contain 7 % DCP and 60 % TDN.

In growing kid

Roughage consisting of sola grass (*Aeschynomene indica*) and rhea leaf (*Accacia leucopholia*) in equal proportions (sola grass + rhea leaf meal 50:50) was fed *ad lib* to all kids and concentrate mixture was fed according to NRC (1981). Un-medicated UMMB was fed *ad lib* to group II while medicated UMMB was fed *ad lib* continuously for 10 days followed by un-medicated UMMB in group III.

Base level of three minerals viz. Cr, Zn and Se was estimated in roughage, concentrate and UMMB. Extraneous supplementation of trace elements: Cr, Zn and Se were made in sub groups at the rate of 0, 0.5, 1, 1.5; 0, 20, 40, 60; 0, 0.5,1 and 1.5 ppm feed, respectively. The optimum level of minerals utilized during first phase was used in second and third phase of the experiment.

Table 3: Dietary feeding schedule of growing kid under different groups

Particulars	**Group I (PC)**				**Group II (UMMB)**				**Group III (MUMMB)**			
Subgroups	M_0	M_1	M_2	M_3	M_0	M_1	M_2	M_3	M_0	M_1	M_2	M_3
No. of kids	4	4	4	4	4	4	4	4	4	4	4	4
[1]Cr (ppm)	0	0.5	1	1.5	0	0.5	1	1.5	0	0.5	1	1.5
[2]Zn (ppm)	0	20	40	60	0	20	40	60	0	20	40	60
[3]Se (ppm)	0	0.5	1	1.5	0	0.5	1	1.5	0	0.5	1	1.5
[a]Roughage	+	+	+	+	+	+	+	+	+	+	+	+
[b]Concentrate	+	+	+	+	+	+	+	+	+	+	+	+
[c]Un-medicated UMMB	-	-	-	-	+	+	+	+	-	-	-	-
[d]Medicated UMMB	-	-	-	-	-	-	-	-	+	+	+	+

a. Roughage consisted of sola grass and rhea leaf in equal proportions (sola grass + rhea leaf meal 50:50).
b. Kids were fed concentrate mixture as per NRC (1981)
c. Un-medicated UMMB were fed *ad lib*.
d. Continuously for 10 days followed by feeding of un-medicated UMMB.
1. Cr as Chromium propionate, 2. Zn as Zinc methionine , 3. Se as Sodium selenite

In non pregnant adult goat

The details of experimental design are presented in the table 4. Twenty four goats of 12-14 months age was divided into six groups having 4 goats in each. *Ad lib* roughage was provided to all goats. Group I was negative control, where goats were fed only *ad lib* roughage. Group II was positive control, where animals were fed concentrate mixture as per NRC (1981). In III, IV, V and VI groups goats were fed *ad lib* roughage with maize (350g), deoiled soybean cake (300g), un-medicated UMMB (*ad lib)* and medicated UMMB (*ad lib*) for ten days followed by un-medicated UMMB, respectively.

Optimum levels of Cr, Zn and Se from phase I were added in concentrate mixture, maize, deoiled soy cake and un-medicated and medicated UMMB of all the groups except negative control.

Table 4. Dietary feeding schedule of adult non pregnant goat under different groups.

Particulars	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*
Roughage	*Ad lib*	*Ad lib*	*Ad lib*	*Ad lib*	*Ad lib*	*Ad lib*
Concentrates	-	NRC(1981)	-	-	-	-
* Cr, Zn , Se	-	+	+	+	+	+
Maize (g/d)		-	350	-	-	-
Deoiled soy bean cake (g/d)		-	-	300		-
Un-medicated UMMB		-	-	-	*Ad lib*	-
Medicated UMMB	-	-	-	-	-	*Ad lib* **

* The optimum level of Cr, Zn and Se from experiment I were included in all the treatment (II, III, IV, V and VI) except NC (I).

** Continuously for 10 days followed by feeding of un-medicated UMMB.

Adult pregnant goat

The details of experimental design are presented in table 5. In third experiment, twenty four pregnant goats of 20-24 months age were divided into six groups having four goats in each. All animals were fed *ad lib* roughage. Group I was fed only roughage (*ad lib*). Group II was positive control, where animals were fed concentrate mixture as per NRC (1981) and roughage (*ad lib*). In groups III, IV and V and VI groups were supplemented with maize (350g), deoiled soy bean cake (300g), and UMMB (*ad lib*) , respectively. Group VI was fed with same diet as in negative control except in addition to it Cr, Zn and Se were supplemented.

Optimum levels of Cr,Zn and Se of phase I were added in concentrate mixture, maize, deoiled soy bean cake and medicated UMMB of all the groups except negative control group.

Table 5: Dietary feeding schedule of pregnant goats under different groups.

Particulars	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+Min)
Roughage	*Ad lib*	*Ad lib*	*Ad lib*	*Ad lib*	*Ad lib*	*Ad lib*
Concentrates	-	NRC,(1981)	-	-	-	-
* Cr, Zn , Se	-	+	+	+	+	+
Maize (g/d)		-	350	-	-	-
Deoiled soy bean cake (g/d)		-	-	300		-
Un-medicated UMMB		-	-	-	*Ad lib*	-

* The optimum level of Cr, Zn and Se from phase I was included in all the treatment (II, III, IV, V and VI) except NC (I).

3.10 Statistical Design

Data of growing stage (kids) was subjected to analysis by 3x4 factorial design for estimation of its effect i.e. control, UMMB and mineral (Cr, Zn, Se) and interaction between the main effects. During adult non pregnant and pregnant stage data were subjected to one way ANOVA (CRD) and individual treatment comparison was made by Dunkan's multiple range tests.

For the above analysis standard procedure given by Snedecor and Cochran, (1994) was followed by using SPSS software.

3.11 Growth trial

The complete feed was offered to kids at 09.00 am. Feeding was continued for 90 days. Daily record of feed intake was done. All kids were weighed fortnightly for three consecutive days during the entire experiment. Daily gain in body weight was calculated to determine the growth pattern and feed conversion ratio of kids.

3.12 Feed conversion ratio (FCR)

Feed conversion in kids was calculated as the ratio of feed consumed over body weight gain. This indicated the amount of feed required for the unit gain in body weight. It was calculated by the given formula:

$$\text{FCR} = \frac{\text{Quantity of feed consumed (g)}}{\text{Gain in body weight (g)}}$$

3.13 Body weight gain

Daily gain in body weight of kids was determined by subtracting the initial body weight from the final body weight.

3.14 Feed intake

Daily feed intakes of kids, adult non pregnant and adult pregnant goats were recorded throughout the experimental period. It was determined by subtracting leftover DM from the amount of DM feed offered.

3.15 Metabolism trial

A 5-day metabolism trials were conducted during mid of the experiment in kids, adult non pregnant, and in pregnant adult goats during advanced stage of pregnancy to determine nutrient utilization, N, Ca and P balances. All goats were kept individually in the especially designed metabolic cages to collect feed, faeces and urine. These samples were analyzed for N, Ca and P balance.

3.16 Collection of feed, faeces and urine

3.16.1 Feed sample

The representative samples of feed offered and residue leftover of each goat of the three experiments were collected daily in polythene bags for the analysis of dry matter. Dried samples of respective groups were pooled, uniformly mixed and ground in a Willey mill. The samples were stored at room temperature for further analysis.

3.16.2 Faecal sample

The daily faeces voided from each goat of the three experiments during metabolism trial were collected in a previously weighed bucket. It was weighed at 07.00 hrs early in the morning. Thereafter it was thoroughly mixed in a plastic tub and a representative sample was brought to the laboratory. A portion of representative samples was dried and processed for proximate analysis including Ca and P. Another portion was mixed with 5 ml of 25% sulphuric acid and kept in

previously weighed wide mouthed air tight glass bottle. At the end of collection period it was pooled, uniformly mixed with the help of spatula and about 10g was processed for nitrogen estimation.

3.16.3 Urine sample

Total urine of 24 hrs was collected in narrow mouthed glass bottles containing 10 ml toluene, for preventing the loss of volatile nitrogen. It was measured with the help of a graduated measuring cylinder.

3.17 Nutritional parameters

Proximate analysis of feed and faeces

Samples of feed offered, residue left and faeces voided were analyzed for various proximate principles (dry matter, organic matter, nitrogen, ether extract, crude fibre, total ash and acid insoluble ash) by the methods described in AOAC (1995). The samples were also analyzed for calcium (Clark and Collip, 1925) and inorganic phosphorus (Fiske and Subbarow, 1925).

Dry matter (DM)

About 5-10 g samples of feed, residue and faeces were taken in previously weighed metallic trays. It was dried at 100±0.5ºC in hot air oven over night. The loss in weight due to moisture gave rise to the dry matter.

Crude protein (CP)

Nitrogen present in the samples of feed, faeces and urine was estimated by Micro-Kjeldahl's method of AOAC (1995). The nitrogen content was multiplied by factor 6.25 to arrive at crude protein content.

Ether extract (EE)

About 5-10 g dried powdered samples of feed were taken in a readymade thimble. The samples were extracted continuously for 60 minutes with petroleum ether (40ºC) at 250ºC in a modified Soxhlet extraction apparatus (Socsplus-Pelican India Ltd.). The ether extract was calculated by difference in the weight of oil flask before and after extraction.

Crude fibre (CF)

About 5-8 g fat free dried sample was taken in one liter capacity spoutless tall beaker. It was boiled with 200 ml 1.25% sulphuric acid for 30 minutes and then filtered through a muslin cloth and washed with hot water till it became acid free. Thereafter it was transferred in the same beaker and boiled with 200 ml 1.25% NaOH solution for 30 minutes. It was then made alkali free through continuous washing with hot water. The residue left was transferred to the previously weighed silica crucible. It was dried at 100±0.5ºC in hot air oven over night. The dried material was ignited in the muffle furnace at 600ºC for 30 minutes .The loss in the weight was considered as crude fibre content of sample.

Total ash (TA)

About 5-10g dried sample was taken in previously weighed silica crucible and charred on a low flame gas burner. It was then ignited in Muffle furnace at 600^{o}C for 30 minutes. After cooling it in desiccators it was weighed to constant weight. The ignited material left in the crucible was considered as total ash.

Acid insoluble ash (AIA)

The dried ash was digested with 5N HCl for 20-30 minutes. Thereafter it was filtered through a Whatman filter paper No. 42 and repeatedly washed with

hot distilled water. The filter paper with residue was removed, folded, put in crucible, dried in oven and ignited in the Muffle furnace at 600^{o}C for 30 minutes. After this, it was cooled in desiccator and weighed. The residue left in crucible after ignition was considered as acid insoluble ash.

Nitrogen free extracts (NFE)

NFE was calculated by subtracting the sum percentage of crude protein, crude fibre, ether extract and total ash from 100.

NFE (%) = 100 - (CP % + CF % + EE % + Total ash %)

Calcium (Ca)

The calcium content in the feed and faeces was determined by the precipitation method (Clark and Collip, 1925). Calcium was precipitated in acidic medium as insoluble calcium oxalate by adding saturated ammonium oxalate solution. The precipitate was dissolved in dilute sulphuric acid (1:9) and the oxalic acid thus released was titrated against N/10 potassium permanganate solution in warm condition, it was calculated as.

$$\text{Calcium (\%)} = \frac{\text{ml N/10 } KMNO_4 \text{ x } 0.002 \text{ x Volume of mineral extract prepared}}{\text{Weight of sample taken for Ashing x Aliquot of precipitate}}$$

Phosphorus (P)

Phosphorus was determined by colorimetric method of Fiske and Subbarow (1925). To 1 ml of sample, 1ml 2.5 N HNO_3 and 1 ml ammonium molybdate were added. Then it was properly mixed with 6 ml distilled water. Simultaneously, a standard was run in the same manner. The optical density was read against blank in colorimeter at 400 nm.

Van Soest analysis of fibre

The feed ingredient sample was analyzed for neutral detergent fibre (NDF), acid detergent fibre (ADF), cellulose, hemicellulose and lignin (Van Soest *et al.*, 1991).

Neutral detergent fibre (NDF)

About 1-2 g of dried sample was taken in a 1000 ml Berzelius beaker. To this 100 ml of neutral detergent solution and 0.5 g sodium sulphite were added. Thereafter the samples were refluxed on hot plate for one hour and then the contents were filtered through 50 ml sintered glass crucible (G-1). The residue left was treated with boiling water followed by acetone. The material along with crucible was oven dried and weighed. The dried material in the crucible was considered as NDF.

Acid detergent fibre (ADF)

About 1-2g of dried sample was treated with 100 ml acid detergent solution in a Berzelius beaker. The material was boiled for one hour. Thereafter the content was processed in a similar manner as in NDF. The dried residue left was considered as acid detergent fibre (ADF).

Hemicellulose

Hemicellulose of feed was arrived at by subtracting ADF from NDF.

Cellulose

To determine the cellulose content in feed sample, ADF content was treated with 72% sulphuric acid and the cellulose content was determined as the loss in weight of samples.

Lignin

The sample was treated with 72% sulphuric acid as in cellulose determination. The residue left was oven dried and ignited at 600^{o}C for 30 minutes in Muffle furnace. The loss in weight was considered as the lignin content.

3.18 Micro Elements

The microelement (Cu, Zn, Fe, Se, Cr, As) content in the diet, faeces and serum was determined by Atomic Absorption Spectrophotometer (Electronics Corporation of India Ltd. AAS 4141). The accurate weighed amount of samples were digested by Tri acid solution (Nitric acid: Sulphuric acid: Perchloric acid – 9: 2: 1) and then known amount of volume was made by adding distilled water to the digested solution.

3.19 Haematological studies

3.19.1 Blood collection

The blood samples were collected at 0, 30, 60, and 90 days from all kids, at 0, 15 and 30 days interval from adult non pregnant and from adult pregnant goats at 0, 30, 60, 90, 120 and 140 days intervals after 4 hours post feeding. About 6 ml of blood was collected aseptically from each goat from jugular vein using 18 gauge needle. Out of which 2 ml blood was taken in a glass vial containing ethylene diamine tetra acetate (EDTA) for haematological studies. Immediately after blood collection the tubes were gently rotated between palms in order to mix it with anticoagulant. Another 4 ml of blood was collected in a wide bore test tube without anticoagulant for separation of serum. The serum samples were preserved in refrigerator at 4ºC for determination of biochemical parameters.

Hemoglobin, packed cell volume (PCV) and total erythrocyte count (TEC), Mean corpuscular hemoglobulin, Mean corpuscular volume and Mean corpuscular hemoglobulin concentration were performed as per the method described by Jain (1986).

3.20 Biochemical parameters

Serum samples were analyzed for Blood glucose (Accu-check active glucometer, Roche), serum insulin (RIA kit supplied by BRIT, BARC, and Mumbai), Total serum protein (Reinhold, J.G., 1953), Serum albumin (Spencer and Price, 1977), and Serum albumin: globulin ratio and serum alkaline phosphatase (Bodansky, A., 1937). Serum globulin (g/dl) was calculated by subtracting the albumin values from the values of total serum protein

CHAPTER- IV
RESULTS AND DISCUSSION

4.1 Chemical composition of diet

The chemical composition of the feed ingredient used in the diets of kid, non pregnant and pregnant goats is presented in table 6. The chemical composition of basal diet (*rhea:sola* grass 50:50), UMMB, concentrate mixture, maize, deoiled soy cake, *rhea* and *sola* grass for dry matter (DM), crude protein (CP), ether extract (EE), crude fibre (CF), total ash (TA), nitrogenfree extract (NFE), acid insoluble ash (AIA), total calcium (Ca) and phosphorus (P) contents of the diet has been presented in table 6. The NDF, ADF, hemicellulose (HC), cellulose (CL) and lignin composition of basal diet (*rhea*:*sola* grass 50:50), UMMB, concentrate mixture, maize, deoiled soy cake, *rhea* and *sola* grass has also been presented in the table 6. The minerals (Zn, Cr, Se, Cu, Fe and As) concentration of above feed ingredients is also presented in the table 6.

Singh (1982) and Tiwari *et al.* (1998) reported that *rhea* leaves contain 15% crude protein as against 13.11 % in the present study which was toward higher side due to the stage of maturity of leaves. The result was reflected by its crude fiber content. The same worker reported relatively lesser crude fiber content (19%) than the actual value (33.70) obtained in this study. The *sola hay* has been reported to contain 12.20, 1.19, 61.06, 44.76, 1.41 and 0.12 % of CP, EE, NDF, ADF, Ca and P, respectively (Jain, 2000). The CP, EE and ADF were found almost similar to the reported values, however, the contents of NDF, Ca and P obtained in the present study was more than the reported one. This was evident

Table 6: Chemical composition of feed and fodder (%DM basis)

Diet	CP	CF	EE	Ash	AIA	NFE	Ca	P	NDF	ADF	HC	CL	L	Zn	Cr	Se	Cu	Fe	As
Basal Diet (Roughage)	13.01	30.8	2.6	15.14	8.62	39.24	1.28	0.78	72.10	42.85	29.25	27.12	15.73	21	0.12	0.2	5.6	130	0.02
UMMB	40.93	4.42	0.26	21.92	2.63	36.13	11.68	4.09	30.12	12.90	17.22	10.41	9.10	25	1.12	3	6.3	90	0.21
Concentrate mixture	19.33	5.82	1.16	10.73	1.81	63.93	1.18	0.38	45.94	23.51	22.43	17.68	5.83	30.7	1.10	2	1.2	67	0.11
Maize	9.8	2.1	3.2	12	3.41	72.9	1.2	1.8	12.8	2.60	10.2	1.64	0.96	16	2.01	1	2.5	72	0.15
Deoiled soy bean cake	43.76	6.13	1.80	8.96	3.94	39.35	2.14	1.19	14.10	8.90	5.2	6.78	2.12	55	0.12	1	24	88	0.12
Rhea *(Acacia leuc-ophloea)*	13.11	33.70	2.09	13.89	0.15	33.85	2.48	0.96	70.42	50.24	20.18	23.83	26.42	15	0.10	0.2	7	151	0.06
Sola grass (*Aeschyno-mene-indica)*	11.16	24.95	1.29	19.12	9.13	43.48	2.11	1.42	70.11	43.16	26.95	14.93	28.23	25	0.12	0.2	10	123	0.05

Concentration of Zn, Cr, Se, Cu, and Fe and As in feeds and fodders are on ppm basis.

from the fact that the changes in even one of the components of feeding material alter the values of other components.

4.2 Kid

4.2.1 Effect on feed intake, growth performance and feed conversion ratio

4.2.1.1 Dry matter intake (DMI)

Effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on daily DM intake was recorded to be significant throughout the experimental period (Table 7). Their interaction also had significant effect ($P<0.01$). There was significant increase in DM intake throughout the experiment due to MUMMB supplementations in the diet as compared to control or due to UMMB supplemented diet. The mineral supplementation drastically affected the DM intake which was more in M3 followed by M2 and M1. The M0 had significantly lower values as compared to M1, M2 and M3. The interactions between UMMB and mineral were highly significant from second fortnight to fifth fortnight at ($P<0.01$) and at first fortnight and sixth fortnight the values were significant at ($P<0.05$).

The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on DM intake (kg/100 kg body weight) of various groups have been presented in table 8. Perusal of data revealed significant difference due to effect of UMMB, minerals supplementation as well as their interaction. MUMMB supplemented group was recorded to have significantly ($P<0.01$) higher value than the other two groups which were non significant themselves. Due to supplementation of minerals, group M_2 had highest and control had lowest value at 0-15 days. However, difference between control

Table 7: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on DM intake (g/day) in kids of various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0-15	296.40^{c}	293.24^{b}	343.57^{a}	8.47	**	290.31^{d}	300.97^{c}	332.99^{a}	320.02^{b}	10.85	**	*
15-30	323.77^{c}	325.52^{b}	396.25^{a}	9.64	**	323.99^{d}	334.86^{c}	370.60^{a}	364.62^{b}	13.83	**	**
30-45	403.09^{c}	379.12^{b}	455.42^{a}	12.82	**	375.94^{d}	398.65^{c}	439.83^{a}	435.78^{b}	15.73	**	**
45-60	449.87^{c}	424.00^{b}	625.16^{a}	13.73	**	417.41^{d}	443.93^{c}	491.76^{a}	645.62^{b}	16.32	**	**
60-75	488.15^{c}	473.83^{b}	555.81^{a}	14.87	**	462.17^{d}	503.33^{c}	541.69^{a}	516.53^{b}	18.34	**	**
75 -90	532.77^{c}	521.46^{b}	620.07^{a}	15.63	**	506.37^{d}	552.16^{c}	589.20^{a}	584.67^{b}	19.93	**	*
Overall	415.68^{b}	402.86^{b}	499.38^{a}	16.41	**	396.03^{b}	422.31^{ab}	461.01^{a}	477.87^{a}	19.03	*	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

Table 8: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on DM intake (kg/100kg body weight) in kids of various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0-15	3.97^{b}	3.95^{b}	4.63^{a}	0.14	**	3.99^{c}	4.01^{bc}	4.54^{a}	4.20^{ab}	0.17	**	NS
15-30	4.06^{b}	4.07^{b}	4.92^{a}	0.14	**	4.20^{b}	4.15^{b}	4.66^{a}	4.39^{a}	0.19	**	NS
30-45	4.69^{b}	4.36^{b}	5.18^{a}	0.16	**	4.58^{b}	4.55^{b}	5.06^{a}	4.79^{b}	0.20	**	NS
45-60	4.85^{b}	4.46^{b}	6.49^{a}	0.55	**	4.72^{b}	4.65^{b}	5.14^{a}	6.55^{a}	0.62	**	NS
60-75	4.84^{b}	4.52^{b}	5.20^{a}	0.15	**	4.83^{b}	4.79^{ab}	5.14^{a}	4.66^{a}	0.19	**	NS
75 -90	4.80^{b}	4.53^{b}	5.26^{a}	0.14	**	4.85^{b}	4.77^{ab}	5.06^{a}	4.77^{a}	0.18	**	NS
Overall	4.54^{b}	4.32^{b}	5.28^{a}	0.18	**	4.53	4.49	4.94	4.89	0.24	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

and M_1, M_2 and M_3, and M_1 and M_3 were non significant. From 15-30 and 45-60 days groups M_2 and M_3 had higher values than groups M_0 and M_1. However, M_2 and M_3 did not differ significantly from each other. From 60 day onwards though M_2 and M_3 were having significantly ($P<0.01$) higher values than M_0 and M_1 but M_0 and M_1, and M_1, M_2 and M_3 were non significant among each other.

DMI ($g/kgW^{0.75}$) due to dietary supplementation of UMMB and MUMMB were found to be significant, whereas mineral supplementation (except at 0-15 days) and their interaction exerted non significant difference among various groups (table 9). Throughout the experimental period except during 45-60 days MUMMB supplemented group has significantly ($P<0.01$) higher DMI ($g/kgW^{0.75}$) as compared to other two groups which were significantly similar to each other. Due to mineral supplementation significant difference could be noticed only at 0-15 days. Group M_2 had significantly ($P<0.05$) higher value than groups M_1 and M_0 which, were non significant to each other. However M_4 was comparable among all the groups.

Overall DMI ($g/kgW^{0.75}$) in kids was significantly affected due to UMMB but non significantly affected due to minerals supplementation (Fig.1). The value was highest ($P<0.01$) for MUMMB supplemented group, other groups being non significantly different from each other. The effect of interaction of two supplements was not marked.

Moonsie and Mowat (1993) showed significantly higher DMI in calves on a corn-silage based diet supplemented with high-Cr yeast. In contrary, Boleman *et al.*(1995) reported reduced DMI in pigs fed Cr tripicolinate from the growing to the finishing phase. However, no significant difference was obtained in calves

Table 9: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on average DM intake (g/kg $W^{0.75}$/d) in kids of various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0-15	65.61^{b}	65.14^{b}	76.36^{a}	2.11	**	65.49^{b}	66.31^{b}	74.62^{a}	69.72^{ab}	2.70	*	NS
15-30	40.61^{b}	40.67^{b}	49.23^{a}	1.39	**	42.02	41.47	46.64	43.89	1.92	NS	NS
30-45	80.29^{b}	74.89^{b}	89.16^{a}	2.61	**	77.51	78.27	86.82	83.20	3.30	NS	NS
45-60	84.59	78.25	114.26	2.57	NS	81.40	81.69	90.41	115.97	3.20	NS	NS
60-75	86.19^{b}	81.34^{b}	94.02^{a}	2.61	**	84.85	86.20	92.63	85.05	3.28	NS	NS
75 -90	87.63^{b}	83.40^{b}	97.35^{a}	2.41	**	87.19	88.00	93.50	89.15	3.16	NS	NS
Overall	74.15^{b}	70.62^{b}	86.73^{a}	3	**	38.96	50.03	53.16	57.25	1.22	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

during the 21 to 23 day (Kegly *et al.,* 2000). In the current study too, the effect was not significant at 90 day, however, it was higher in mid of the trial.

There was a significant correlation between dietary protein, chromium and DMI. Cr in the diet increased all three variables in lambs fed high protein and decreased all three variables when fed low protein diet (Gentry *et al*., 1999). Though in the present investigation no such relationship was established, however, it seems from the data that Cr affected the overall performance of kids which might be due to the efficient utilization of dietary protein and energy.

Paul *et al*. (2005) reported that the intake of DM, was higher in the Cr supplemented bucks compared to the control though the difference between the 0.2 and 0.4 mg Cr supplemented bucks was not significant ($p > 0.05$). In the present study the difference was significant when diet was supplemented with 1.5 ppm Cr along with 1.5 ppm Se and 60 ppm Zn. Wagner *et al*. (1999) reported, no significant variation for dry matter intake between zinc supplemented group and control group.

Malcolm-Callis *et al.* (2000) observed that, there was a linear ($P < 0.10$) decrease in daily DM intake with increasing zinc concentration, suggesting that higher concentration of $ZnSO_4$ may have a negative influence on palatability. Though, it was found positive in the present investigation when diet was supplemented with organic Zn.

Garg *et al.* (2003) reported that, intake of dry matter, was significantly higher in Zn-methionine group as compared to control group lambs. However, digestibility of cellulose and acid detergent fiber was significantly higher in Zn-

methionine group as compared to control group. The findings in the present experiments were in accordance to the Garg *et al.* (2003).

DMI was not affected by supplementation of 0.3 ppm Se in male buffalo calves (Ivancic and Weiss, 2001; Mudgal *et al*., 2007; Shinde *et al*., 2008 and Kumar *et al*., 2009) and 0.38 ppm Se (Lawler *et al*.,2004) in steers however it was significantly higher in the present investigation when diet was supplemented with 1.5 ppm Se.

4.2.1.2 Growth Performance

There was significant effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on average body weight of various groups (Table 10). Due to UMMB supplementation body weight was significant during last two fortnights while at other periods it was recorded to be non significant. Value observed in control was significantly ($P<0.01$) lower than supplemented groups.

Significant effect on body weight changes was noticed from 30 days onwards due to effect of mineral supplementation. Group M_3 was significantly ($P<0.01$) higher than other groups, control having lowest value among all during 45-90 day. However, groups M_1, M_2 and M_3 were non significant between 30-45 days.

Effect of interaction between the two supplements was recorded to be non significant ($P>0.05$) throughout the experiment period.

Significant effect could be recorded due to UMMB/MUMMB and mineral supplements on gain of kids. Marked effect of interaction was also observed (Table 11). Gain was highest for MUMMB than control groups followed by

Table 10: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on average body weight changes (kg) in kids of various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0-15	7.48	7.46	7.48	0.13	NS	7.32	7.51	7.39	7.67	0.14	NS	NS
15-30	7.99	8.04	8.09	0.13	NS	7.75	8.07	7.99	8.35	0.14	NS	NS
30-45	8.58	8.72	8.84	0.15	NS	8.25^{b}	8.75^{a}	8.73^{a}	9.13^{a}	0.15	**	NS
45-60	9.27	9.55	9.73	0.17	NS	8.87^{c}	9.54^{b}	9.59^{b}	10.06^{a}	0.16	**	NS
60-75	10.09^{b}	10.51^{a}	10.75^{a}	0.19	**	9.61^{c}	10.49^{b}	10.57^{b}	11.12^{a}	0.17	**	NS
75 -90	11.08^{b}	11.54^{a}	11.85^{a}	0.21	**	10.46^{c}	11.55^{b}	11.67^{b}	12.29^{a}	0.18	**	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 11: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on average body gain (g/day) in kids of various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0-15	33.16	32.36	34.26	1.09	NS	34.80	31.03	33.69	35.51	0.85	NS	*
15-30	33.57^{c}	38.49^{b}	40.94^{a}	1.55	**	37.80^{c}	37.26^{c}	39.83^{b}	44.78a	1.01	**	**
30-45	39.76^{c}	45.74^{b}	49.77^{a}	1.97	**	32.95^{d}	45.56^{c}	49.49^{b}	52.35^{a}	1.33	**	**
45-60	45.51^{c}	55.17^{b}	59.39^{a}	2.02	**	41.37^{d}	52.96^{c}	57.44^{b}	61.66^{a}	1.81	**	**
60-75	54.84^{c}	63.95^{b}	67.62^{a}	2.20	**	49.26^{d}	63.05^{c}	65.01^{b}	71.21^{a}	1.70	**	**
75 -90	66.21^{c}	69.11^{b}	73.42^{a}	2.12	**	56.56^{d}	70.30^{c}	73.47^{b}	77.98^{a}	1.05	**	*
Overall	44.67^{c}	50.64^{b}	54.23^{a}	1.78	**	73.08^{d}	73.66^{c}	80.77^{b}	81.16^{a}	3.96	**	**

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

UMMB. Among mineral supplemented groups M_3 had higher value than NC (M_0) followed by M_2 and M_1.

Use of UMMB increased live weight gain of buffalo heifers (Akbar *et al*.; 1991) and indigenous cow (Ghosh *et al*., 1993). Moonsie and Mowat (1993) showed improved ADG in calves supplemented with high-Cr yeast in a corn-silage diet. Whereas Boleman *et al*. (1995) reported reduced ADG in pigs fed Cr tripicolinate.

Xu and Wang (1994) observed 23 per cent more gain in sheep having access to lick blocks, compared with controls. Similar trends were observed by earlier workers (Jia *et al*., 1995; Liu *et al*., 1995; Yang *et al*., 1996; Zhang *et al*., 1999 and Guan *et al*., 2001b) in goats. In other studies Sanyal and Singh (1995a) and Waruiru and Onyando (2001) in heifer and Forsberg *et al* (2002) in sheep reported more weight gain when diet was supplemented with Med-UMMB than control. However Roy (2007) found no significant difference in live weight gain of goats consuming UMMB and medicated UMMB compared to control group. In the present investigation too the MUMMB supplementation increased the gain in body weight of kids due to continuous deworming which resulted in efficient utilization of nutrients for better gain

Page *et al*. (1993) reported a linear reduction in daily gain for pigs supplemented with 50, 100 and 200 ppb chromium picolinate. Other studies (Mooney and Cromwell, 1997) have confirmed the positive effect of supplementing 0.2 mg/kg of Cr on weight gain. Pechova *et al.* (2002) in bull and Paul *et al*. ((2005) in goats also reported the similar findings below 0.2 ppm. However Harris *et al*. (1995) in pigs, Shain *et al.* (2001) in growing rabbits,

Kitchalong *et al.* (1995) in lambs, Kegly *et al.* (2000) in beef cattle, Uyanik (2001) in sheep and Haldar *et al.* (2007) in goats reported no significant gain in body weight when diets were supplemented with chromium picolinate. In the present investigation supplementation of 1.5 ppm Cr along with 1.5 ppm Se and 60 ppm Zn gave better growth performance than other levels.

Pond (1983) reported that feeding of 19 to 26 ppm Zn in Columbia and Suffolk lambs, 25 ppm Zn with Zn protein in steers (Kegley and Spears, 1994) and 15 ppm zinc in lambs (Hatfield *et al*., 1993) was adequate for normal weight gain. However reduction in gain was recorded by Malcolm-Callis *et al.* (2000) when diet was supplemented with increased levels of Zn. Garg *et al.* (2003) reported that, average daily gain of the lambs was also significantly higher when diet was supplemented with Zn-methionine. However Wang *et al.* (2006) reported no significant difference in body weight gain and feed/gain between zinc supplemented group and control group. Zali *et al.* (2008) reported that the ewe body weight gain and ADG at the end of the study and ewe body weight gain and ADG change from beginning to end of the study did not differ between ewes supplemented with sulfate zinc and control ewes. In the present study the daily gain in body weight and feed conversion ratio was found to be higher as compared to the control when diet was supplemented with Zn methionine along with Cr propionate and sodium selinite. This was due to the more availability of these nutrients across the gastrointestinal tract.

Ellis *et al*. (1987) found no significant difference in weight gain in Poll-Dorset cross lambs when diet was supplemented with Se alone, however, the effect was positive when supplemented with cobalt orally as bullet or with

subcutaneous injection of vitamin $B_{12.}$ In another study (Wichtel *et al*., 1996) it has been observed that intraruminal Se pellets (designed to release Se about 3 mg/day) increased body weight gain due to increase plasma concentration of insulin like growth factor I. The grazing pasture deficient in Se when supplemented with it improved the growth in sheep and other grazing ruminants (Wichtel, 1998).

Gabryszuk and Klewiec (2002) administered the Se in growing lamb and found significantly increase in daily weight gain.

Grace and Knowles (2002) conducted 20 trials in lambs using sodium selenite and found an increased growth rate of 63 g/day higher than that of untreated lambs. There was a positive relationship between blood Se concentration and growth response. However no such response had been recorded in buffalo calves when diet was supplemented with 0.3 ppm Se (Mudgal *et al*., 2007; Shinde *et al*., 2008). In a recent study (Kumar *et al.,* 2009) the growth of lambs was found improved when diet was fortified with sodium selenite or the organic selenium at the rate of 0.15 ppm. In our study too such observations were recorded which might be due to better humoral immune response and antioxidant status of the lambs.

4.2.1.3 Feed conversion ratio (FCR)

The effect of dietary supplementation of UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite on feed:gain ratio of various groups has been summarized in table12. MUMMB supplemented group and control was recorded to have significantly higher value than UMMB except during 45-60 days, where the difference between these groups were non

Table 12: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on feed: gain ratio in kids of various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0-15	10.59^{a}	9.51^{b}	10.22^{a}	0.36	*	11.69^{a}	9.77^{b}	9.89^{b}	9.07^{b}	0.33	**	*
15-30	9.71^{a}	8.64^{b}	9.98^{a}	0.37	**	11.22^{a}	8.99^{bc}	9.35^{b}	8.21^{c}	0.35	**	NS
30-45	10.18^{a}	8.56^{b}	9.46^{a}	0.41	**	11.37^{a}	8.79^{b}	9.05^{b}	8.40^{b}	0.4	**	**
45-60	9.89	7.85	10.51	0.82	NS	10.06	8.50	8.76	7.84	0.43	NS	NS
60-75	8.97^{a}	7.53^{b}	8.42^{a}	0.35	**	9.38^{a}	8.03^{bc}	8.53b	7.28^{c}	0.37	**	**
75 -90	8.10^{ab}	7.61^{b}	8.51^{a}	0.24	*	8.93^{a}	7.86^{b}	8.02^{b}	7.49^{b}	0.24	**	NS
Overall	9.57^{a}	8.28^{b}	9.52^{a}	0.35	**	10.44^{a}	8.66^{b}	8.93^{b}	8.47^{b}	0.39	**	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

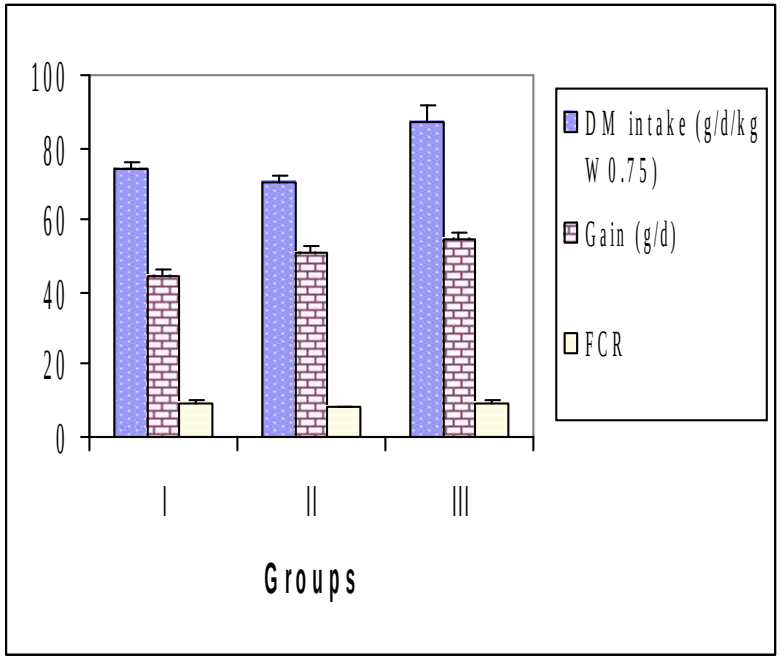
significant. When different levels of minerals were supplemented control was observed to have significantly higher value than other groups. During 0-15, 30-45 and 75-90 days groups M_1, M_2 and M_3 were non significant among themselves while at 15-30 and 60-75 days M_3 had significantly ($P<0.01$) lower value than other groups. Groups M_1 and M_2 were non significant. The effect of interaction of two supplements i.e. UMMB/MUMMB and mineral was significant at 0-15, 30-45 and 60-75 day.

The overall FCR of kid was lower for UMMB than either control or MUMMB supplemented diets. Among the mineral supplemented groups it was lowest in M_3 however significantly higher value was recorded in control (M_0) (Fig. 1).

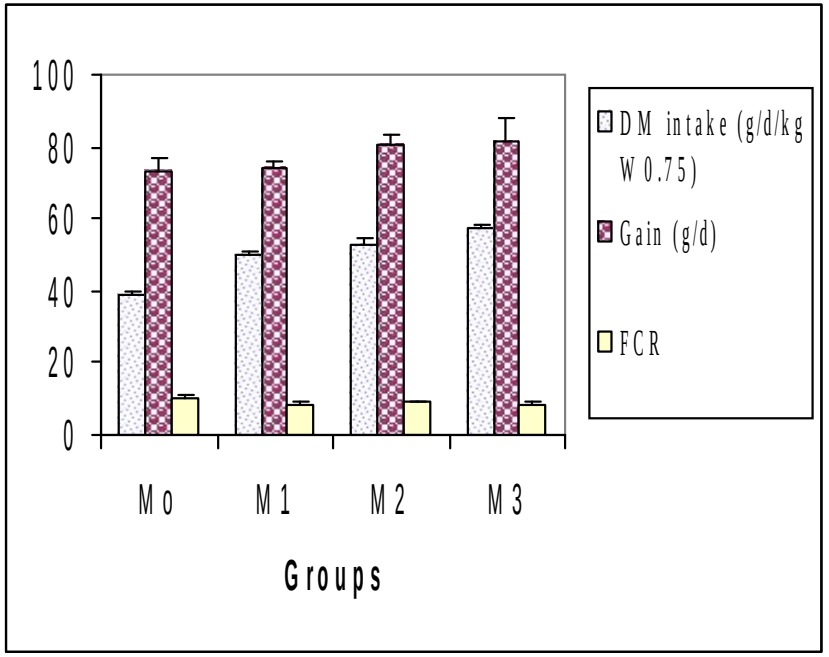
Though there was significant increase in the DMI and daily gain in body weight in UMMB supplemented groups in the present study the feed conversion ratio did not differ significantly however MUMMB supplementation in the diet increase the feed conversion ratio significantly. The earlier workers (Jain *et al*., 2005; Roy, 2007) also reported the similar trends using urea molasses mineral granules or UMMB in their studies in kids.

Kegly *et al.* (2000) reported no significant difference in daily gain of body weight or the feed conversion efficiency in steers due to dietary supplementation of Cr however Gentry *et al*. (1999) found significant increase in gain:feed ratio in lambs. The later report was in accordance to the present investigation in kids. A similar positive quadratic ($P < 0.10$) response in growth performance and linear trends in feed efficiency was also observed in steers due to dietary

Fig.1: The overall dry matter intake (g/kgW $^{0.75}$), gain (g/d) and FCR in the kid of various groups due to UMMB (a) and mineral effect (b)



(a) UMMB effect



(b) Mineral effect

supplementation of zinc (Malcolm-Callis *et al*., 2000). No significant change was obtained due to mineral supplementation in the present study.

4.2.2 Nutrient utilization

There was significant effect of dietary supplementation of UMMB, Med UMMB, Zn methionine, Cr propionate and Se selenite on digestibility coefficient of certain nutrients as presented in table 13 and 14.

Digestibility coefficient of dry matter was 22.51% higher in UMMB and 21.32 % in MUMMB supplemented diets than the control. Data between supplemented groups did non differ significantly. No significant difference in DM digestibility was recorded due to different levels of Zn, Cr, and Se in the diets or their interaction with UMMB /MUMMB. Though, the CP intake and CP digested were maximum in UMMB/MUMMB supplemented groups. The overall digestibility was significantly lower as compared to control. Zn, Cr and Se supplementation in the diet did not affect the overall digestibility of CP although the amount digested was significantly higher in M_1 to M_3 than M_0. The interaction was non significant (Fig. 2).

Highly significant ($P<0.01$) effect was observed due to supplementation of UMMB, mineral as well as their interaction with regards to EE digestibility. It was highest in group II, followed by control and groups III. Due to mineral supplementation lowest value was recorded in group M_2. The difference between M_0 and M_1 was non significant.

The digestibility of CF, NFE, NDF and ADF was not significant amongst groups due to supplementation of UMMB/MUMMB and different levels of minerals. Their interaction was also non significant.

Table 13: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on average nutrient intake (g/day) and digestibility coefficient in kid of various groups

Particulars	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB+Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
Dry Matter												
Intake	530.9^{b}	596.25^{a}	642.26^{a}	23.63	**	512.41^{c}	569.82^{bc}	655.53^{a}	621.46^{ab}	26.25	**	NS
Voided	266.83	240.1	266.47	12.18	NS	238.37^{b}	240.24^{b}	299.3^{a}	253.29^{b}	11.80	**	NS
Digested	264.08^{b}	356.15^{a}	375.79^{a}	24.12	**	274.04	329.57	356.23	368.18	29.83	NS	NS
DC	47.94^{b}	58.73^{a}	58.16^{a}	2.83	*	52.59	55.85	53.22	58.12	3.54	NS	NS
Crude protein												
Intake	84.16^{c}	121.52^{b}	142.52^{a}	5.50	**	97.19^{b}	116.85^{a}	128.08^{a}	122.14^{a}	9.06	**	NS
Voided	15.93^{c}	31.33^{b}	40.2^{a}	1.64	**	27.87	26.73	31.36	30.66	3.60	NS	NS
Digested	68.23^{b}	90.19^{a}	102.32^{a}	5.77	**	69.32^{b}	90.12^{a}	96.72^{a}	91.49^{a}	7.33	*	NS
DC	80.61^{a}	72.99^{b}	70.87^{b}	1.91	**	72.09	76.91	75.09	75.19	2.54	NS	NS
Ether extract												
Intake	13.18^{a}	12.27^{b}	12.13^{b}	0.34	*	11.64^{b}	11.97^{b}	13.47^{a}	13.02^{a}	0.39	**	NS
Voided	3.92^{a}	3^{b}	4.58^{a}	0.31	**	3.31^{b}	3.34^{b}	4.87^{a}	3.81^{b}	0.38	**	*
Digested	9.26^{a}	9.27^{a}	7.55^{b}	0.40	**	8.33	8.63	8.6	9.21	0.51	NS	**
DC	69.92^{b}	75.65^{a}	62.57^{c}	2.38	**	71.53^{a}	72.41^{a}	63.34^{b}	70.25^{a}	3.16	*	**
Crude fiber												
Intake	102.9	98.54	104.1	5.29	NS	84.64^{b}	92.23^{b}	118.07^{a}	112.45^{a}	5.22	**	NS
Voided	56.3	50.12	59.91	3.90	NS	47.35^{b}	49.97^{b}	68.64^{a}	55.82^{b}	4.10	*	NS
Digested	46.6	48.42	44.19	3.30	NS	37.29^{c}	42.26^{bc}	49.43^{ab}	56.63^{a}	3.37	**	NS
DC	44.87	49.53	42.67	2.49	NS	43.66	46.26	42.47	50.37	2.83	NS	NS
Nitrogen free extract												
Intake	212.18	222.19	229.99	9.32	NS	188.76^{b}	207.92^{b}	242.73^{a}	246.41^{a}	8.24	**	NS
Voided	115.22	115.45	119.35	6.05	NS	104.48^{b}	105.39^{b}	139.13^{a}	117.69^{b}	5.48	**	NS
Digested	96.96	106.74	110.64	8.59	NS	84.27^{b}	102.53^{ab}	103.6^{ab}	128.72^{a}	8.89	*	NS
DC	44.99	46.84	47.72	2.69	NS	44.04	48.49	41.46	52.08	2.91	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2**: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significant

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

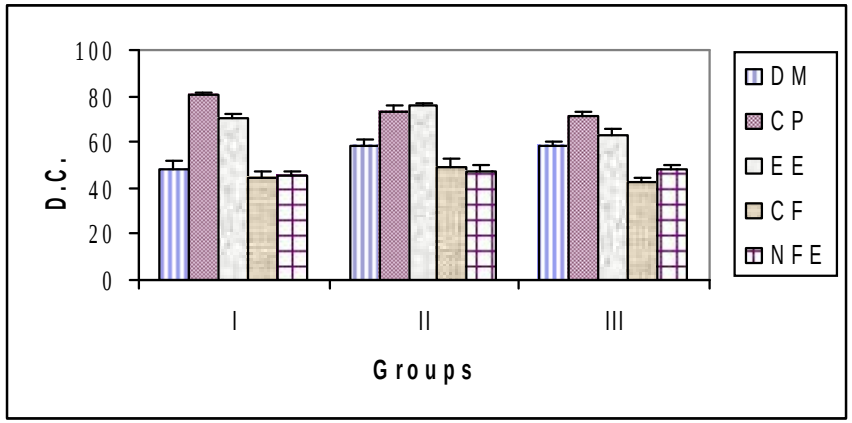
Table 14: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on average fiber intake (g/day) and digestibility coefficient of various groups

Particulars	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB+Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
Neutral detergent fiber												
Intake	337.48	338.19	346.72	13.19	NS	301.32^{c}	323.76^{bc}	378.66^{a}	359.44^{ab}	12.84	**	NS
Voided	168.72	164.4	165.32	8.88	NS	158.17^{b}	150.39^{b}	195.31^{a}	160.73^{b}	8.73	**	NS
Digested	168.76	173.78	181.4	12.65	NS	143.15	173.38	183.35	198.71	13.58	NS	NS
DC	49.77	50.47	51.74	2.71	NS	46.85	53.51	47.49	54.78	3.00	NS	NS
Acid detergent fiber												
Intake	188.89	182.35	185.44	7.75	NS	163.22^{c}	174.38^{bc}	208.02^{a}	196.63^{ab}	7.47	**	NS
Voided	103.9	94.84	107.45	4.95	NS	92.4^{b}	90.86^{b}	115.08^{a}	109.91^{a}	4.90	**	NS
Digested	84.99	87.51	77.99	6.74	NS	70.82	83.52	92.95	86.72	7.45	NS	NS
DC	44.19	47.41	41.52	2.57	NS	42.55	47.79	44.41	42.74	2.93	NS	NS
Hemicellulose												
Intake	149.37	155.84	161.28	5.44	NS	139.43^{c}	149.12^{bc}	170.62^{a}	162.81^{ab}	5.52	**	NS
Voided	64.83^{a}	63.94^{a}	49.75^{b}	5.42	*	53.28^{b}	58.7^{ab}	72.74^{a}	53.32^{b}	6.21	*	*
Digested	84.54^{b}	91.9^{b}	111.53^{a}	6.11	**	86.15	90.42	97.88	109.5	7.47	NS	NS
DC	57.27^{b}	58.55^{b}	68.56^{a}	3.29	*	61.86	60.56	56.48	66.94	4.01	NS	NS
Cellulose												
Intake	130.05	129.98	135.76	4.82	NS	116.61^{c}	125.36^{bc}	149.02^{a}	136.72^{b}	4.36	**	NS
Voided	40.67^{b}	36.30^{b}	50.45^{a}	2.68	**	39.38^{b}	37.12^{b}	49.10^{a}	44.29^{ab}	3.30	*	*
Digested	89.38	93.67	85.31	4.25	NS	77.24^{b}	88.24^{ab}	99.92^{a}	92.43^{a}	5.16	*	NS
DC	67.07^{ab}	72.55^{a}	63.02^{b}	2.04	*	66.04	70.05	66.83	67.27	2.75	NS	NS

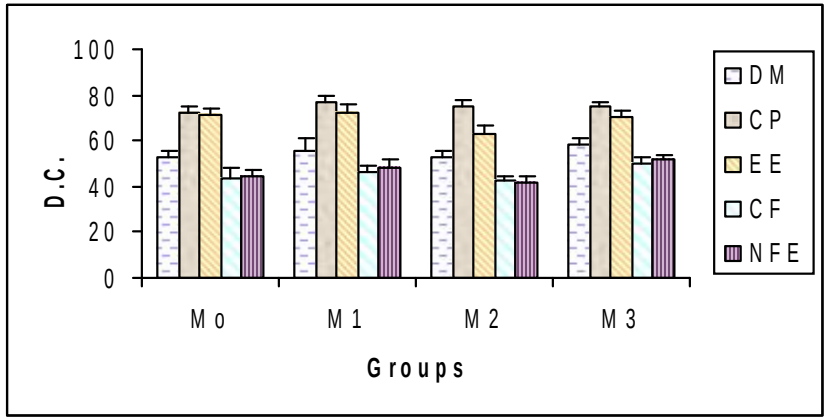
PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

Fig.2: The digestibility coefficient of DM, CP, EE, CF and NEF in the kid of various groups due to UMMB (a) and mineral effect (b)



(a) UMMB effect



(b) Mineral effect

Significant effect was obtained in the digestibility of HC due to effect of UMMB and MUMMB supplementation. It was highest in MUMMB followed by UMMB and lowest in the control. The mineral supplementation and its interaction with UMMB/MUMMB did not affect the HC digestibility.

Significantly higher value was recorded for digestibility of CL due to UMMB than MUMMB. The control was at par with UMMB and MUMMB groups however it was at par with control. Digestibility coefficient was non significant among the groups due to mineral and interaction effect (Fig. 3).

A significant increase in the digestibility of DM, protein, NDF and cellulose was reported by Tiwari *et al.* (1990) in buffalo calves and Jain *et al* (2005) in kids when poor quality roughages were supplemented with UMMB or urea molasses granules. In the present study too a significant increase in the digestibility of nutrients except CF, NFE, NDF and ADF were observed in kids. The Se supplementation (1 ppm) did not make significant change in dry matter and organic matter digestibility in calf (Nicholson *et al*., 1991). A similar report was published by Mudgal *et al.* (2007) and Shinde *et al.* (2008) in buffalo calves where diet was supplemented with 0.3 ppm Se alone or in combination with alpha tocopherol. Also Kumar *et al.* (2009) reported the similar effect on DM, OM, CF, EE, NDF, ADF and hemicellulose digestibilities in lambs. In present study also the mineral supplementation did not affect these parameters in kids.

4.2.3 Balance study

UMMB supplementation exerted highly significant effect among the groups for N, Ca and P balance in kid (Table 15).

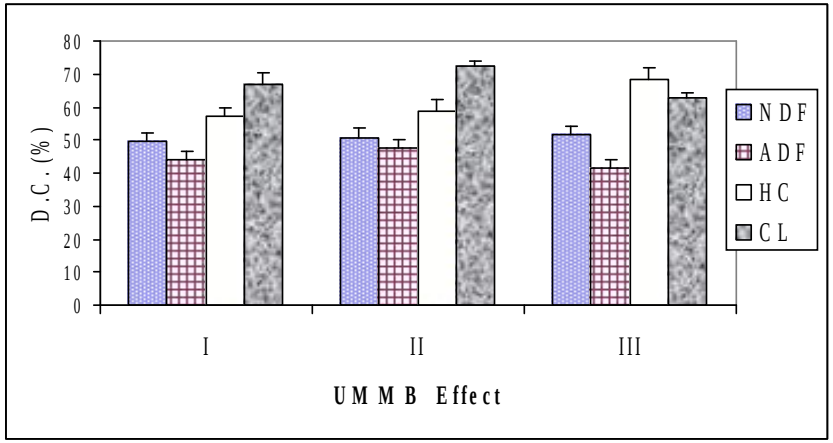
Table 15: The effect of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and sodium selenite on N, Ca and P balance in kids of various groups

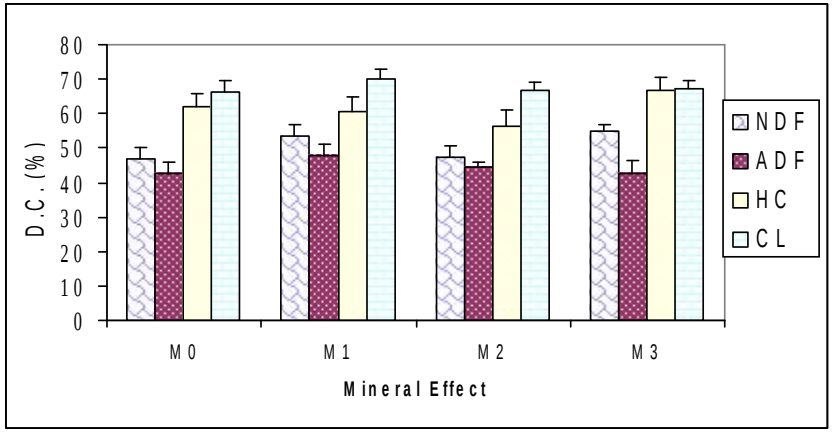
Particulars	UMMB			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB+Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
Nitrogen (g/day)												
Intake	5.26^{c}	7.60^{b}	8.91^{a}	0.34	**	6.07^{b}	7.30^{a}	8.01^{a}	7.64^{a}	0.57	**	NS
Faecal outgo	1.00^{c}	1.96^{b}	2.51^{a}	0.10	**	1.74	1.67	1.96	1.92	0.22	NS	NS
Urinary outgo	0.38^{b}	0.79^{a}	0.80^{a}	0.08	**	0.65	0.57	0.83	0.57	0.10	NS	NS
Balance	3.89^{b}	4.85^{ab}	5.59^{a}	0.38	*	3.68	5.07	5.21	5.15	0.46	NS	NS
Balance (%)	73.2^{a}	62.27^{b}	61.41^{b}	2.83	*	61.67	68.88	64.38	67.59	4.07	NS	NS
Calcium (g/day)												
Intake	6.81^{a}	15.4^{a}	15.40^{a}	0.62	**	11.86	12.06	12.81	13.41	1.42	NS	NS
Faecal outgo	4.98^{a}	2.32^{c}	3.96^{b}	0.29	**	3.09^{b}	3.79^{ab}	4.62^{a}	3.51^{b}	0.44	**	NS
Urinary outgo	0.99^{b}	1.45^{a}	1.54^{a}	0.09	**	1.16	1.42	1.48	1.26	0.12	NS	NS
Balance	0.84^{b}	11.63^{a}	9.90^{a}	0.63	**	7.61	6.86	6.72	8.64	1.64	NS	NS
Balance (%)	12.82^{c}	74.1^{a}	62.24^{b}	2.98	**	52.29	46.22	44.26	56.11	9.06	NS	NS
Phosphorus (g/day)												
Intake	3.94^{c}	7.72^{b}	9.88^{a}	0.44	**	5.93	7.47	7.42	7.91	0.90	NS	NS
Faecal outgo	2.04^{c}	3.08^{b}	4.08^{a}	0.26	**	2.50	3.08	3.49	3.21	0.38	NS	NS
Urinary outgo	0.51^{c}	0.28^{b}	1.06^{a}	0.08	**	0.45	0.59	0.76	0.68	0.13	NS	*
Balance	1.39^{b}	4.36^{a}	4.74^{a}	0.34	**	2.98	3.80	3.17	4.03	0.60	NS	NS
Balance (%)	36.04^{b}	56.28^{a}	46.39^{a}	3.45	**	46.83	49.57	37.00	51.55	4.08	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Fig.3: The digestibility coefficient of NDF, ADF, HC and CL in the kid of various groups due to UMMB and mineral effect





Nitrogen intake (g/day) was significantly (P<0.01) highest for MUMMB followed by UMMB supplemented groups and lowest in control. Balance of N was also highest in group MUMMB. However, UMMB was comparable to both MUMMB and control groups. Mineral supplementation (M_1 – M_3) significantly increased the N intake than control, however, N balance was non significant amongst groups. Though, N intake did not differ significantly amongst mineral supplemented groups. The interactions of UMMB/MUMMB and minerals for N intake and N balance were non significant.

Calcium (g/day) intake and its balance was significantly (P<0.01) higher for both UMMB and MUMMB supplemented groups than control, whereas groups UMMB and MUMMB were comparable to each other. Mineral supplementation had non significant effect on Ca intake and balance and the effect of interaction was also non significant.

Phosphorus intake (g/d) was significantly higher (P<0.01) for MUMMB followed by UMMB and control. P balance was lower in control, whereas UMMB and MUMMB did not differ from each other. The effect of different levels of minerals and their interaction did not differ significantly.

No changes in the mineral balances were obtained in buffalo calves when diets were supplemented with various levels of Se individually or in combination with vitamin E (Shinde *et al.*, 2008; Kumar *et al*., 2009). Though the bioavailability of Zn in lambs was more when the sources of Zn were compared the over all utilization and retention of other minerals were not effected due to the dietary supplementation of Zn (Garg *et al*., 2003). In the present study also group M_o was found at par with the mineral supplemented groups indicating no

Table 16: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on haemoglobin (g/dl) in kids under various groups

Periods (Days)	UMMB effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	6.2	6.53	6.47	0.10	NS	6.45	6.36	6.46	6.34	0.11	NS	NS
30	6.59^{b}	7.92^{a}	7.38^{a}	0.24	**	7.32	7.22	6.96	7.68	0.32	NS	NS
60	8.01	7.9	7.68	0.21	NS	7.5^{bc}	7.41^{c}	8.08^{ab}	8.47^{a}	0.21	**	NS
90	8.61^{c}	9.78^{a}	9.18b	0.20	**	8.68b	9.06b	9.09^{b}	9.93^{a}	0.23	**	NS
Overall	7.35^{c}	8.03^{a}	7.68^{b}	0.11	**	7.49^{b}	7.51^{b}	7.65^{b}	8.11^{a}	0.14	**	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

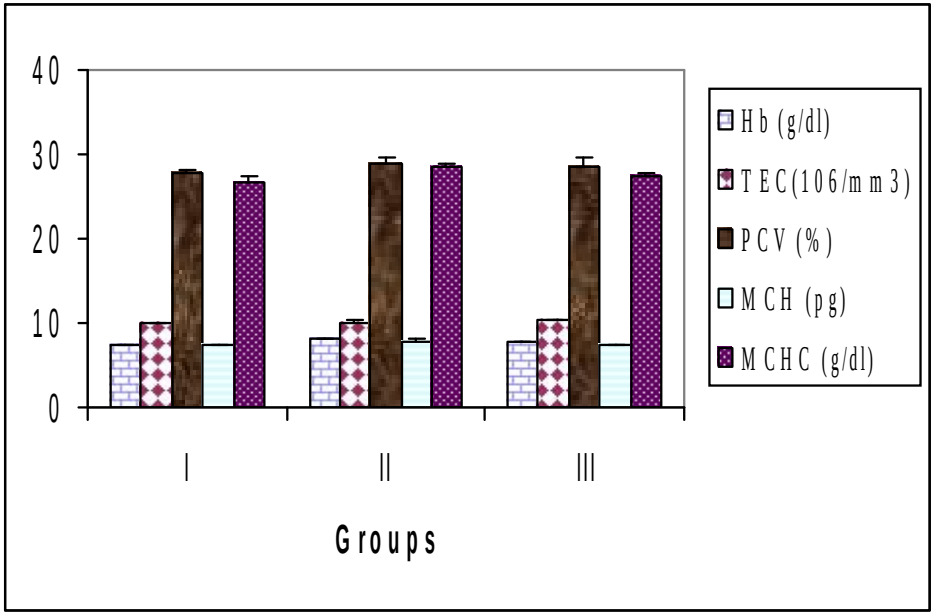
Table 17: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on total erythrocyte count (10^6/mm^3) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	9.25	9.16	9.41	0.07	NS	9.17	9.31	9.27	9.34	0.08	NS	NS
30	9.79^{b}	10.07^{b}	10.48^{a}	0.15	**	9.61^{c}	10.12^{b}	10.14^{b}	10.58^{a}	0.16	**	NS
60	9.66	10.34	10.84	0.30	NS	9.94	9.66	10.94	10.57	0.33	NS	NS
90	10.41^{b}	10.85^{a}	10.94^{a}	0.11	**	10.64^{c}	10.41^{b}	10.88^{ab}	11.00^{a}	0.12	**	NS
Overall	9.92^{c}	10.11^{b}	10.42^{a}	0.08	**	9.84^{c}	9.88^{d}	10.31^{b}	10.37^{a}	0.13	**	**

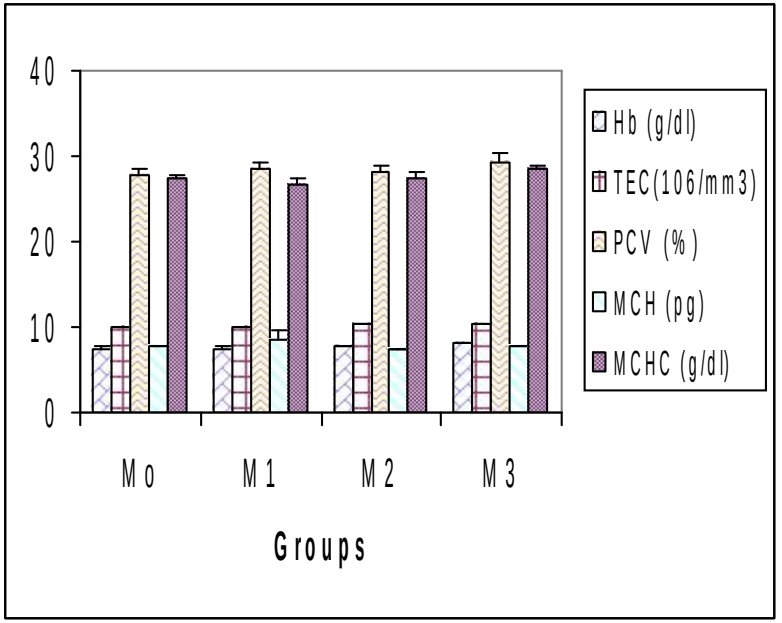
PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Fig.4: The overall haematological (Hb) parameter and RBC (TEC, PCV, MCH and MCHC) in the kid of various groups due to UMMB and mineral affect



(a) UMMB effect



(b) Mineral effect

significant change in the balance study amongst groups except in M_2 where 40 ppm Zn methionine along with 1 ppm of Cr propionate and 1 ppm of sodium selenate supplemented diet reduced the p balance in kids.

4.2.4 Heamatological study

4.2.4.1 Haemoglobin (Hb)

Influence of dietary supplementation of UMMB, Med UMMB, Zn methionine, Cr propionate and Se selenite on haemoglobin under various groups has been presented in table 16.

Significant effect due to UMMB and MUMMB supplementation could be recorded among groups at 30 and 90 days and due to different levels of minerals at 60 and 90 days. At 30 days higher values were observed in UMMB and MUMMB supplemented groups and lower in control. At 60 days highest value was recorded in group M_3 and lowest in group M_1 due to minerals supplementation. However, no significant difference was obtained between groups M_2 and M_3, M_0 and M_2, and M_0 and M_1. On 90 days significant difference was noticed due to the supplementations or due to their interaction. Highest Hb value was recorded in UMMB followed by MUMMB and control group. M_3 resulted higher Hb than M_0, M_1 and M_2 which were non significant among themselves.

UMMB and MUMMB affected the overall Hb concentration when the period was not considered (Fig 4). Highest ($P<0.01$) was noted due to UMMB followed by MUMMB and control. Amongst the mineral supplemented groups M_3 was found to have significantly highest value though other groups did not differ significantly. The interaction also did not differ significantly.

Zhang *et al.* (1998) reported significantly higher Hb in goats with multinutrient blocks and Sanyal and Singh, (1993a) reported higher Hb in calves with med UMMB. In the present study also UMMB individually or in combination with minerals in M_3 significantly increased the Hb levels in kids.

Mineral supplementation also effected significantly the Hb concentrations. Kumar (2008) found a significant increase of Hb in lamb due to Zn supplementation. However Cr supplementation did not effect Hb concentration (Gentry *et al*., 1999) in lambs.

4.2.4.2 Total erythrocyte count (TEC)

Significant difference in TEC was recorded due to block and mineral supplementation at 30 and 90 days (Table 17). However, the interaction was not marked among the groups at any stage of experiments. Significantly ($P<0.01$) highest TEC was recorded in MUMMB supplemented group at 30 days. The other two groups were not significantly different. Among minerals supplemented groups highest value was recorded in group M_3 and lowest in control. At 90 days significantly higher value was recorded in UMMB and MUMMB supplemented groups as compared to control. These two groups did not differ among themselves. Due to minerals supplementation highest value was recorded in M_3 and M_2, and lowest in M_1. However, groups, M_0, M_1 and M_0, M_2 did not differ with each other.

Overall TEC was highest in MUMMB followed by UMMB and control group. On the other hand M_2 and M_3 had higher value followed by M_1 and M_0. Marked effect of interaction was noticed in different groups.

Total erythrocyte counts were significantly increased due to dietary supplementation of med UMMB (Sanyal and Singh, 1993), and Cr (Gentry *et al*., 1999) and Zn (Kumar, 2008) in calves and lambs, respectively. In the present study similar trends of med UMMB and minerals supplementation were recorded in kids.

4.2.4.3 Packed cell volume (PCV)

Influence of dietary supplementation of UMMB, MUMMB, Zn methionine, Cr propionate and Se selenite on packed cell volume have been presented in table 18. Perusal of data revealed significant effect due to UMMB and MUMMB supplementation on 30 and 90 days. The effect due to mineral supplementation was marked on 90 days. However, it was not significant at other period of growth. Highest PCV was recorded in UMMB supplemented group, while other two groups did not differ significantly. On 90 days M_3 and M_2 were significantly ($P<0.01$) higher than M_0 and M_1, however, M_3 and M_2 did not differ from each other. The effect of interaction was ($P<0.05$) significant.

No significant effect was obtained on overall PCV due to UMMB, MUMMB or mineral supplementation or due to their interaction.

A significantly higher values ($P<0.01$) of PCV was recorded in Med-UMMB treated calves in comparison to untreated infected controls (Sanyal and Singh, 1993 a and b). However Cr (Gentry *et al*., 1999) and Zn supplementation did not affect PCV in lambs (Kumar, 2008). In the present study these supplements effect the PCV at 60 days however it did not effect the over all PCV value.

Table 18: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on packed cell volume (%) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	24.95	25.2	25.35	0.19	NS	25.35	25.25	24.9	25.16	0.23	NS	NS
30	26.95^{b}	32.72^{a}	27.47^{b}	1.23	*	28.89	32.21	27.46	27.64	1.74	NS	NS
60	30	27.51	32.63	2.00	NS	28.09	27.77	30.75	33.57	2.07	NS	NS
90	28.98^{b}	29.99^{a}	29.27^{b}	0.28	**	28.52^{b}	29.01^{b}	29.88^{a}	30.25^{a}	0.28	**	*
Overall	27.72	28.85	28.69	0.75	NS	27.71	28.56	28.25	29.16	0.87	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

4.2.4.4 Mean corpuscular heamoglobin (MCH)

Significant effect on MCH value was recorded due to UMMB and MUMMB at 30 and 90 days. Mineral supplementation or interaction effect was recorded only at 90 days (Table 19). Significantly higher value was recorded in UMMB as compared to control and MUMMB groups on 30 and 90 days. On 90 days M_3 resulted highest and control lowest value of MCH. However, M_1 and M_3, and M_0, M_1 and M_2 did not differ themselves.

Overall MCH was significantly higher in UMMB as compared to MUMMB or control. However control and MUMMB did not differ from each other. Group M_3 had highest ($P<0.01$) value among minerals supplemented groups, though it was not significantly different from control. Other groups were non significant than control.

Non significant difference was reported in mean corpuscular hemoglobin in lamb due to dietary supplemental chromium with high protein diet (Gentry *et al*., 1999). In the present study it did not affect at 60 days while significant rise was observed on 30^{th} and 90^{th} days.

4.2.4.5 Mean corpuscular heamoglobin concentration (MCHC)

Significant effect in MCHC values was noted on 90^{th} day due to supplementation and interaction (Table 20). Values of UMMB and MUMMB supplemented groups were significantly ($P<0.01$) higher than control. The level in M_3 was significantly ($P<0.05$) higher than other groups except M_1. Groups M_0, M_1 and M_2 did not differ among themselves.

Table 19: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on mean corpuscular haemoglobin (pg) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	6.71	7.14	6.88	0.12	NS	7.05	6.83	6.98	6.79	0.15	NS	NS
30	6.71^{b}	7.89^{a}	7.05^{b}	0.23	**	7.63	7.16	6.84	7.24	0.30	NS	NS
60	11.22	7.68	7.09	1.27	NS	7.57	11.59	7.42	8.08	1.35	NS	NS
90	8.28^{b}	9.02^{a}	8.41^{b}	0.19	**	8.2^{b}	8.71^{ab}	8.34^{b}	9.03^{a}	0.22	*	*
Overall	7.39^{b}	7.93^{a}	7.36^{b}	0.1	**	7.61^{ab}	8.57^{b}	7.39^{b}	7.78^{a}	0.39	*	**

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 20: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on mean cell haemoglobin concentration (g/dl) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	24.88	25.91	25.55	0.44	NS	25.48	25.19	25.91	25.21	0.53	NS	NS
30	24.51	26.41	26.97	1.31	NS	26.48	24.03	25.52	27.82	1.52	NS	NS
60	27.51	28.73	25.34	1.02	NS	26.75	26.77	27.32	27.93	1.24	NS	NS
90	29.76^{b}	32.63^{a}	31.33^{a}	0.64	**	30.48^{b}	31.23^{ab}	30.4^{b}	32.85^{a}	0.75	*	*
Overall	26.67^{b}	28.42^{a}	27.30^{ab}	0.49	NS	27.29	26.80	27.29	28.45	0.57	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Overall highest MCHC was recorded in UMMB and lowest in control. Group MUMMB was found to be non significant with other groups. Also there was no marked effect due to interaction

Gentry *et al*. (1999) reported non significant difference in mean corpuscular hemoglobin concentration in lamb due to dietary supplemental chromium with high protein diet. No reports are available for the effect of UMMB supplementation in the diet. The finding of present study was in accordance to this report.

4.2.5 Biochemical study

4.2.5.1 Total serum protein

Total serum protein was significantly higher (Table 21) in UMMB and MUMMB supplemented groups at 60 days. At other periods the difference was not significant. Mineral supplementation did not affect the level of serum protein at any period of growth; however, interaction affected it at 30 and 60 days.

When serum protein level was considered as whole irrespective of periods no significant difference was obtained amongst the groups due to the supplementation, however, effect of interaction was marked (Fig 5).

Jain *et al.* (2005) reported that feeding of urea molasses mineral block increased total serum protein in kids. Pechova *et al*. (2002) in bull and Kumar (2008) in lambs obtained a significantly higher concentration of total blood plasma proteins due to dietary supplementation of chromium in diet. However Kitchalong *et al*. (1995) reported no significant change due to Cr-Picolinate and Haldar *et al.* (2007) due to Cr chloride and Cr yeast supplementation in the diet of goats. In another study no significant change in the serum protein levels found

Table 21: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on total serum protein (mg/dl) in kids

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	5.32	5.24	5.78	0.32	NS	4.86	5.1	5.77	6.06	0.35	NS	NS
30	5.65	5.98	5.45	0.38	NS	5.04	5.62	5.64	6.47	0.40	NS	*
60	6.43^{b}	5.23^{a}	6.5^{a}	0.28	**	6.1	5.91	6.09	6.12	0.35	NS	**
90	5.95	5.1	5.58	0.47	NS	5.21	5.43	5.57	5.97	0.55	NS	NS
Overall	5.84	5.39	5.83	0.25	NS	5.35	5.48	5.56	6.15	0.26	NS	*

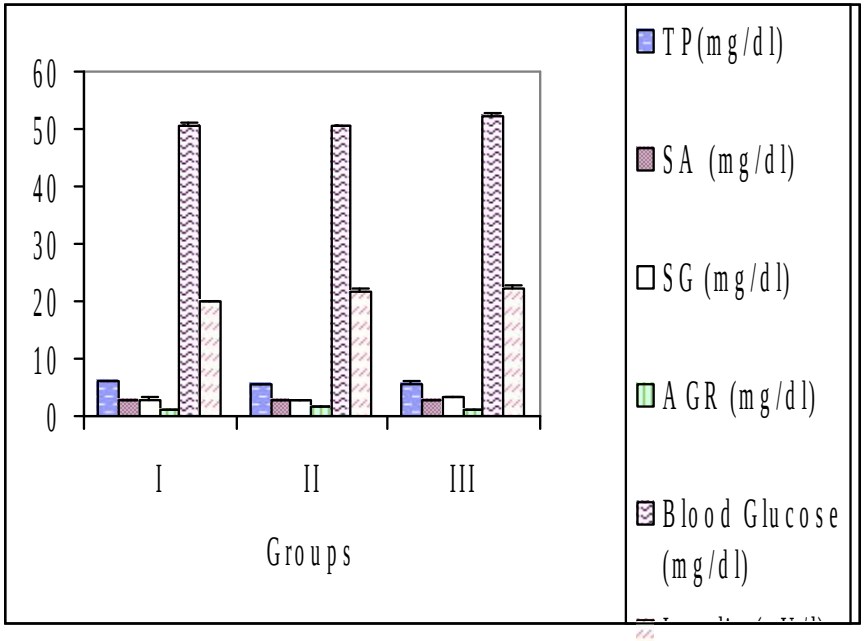
PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 22: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on total serum albumin (mg/dl) in kids under various groups

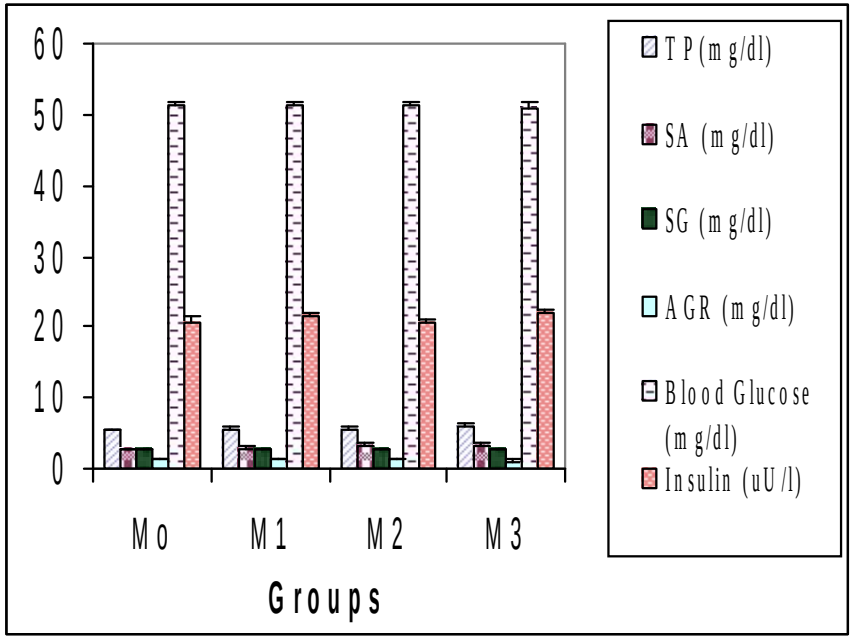
Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	2.29	2.49	2.41	0.06	NS	2.27	2.39	2.44	2.5	0.07	NS	NS
30	2.51	2.64	2.48	0.08	NS	2.6	2.64	2.47	2.46	0.10	NS	NS
60	3.42^{a}	2.96^{b}	3.71^{a}	0.12	**	3.47^{a}	3.04^{a}	3.36^{ab}	3.59^{a}	0.16	*	NS
90	3.03	2.53	2.42	0.24	NS	2.73	2.78	2.37	2.76	0.28	NS	NS
Overall	2.82	2.65	2.76	0.07	NS	2.54	2.80	3.11	3.33	0.23	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Fig. 5: The overall total protein (TA), serum albumin (SA), serum globulin (SG), albumin: globulin ratio (AGR), blood glucose and insulin in the kid of various groups due to UMMB (a) and mineral effect (b)



(a) UMMB effect



(b) Mineral effect

when diet was supplemented with 19 to 26 ppm Zn (Pond (1983), and 20, 100, and 200 ppm Zn (Malcolm-Callis *et al*.(2000), respectively in Columbia and Suffolk lambs and goat. Similar findings were recorded by earlier workers (Spears *et al*., 2004; Wang *et al*., 2006) in goats and lambs (Ozcel *et al*., 2001). In the present study too the levels of total serum protein was not affected due to UMMB or med UMMB supplementation in the diet however it was significantly increased at 60 days. The levels of Cr, Zn and Se individually or their interaction with the above supplement in the diet also did not effect the levels of serum protein in kids.

4.2.5.2 Serum albumin

Serum albumin level differed significantly at 60 days due to effect of UMMB/MUMMB and mineral (Table 22). However, it was non significant at other periods. No interaction effect was recorded in kids at different periods. Level of serum albumin was lower in UMMB than control or MUMMB supplemented groups. It was significantly higher in M_0 and M_3, as compared to M_1, however, these were non significant. M_2 was comparable to all groups.

Overall serum albumin was not affected due to the supplementation and also due to their interaction.

Though the supplementation of UMMB in the diet significantly increased the levels of serum albumin in the kids (Jain *et al.*, 2005), the supplementation of Cr (Kitchalong *et al*., 1995; Uyanik,2001) in lambs and goats, and Zn (Pond,1983) in lambs did not affect its level in serum. In the current study UMMB individually and in combination with minerals in M3 affected the levels of serum protein on 60^{th} day while it did not affect the levels in the remaining periods.

4.2.5.3 Serum globulin

No significant difference was obtained due to supplementation of UMMB/MUMMB and minerals, however, their interaction was highly significant (Table 23).

The supplementation of UMMB in kids (Jain *et al.*, 2005) and Cr in lambs (Kumar, 2008) increased the levels of serum globulin while no effect has been recorded in the present investigation.

4.2.5.4 Blood glucose

Marked effect of interaction was noticed on blood glucose concentration. Also the effect was significant at 30 and 60 days due to UMMB and at 60 and 90 days due to minerals supplementation (Table 24). Blood glucose concentration was highest in MUMMB supplemented group followed by UMMB and control at 30 days. At 60 days UMMB had lower value as compared to other two groups which were non significant with each other. Among minerals supplemented groups, M_3 had lower value than M_0 and M_1, however, M_0 and M_1 were not significant on 60^{th} day. On 90^{th} day M_0 had significantly higher value as compared to mineral supplemented groups. The interaction due to two effects was significant at 30, 60 and 90 days.

Overall blood glucose was significantly higher ($P<0.01$) in MUMMB supplemented group than other groups which did not differ significantly among themselves. Mineral supplementation did not differ significantly amongst groups. Also their effect of interaction was not significant.

Jain *et al.* (2005) reported that feeding of urea molasses mineral block increased the blood glucose in kids. The supplementation of Cr in the diet of goats

Table 23: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on total serum globulin (mg/dl) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	3.03	2.76	3.36	0.30	NS	2.59	2.71	3.34	3.56	0.34	NS	NS
30	3.14	3.34	2.97	0.40	NS	2.44	2.98	3.17	4.01	0.43	NS	NS
60	3.01	2.27	2.79	0.26	NS	2.64	2.87	2.73	2.53	0.31	NS	**
90	2.92	2.58	3.16	0.37	NS	2.48	2.65	3.2	3.22	0.43	NS	NS
Overall	3.03	2.74	3.07	0.22	NS	2.79	2.69	2.68	2.81	0.06	NS	**

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 24: Changes in blood glucose (mg/dl) concentrations due to dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite in kids

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	46.19	46.44	46.63	1.03	NS	46	45.42	46.17	45.42	1.95	NS	NS
30	48.63^{c}	51.75^{b}	54.13^{a}	2.14	**	50.42	52.33	52	51.25	4.12	NS	*
60	53.69^{a}	49.75^{b}	53.13^{a}	2.05	**	53.25^{a}	53.33^{a}	51.58^{ab}	50.58^{b}	3.42	*	**
90	55.25	55.31	56.38	1.55	NS	55.42^{ab}	54.33^{b}	55.92^{b}	56.92^{a}	2.23	**	*
Overall	50.81^{b}	50.49^{b}	52.35^{a}	0.31	**	51.27	51.35	51.42	51.04	0.45	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

did not effect the glucose concentration (Hayirli *et al*., 2001) except on 55th day of experiment (Uyanik (2001). Zn supplementation also did not affect the blood glucose level (Wang *et al*., 2006) in goats. In the present investigation UMMB increased the blood glucose while mineral did not affect its levels. In other studies it was found significantly reduced (Haldar *et al.*, 2007; Kumar, 2008).

4.2.5.5 Insulin

Significantly higher level of insulin was recorded due to supplementation of UMMB and MUMMB at 60 days as compared to control (Table 25). Under mineral supplemented groups M_0 and M_1 had significantly higher level than M_2 and M_3 though these were non significant from each other. The effect of interaction was also not marked. With respect to overall insulin value, lowest was recorded in control. Other two supplemented groups (UMMB/MUMMB) did not differ significantly. Similarly effect of interaction was not significant.

The levels of insulin were significantly increased in the Cr supplemented diet. The level of zinc was also improved accordingly (Kang, 2002). In the present investigation the level of insulin was increased due to UMMB supplementation however mineral supplementation did not affect it.

4.2.5.6 Albumin:globulin ratio

Non significant effect on albumin globulin ratio was recorded at all stages of growth due to supplementation of block and mineral in the basal diet but the effect of interaction was significant at 60 days. Overall albumin:globulin ratio was not affected due to the supplementation. However, effect of interaction was noticed significantly (Table 26). The increased trend was reported by Jain *et al.* (2005) in kids.

Table 25: Changes in insulin (uU/l) concentrations due to dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite in kids

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	15.38	13.44	15.06	0.65	NS	14.08	14.75	15.58	14.08	0.76	NS	NS
30	23.38	25.25	26.81	0.65	NS	24.08	24.42	25.75	26.33	0.83	NS	NS
60	19.38^{b}	26^{a}	25^{a}	0.76	**	24.33^{a}	25.92^{a}	21.83^{b}	21.75^{b}	1.15	**	NS
90	21.25	21.56	21.69	1.63	NS	20.67	20.92	19	25.42	1.69	NS	NS
Overall	19.84^{b}	21.56^{a}	22.14^{a}	0.42	**	20.79	21.50	20.54	21.90	0.54	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 26: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on albumin:globulin ratio (mg/dl) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	0.96	1.1	0.98	0.18	NS	1.18	1.02	1.09	0.75	0.18	NS	NS
30	0.94	1.42	1.56	0.29	NS	1.39	1.23	1.61	1	0.37	NS	NS
60	1.32	1.77	1.53	0.21	NS	1.59	1.36	1.68	1.54	0.25	NS	**
90	1.3	1.5	1.03	0.27	NS	1.3	1.73	0.99	1.09	0.30	NS	NS
Overall	1.13	1.45	1.28	0.13	NS	1.36	1.34	1.34	1.10	0.16	NS	*

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

4.2.5.7 Alkaline phosphatase activity

Significant effect of UMMB and MUMMB was recorded at 90 day as compared to control (Table 27). The UMMB and MUMMB groups did not differ from each other. No significant change was recorded in the alkaline phosphatase activity due to supplementation of different levels of Zn, Cr and Se in the basal diet. However, there was marked effect of interaction on 60 day. Paul *et al*. (2005) and Kumar (2008) in lamb found higher alkaline phosphatase activity in the chromium supplemented bucks because, Cr augmented new bone crystal formation by enhancing the uptake of circulatory Ca into the bone matrix.

Pond (1983) in lambs and Spears *et al*. (2004) in ewes reported no effect on normal plasma concentrations of alkaline phosphatase activity between zinc supplemented group and control. However, Zali *et al*. (2008) and Kumar (2008) reported that it was significantly ($P<0.05$) higher in Zn supplemented groups. In the present investigation there was increase in activity of alkaline phosphatase in the UMMB supplemented group, however, no significant difference was obtained due to supplementation of minerals.

4.2.6 Mineral study

MUMMB supplemented group had lower serum zinc on 90^{th} day as compared to control and UMMB supplemented group (Table 28 and Fig 6). No significant effect was noted at other periods. Minerals supplementation did not affect the Zn concentration in kids. However, marked effect on interaction was observed on 90^{th} day. Overall Zn value was not affected significantly due to the supplementation. Also their effect of interaction was not marked.

Table 27: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on alkaline phophatase activity (IU/100 ml) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	99.53	99.04	100.45	1.21	NS	98.96	99.7	97.7	102.34	1.22	NS	NS
30	109.88	111.42	113.95	5.36	NS	103.51	118.17	108.63	116.69	5.40	NS	NS
60	109.4	116.71	126.75	6.20	NS	111.69	127.15	106.67	124.96	7.08	NS	*
90	95.47^{b}	145.81^{a}	138.1^{a}	8.23	**	129	123.06	131.72	122.06	11.51	NS	NS
Overall	103.57^{b}	118.25^{a}	119.81^{a}	2.88	**	110.79	117.02	111.18	116.51	3.86	NS	NS

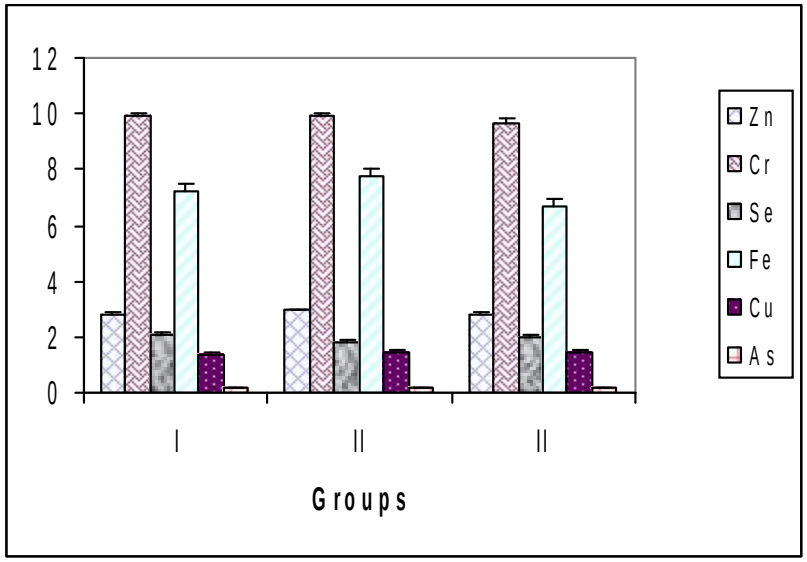
PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 28: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on serum zinc (ppm) in kids under various groups

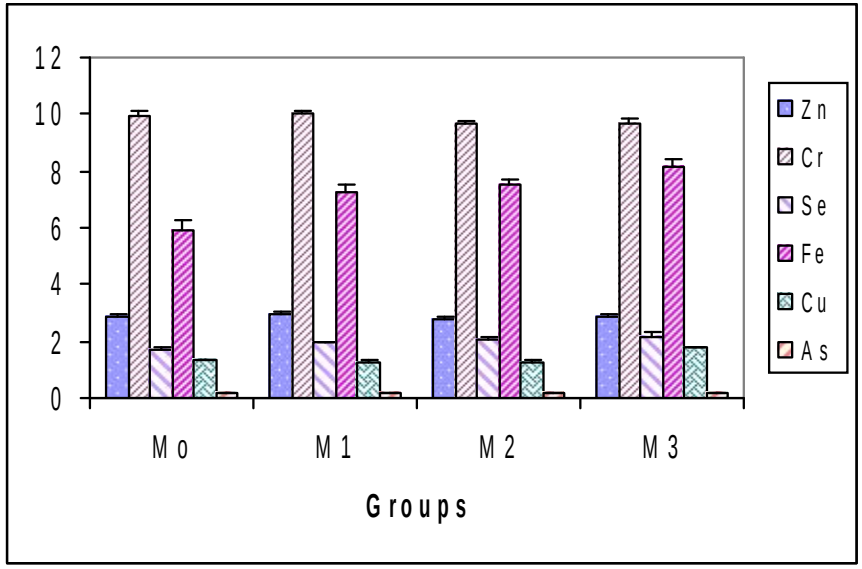
Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	1.55	1.36	1.41	0.05	NS	1.59	1.39	1.33	1.44	0.06	NS	NS
30	3.05	2.92	2.6	0.12	NS	2.88	2.84	2.94	2.76	0.19	NS	NS
60	2.85	3.39	3.94	0.26	NS	3.23	3.3	2.88	3.8	0.28	NS	NS
90	3.75^{a}	4.07^{a}	3.21^{b}	0.16	**	3.72	3.92	3.85	3.38	0.20	NS	*
Overall	2.80	2.94	2.79	0.09	NS	2.86	2.92	2.75	2.85	0.1	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Fig. 6: The overall serum Zn, Cr, Se, Fe, Cu and As concentrations (ppm) in the kid of various groups due to UMMB (a) and mineral effect (b)



(a) UMMB effect



(b) Mineral effect

Garg *et al*. (2003) and Kumar *et al.* (2003) reported higher levels of zinc in the serum of goats on Zn supplemented diet as compared to the control. Similar findings were observed in the present investigation. The effect of interaction of minerals was established by several workers. Paul *et al*. (2005) found in the bucks Zn concentration increased due to Cr supplementation though it was dose dependent. Spears *et al*. (2004) reported that, plasma Zn concentrations were significantly higher for the supplemented groups as compared to the control group.

Pond (1983) also reported 19 to 26 ppm Zn did not had significance difference in plasma concentrations of Zn in Columbia and Suffolk lambs. Ozcel *et al.* (2001) observed no significant change on Zn serum level in lambs due to supplementation of zinc bacitracin.in the basal diet. Also Zali *et al* (2008) and Kumar (2008), reported non significance difference in concentration of Zn between Zn supplemented and control ewes. The present investigation was in accordance to these reports.

No significant effect due to supplementation of UMMB/MUMMB and minerals (Zn, Cr and Se) was recorded on serum Cr level (table 29). However; the interaction effect of the two was significant on 30^{th} day. Overall Cr value was not affected significantly due to the supplementation. Also their effect of interaction was not marked (Fig 7 and 8). Earlier workers (Uyanik, 2001; Paul, 2005 and Pechova *et al*., 2002) also did not report any significant change in the values of Cr in lambs and dairy cows. However, it was reported by Kumar (2008) higher than control in lamb.

Table 29: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on serum chromium (ppm) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	9.68	10.15	9.79	0.14	NS	9.72	10.1	9.83	9.86	0.17	NS	NS
30	9.89	9.82	9.56	0.20	NS	9.79	9.93	9.69	9.58	0.23	NS	*
60	9.35	9.63	9.18	0.28	NS	9.54	9.61	9.34	8.96	0.34	NS	NS
90	10.65	10.05	10.09	0.30	NS	10.81	10.19	9.72	10.3	0.33	NS	NS
Overall	9.89	9.92	9.66	0.12	NS	9.97	10.00	9.64	9.68	0.13	NS	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 30: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on serum selenium (ppm) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	1.29	1.03	1.3	0.06	NS	1.13	1.09	1.26	1.36	0.08	NS	NS
30	2.22^{a}	1.86^{a}	2.46^{b}	0.14	**	1.96^{c}	2.18^{b}	1.96^{b}	2.62^{a}	0.17	**	**
60	1.75^{a}	1.55^{a}	2.4^{b}	0.16	**	1.51^{b}	1.7^{a}	2.37^{a}	2.01^{a}	0.18	**	NS
90	2.88^{b}	2.77^{a}	1.96^{ab}	0.20	*	2.1^{b}	2.74^{ab}	2.68^{ab}	2.64^{a}	0.26	*	NS
Overall	2.04^{a}	1.80^{b}	2.03^{a}	0.08	*	1.68^{b}	1.93^{a}	2.07^{a}	2.16^{a}	0.08	**	**

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance
Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Serum Se level was significantly affected due to supplementation of either UMMB/MUMMB or minerals throughout the experimental period (Table 30). On 30^{th} and 60^{th} day Se level in control and UMMB supplemented groups were significantly higher than MUMMB. In mineral supplemented groups highest ($P<0.01$) value was recorded in group M_3 and lowest in group M_0 on 30^{th} day, however, difference between M_1 and M_2 was non significant. At 60^{th} day the level of Se was significantly lower ($P<0.01$) in control as compared to other groups. Other groups were non significantly different amongst themselves. On 90^{th} day highest value was recorded in UMMB followed by control, though MUMMB was comparable to both control and UMMB. Among mineral supplemented groups lower value ($P<0.01$) was recorded in control as compared to M_3. Other groups were non significant among themselves. Effect of interaction of the two supplements was significant at 30 day however, at other periods it was not marked. Overall Se level was significantly affected due to the both type of supplementations and also due to their interaction. It was recorded to be lowest in UMMB supplemented group, control and MUMMB being at par and did not differ significantly. Among mineral supplemented groups lowest value was measured in control. The other three groups were not affected significantly.

Influence of dietary supplementation of UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite on serum iron has been presented in table 31. Perusal of the table reveals significant effect due to UMMB at 30 and 90 day and at all periods of growth due to minerals supplementation. At 30 day highest value was recorded in control group, which was similar to UMMB group and lowest in MUMMB supplemented group. At 90 days the value in control was

lower as compared to UMMB/MUMMB supplemented groups. However UMMB/MUMMB were similar to each other. Highest value was recorded in M_3 as compared to other mineral supplemented groups. The interaction effect at 30 day was found to be significant, while it was non significant at other periods. With regards to overall value of Fe, highest level was noted in UMMB groups. The other two groups were non significant. Among mineral supplemented groups highest value was obtained in group M_3. Fe level was lowest in control while M_1 and M_2 did not vary significantly with each other. In contrary, Paul *et al*. (2005) found that neither the intake nor the apparent absorption of Fe in the bucks was affected by Cr supplementation. Similarly Zali *et al.* (2008) reported Fe concentration did not differ ($p>0.05$) between ewes supplemented with sulfate zinc and control ewes.

Significant effect on serum Cu concentration was observed due to UMMB as well as different levels of mineral supplementation as presented in table 32. At 30 day of trial UMMB supplemented group was recorded to have lower value as compared to two other groups. Which were non significant with each other. Among mineral supplemented groups M_3 was recorded to have significantly highest value of 1.67 ppm serum Cu as compared to other groups. There was marked effect of interaction due to two supplements at 30 and 60 days. At 60 day UMMB supplemented group was having significantly higher value ($P<0.01$) as compared to other two groups. Highest value among mineral supplemented group was observed in group M_3 and lowest in control. However, the difference among M_0, M_1 and M_2 was not significant. Significantly lower value was recorded in control, though the difference was significant as compared to M_1. The effect of

interaction of the two effects was again significant at this stage. At 90 day of trial significantly lower serum copper value ($P<0.01$) could be obtained in MUMMB supplemented group as compared to control and UMMB. The effect due to mineral supplementation as well due to interaction was not significant on 90^{th} day.

With regard to overall value of Cu, highest level was noted in UMMB supplemented groups, other two groups being non significant. Among mineral supplemented groups highest value was observed in M_3. Non significant difference was noted for groups M_0, M_1 and M_2. Though, individual effect of Cr on serum Cu level was non significant (Paul *et al*., 2005) in goat. However Pechova *et al.* (2002) demonstrated significantly lower level of Cu on Cr supplemented diet than control in dairy cows. The dietary supplementation of Zn in ewe significantly increased the zinc concentration in the serum (Zali *et al.*, 2008) as also observed in the present investigation.

The effect of UMMB supplementation on serum arsenic level was significant at 60 and 90 days while it was significant only at 60 day due to mineral supplementation (Table 33). The effect of their interaction was also marked at 60 day of trial. At other periods the effects were non significant.

Significantly higher value of serum As was recorded in control as compared to both UMMB and MUMMB supplemented groups. Significantly lowest value of serum As was recorded in group M_1 among mineral supplemented groups however, the difference was non significant when compared with group M_3. The serum arsenic value was lowest in group M_1 than group M_0 and M_1, though these groups did not differ significantly while group M_3 was comparable

Table 31: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on serum iron (ppm) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	5.76	5.3	5.5	0.16	NS	5.65	5.39	5.84	5.21	0.19	NS	NS
30	8.76^{a}	8.55^{a}	7.48^{b}	0.45	**	6.85^{b}	7.62^{b}	8.05^{b}	10.27^{a}	0.40	**	*
60	8.88	9.41	7.16	0.43	NS	6.27^{b}	8.87^{b}	9.14^{b}	9.41^{a}	0.46	**	NS
90	5.35^{b}	7.68^{a}	6.63^{a}	0.62	*	4.92^{b}	6.67^{b}	6.88^{b}	7.82^{a}	0.71	**	NS
Overall	7.19^{b}	7.74^{a}	6.69^{b}	0.28	**	5.92^{c}	7.25^{b}	7.48^{b}	8.18^{a}	0.25	**	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 32: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on serum copper (ppm) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB +Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	1.22	1.26	1.14	0.03	NS	1.27	1.23	1.17	1.17	0.04	NS	NS
30	1.4^{a}	1.38^{b}	1.54^{a}	0.03	**	1.41^{b}	1.33^{b}	1.34^{b}	1.67^{a}	0.04	*	*
60	1.36^{b}	1.39^{a}	1.37^{a}	0.06	**	1.25^{c}	1.26^{bc}	1.28^{b}	1.69^{a}	0.05	**	**
90	1.33^{a}	1.88^{a}	1.78^{b}	0.20	**	1.34	1.32	1.39	2.59	0.18	NS	NS
Overall	1.33^{b}	1.48^{a}	1.46^{a}	0.07	*	1.32^{b}	1.29^{b}	1.30^{b}	1.78^{a}	0.05	**	NS

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, $\mathbf{M_0}$: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), $\mathbf{M_1}$: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) $\mathbf{M_2}$: Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) $\mathbf{M_3}$:Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

to all other groups due to mineral supplementation. Interaction due to both effects was significant at 30 and 60 days of trial except at 90 day.

In respect to overall value of As for entire period, highest value was recorded in control. The other two UMMB supplemented groups were non significant. Groups M_0 and M_3 had higher value as compared to M_1 and M_2 due to mineral supplementation. M_0 and M_3 were non significant from each other.

4.2.7 Nutritional plane of kids

Influence of dietary supplementation of UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite on plane of nutrition and nutritive value of diets have been presented in table 34.

There was significant change in DMI by kids due to dietary supplementation of UMMB, MUMMB and different levels of Zn, Cr and Se in the diet. It was significantly higher in MUMMB/UMMB as compared to control which was 5.83-5.93 kg/100 kg body weight as against 5.66 kg/100 kg body in control. The differences were highly significant. Similar is the case with the mineral supplemented groups where high DM intake was observed in M_3 (6.09 kg/100 kg body weight) which was higher with M_1 and M_2, Mo being the lowest one. Here also the differences were highly significant ($P<0.01$). However, the interaction were non significant. With regards to CP intake the values were significantly higher in MUMMB followed by UMMB and lowest in control. The intake in supplemented groups ranges from 1.17 -1.37 kg /100 kg body as against 0.84 kg/100 body weight in control though the differences were non significant either due to mineral supplementation or due to interaction. The higher intake of CP has drastically reflected the DCP intake in MUMMB and UMMMB groups as

Table 33: Influence of dietary supplementation of UMMB, Med-UMMB, Zn methionine, Cr propionate and Sodium selenite on serum arsenic (ppm) in kids under various groups

Periods (Days)	UMMB Effect			SEM	Sig.	Mineral effect				SEM	Sig.	Interaction (UMMB + Mineral)
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)			M_0	M_1	M_2	M_3			
0	0.17	0.17	0.16	0.01	NS	0.17	0.17	0.18	0.17	0.01	NS	*
30	0.18	0.18	0.17	0.01	NS	0.19	0.17	0.17	0.18	0.01	NS	*
60	0.19^{a}	0.16^{b}	0.17^{b}	0.01	**	0.18^{a}	0.16b	0.18^{a}	0.17^{ab}	0.01	*	**
90	0.2^{a}	0.18^{b}	0.17^{b}	0.01	**	0.19	0.19	0.16	0.2	0.01	NS	NS
Overall	0.18^{a}	0.17^{b}	0.17^{b}	0.01	**	0.18^{a}	0.17^{b}	0.17^{b}	0.18^{a}	0.01	*	**

PC: Positive control, **UMMB** :Urea molasses mineral block, **MUMMB**: Medicated urea molasses mineral block, **M_0**: Zn Methionine (0 ppm), Cr propionate (0ppm) and sodium selenite (0 ppm), **M_1**: Zn methionine (20 ppm), Cr propionate (0.5ppm) and sodium selenite (0.5ppm) **M_2** : Zn methionine (40ppm), Cr propionate (1ppm) and sodium selenite (1ppm) **M_3** :Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5 ppm), **Sig**: Significance, **NS**: Non significance

Means^{abcd} having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

compared to control. The DCP intake was highest in MUMMB followed by UMMB and lowest in control group. Though the minerals did not affect the CP intake however it affected the DCP intake at significant level. It was highest in M_2 however $M_{0,}$ M_1 and M_3 were at par though M_1 to M_3 did differ significantly. The TDN intake /100 kg body weight was highly significant due to the mineral supplementation in $M_{3,}$ however, it was not affected due to UMMB or MUMMB. The interaction was also non significant. The CP content of diet was worked out and it varied from 16.17 % in control to 24.42 % in UMMB/MUMMB supplemented groups. In minerals supplemented groups the levels were constant and equal to UMMB and MUMMB groups. The similar trend followed for DCP though it was higher in mineral supplemented groups. The diet contained maximum TDN of 61.13 % in M_3 and lowest in M_2 however it was similar in UMMB or MUMMB supplemented groups.

4.2.8 Economics

The economics of raising kids with different types of diets supplemented with UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite have been given in table 35. Higher expenditure incurred in the UMMB and MUMMB supplemented groups than control, however, the income received in UMMB group was higher than the control and MUMMB. It has been reflected by maximum net profit in UMMB (Rs 9.07/kg live weight). Similarly amongst the mineral supplemented groups maximum net profit was received in M_3 (Rs. 6.39/kg) where the supplemental Zn methionine, Cr propionate and sodium selenite were 60, 1.5 and 1.5 ppm respectively.

Table 35: Economics of raising kids on different diets

Particulars	UMMB effect			Mineral effect			
	I (PC)	II (PC+UMMB)	III (PC+MUMMB)	M_0	M_1	M_2	M_3
DMI (g/d)	415.68	402.86	499.38	396.03	422.31	461.01	477.87
Total DMI (kg)	37.41	36.26	44.94	35.64	38.01	41.49	43.01
Cost of feed (Rs/kg)	4.2	4.5	4.6	4.3	4.6	4.6	4.6
Total feed cost (Rs)	157.13	163.16	206.74	153.26	174.84	190.86	197.84
Total Gain (kg)	4.02	4.56	4.88	3.51	4.5	4.78	5.15
Live weight cost (Rs)	180.9	205.2	219.6	157.95	202.5	215.1	231.75
F: Gain	9.57	8.28	9.52	10.44	8.66	8.93	8.47
Feed cost/kg meat (Rs)	40.194	37.26	43.792	44.892	39.836	41.078	38.962
Profit / Loss (Rs)	23.77	42.04	12.86	4.69	27.66	24.24	33.91
Cost of Dewormer (Rs)	0.7	0.7	1	1	1	1	1
Total expenditure (Rs)	157.83	163.86	207.74	154.26	175.84	191.86	198.84
Net profit / loss (Rs)	23.07	41.34	11.86	3.69	26.66	23.24	32.91
Profit / kg meat(Rs)	5.74	9.07	2.43	1.05	5.93	4.86	6.39

4.3 Adult non pregnant goats

4.3.1 Dry matter intake (DMI)

DMI was significantly different amongst the groups throughout the experiment (30 days) as presented in table 36. Significantly highest intake was recorded in group IV having soy deoiled cake followed by groups V, III, II, VI and NC. However during 8-14 and 15-21 days groups II and III and during 22-30 days group II was non significantly different from groups III and VI.

Dry matter intake (kg/100 kg body weight) for 7, 14, and 21 days was highest for group IV and lowest for NC (Table 37). However, difference between groups IV and V was found to be non significant. Also on comparison of groups II and III as well as groups II and VI the difference was non significant. Significant difference could also not be obtained between III and V. On 30^{th} day of trial dry matter intake was significantly lowest for NC and highest in group IV. No significant difference was recorded among the groups II, III and VI. Group V was similar to all the groups except control.

Dry matter intake (g/kg $W^{0.75}$) for 7 days was highest for group IV and lowest for NC (Table 38). However, difference between groups IV and V was found to be non significant. Also on comparison of groups II and III as well as group II and group VI the difference was non significant. Significant difference could not be obtained between III and V. On 14 days it was significantly higher for group IV and V and lower for NC. Significance difference could not be established either between control and maize supplemented groups or between control and MUMMB supplemented groups. On 21 days of trial, significantly higher value was observed in group IV followed by V, III, VI and NC. Difference

Table 36: The mean dry matter intake (g/d) in adult non pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC +M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0 - 7	329.70^{f}	536.99^{d}	555.22^{c}	643.00^{a}	600.89^{b}	512.70^{e}	5.71	**
8-14	344.29^{e}	570.95^{c}	578.27^{c}	687.47^{a}	635.53^{b}	537.56^{d}	6.15	**
15-21	350.00^{e}	598.98^{c}	608.99^{c}	729.30^{a}	667.71^{b}	574.03^{d}	5.04	**
22-30	364.69^{c}	622.96^{b}	637.39^{b}	793.04^{a}	730.07^{ab}	606.29^{b}	34.41	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abcdef} having different superscripts in row differ significantly ** (P<0.01)

Table 37: The mean dry matter intake (kg/100 kg body weight/d) in adult non pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0 - 7	2.51^{c}	4.01^{cd}	4.26^{bc}	4.82^{a}	4.57^{ab}	3.82^{d}	0.13	**
8-14	2.59^{d}	4.27^{c}	4.38^{bc}	5.09^{a}	4.77^{ab}	3.95^{c}	0.15	**
15-21	2.61^{d}	4.37^{c}	4.57^{bc}	5.33^{a}	4.96^{ab}	4.14^{c}	0.14	**
22-30	2.72^{c}	4.56^{b}	4.79^{b}	5.80^{a}	5.41^{ab}	4.33^{b}	0.28	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abcdef} having different superscripts in row differ significantly ** (P<0.01)

Table 38: The mean dry matter intake (g/kg $W^{0.75}$/d) in adult non pregnant goats of Different groups

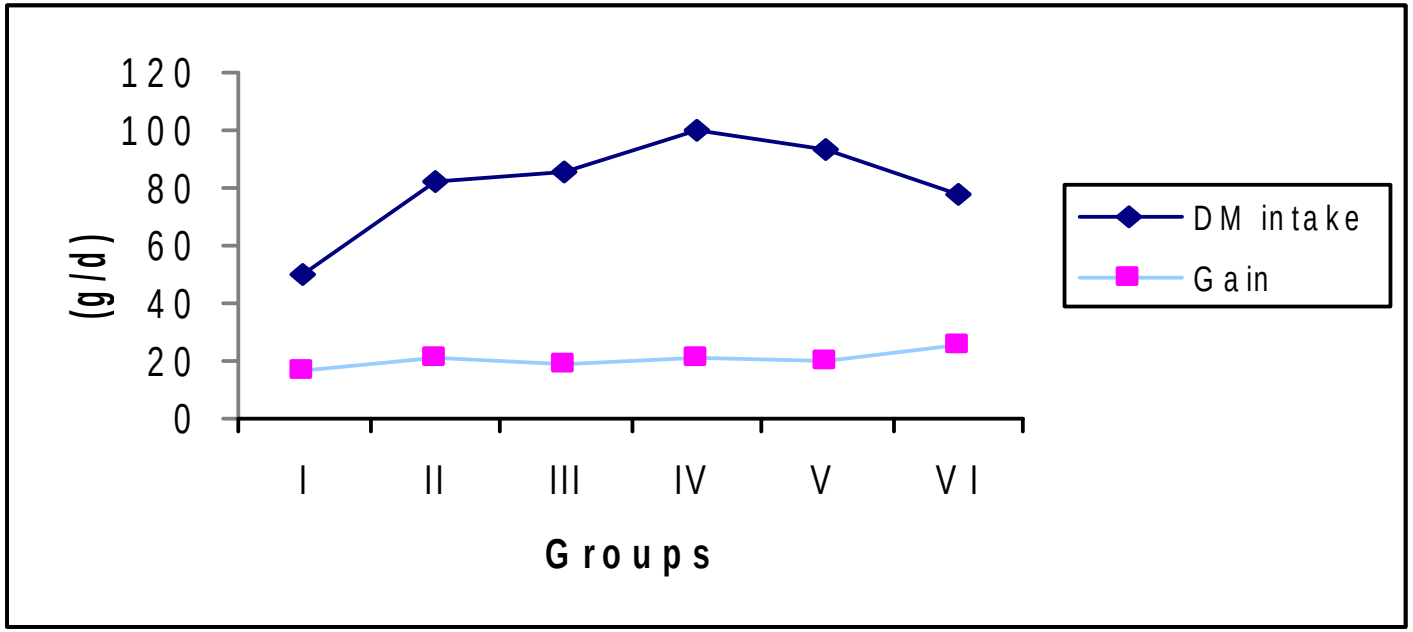
Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC +M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0 - 7	47.71^{e}	76.73^{cd}	80.875^{bc}	92.06^{a}	87.00^{ab}	73.11^{d}	1.97	**
8-14	49.47^{d}	80.89^{bc}	83.56^{b}	97.53^{a}	91.18^{a}	75.90^{c}	2.24	**
15-21	49.91^{e}	84.11^{cd}	87.29^{c}	102.51^{a}	94.99^{b}	79.84^{b}	2.11	**
22-30	52.04^{c}	87.62^{b}	91.41^{b}	111.40^{a}	103.70^{ab}	83.61^{b}	5.04	**
Overall	49.73^{d}	81.78^{bc}	85.2625^{b}	99.6625^{a}	93.545^{a}	77.8325^{c}	2.05	*

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance.

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means^{abcdef} having different superscripts in row differ significantly ** ($P<0.01$)

Fig. 7: The overall mean DM intake (g/kg $W^{0.75}$/d) and gain g/d) of adult non pregnant goats under different groups



between groups II and III or II and V was not significant. On 30 days of trial dry matter intake was significantly lowest for NC and highest for group IV. Non significant difference was recorded among the groups II, III and VI. Group V were similar to all the groups except control.

Overall DMI was significantly ($P<0.01$) higher in groups IV and V as compared to other groups, the groups IV and V were non significantly different from each other. Lowest value was recorded in NC. Group supplemented with soy deoiled cake was higher than group VI and I. However, group II was similar to groups III and VI (Fig. 7).

Aliarabi and Chhabra (2005) reported no significant difference in DMI amongst treatment groups due to dietary supplementation of zinc in crossbred calves, however, in the present investigation the DMI was significantly higher in group IV where NC diet was supplemented with DOC soy and a combined minerals of zinc methionine (60 ppm), chromium propionate (1.5ppm) and sodium selenite (1.5 ppm). Amongst the treatments groups, DMI was lowest in group VI where NC diet was supplemented with MUMMB and above mineral supplements suggesting a positive effect of DOC soy on DMI.

4.3.2 Nutrient utilization

The dry matter intake (g/d) by adult non pregnant goats in control and treated groups has been presented in table 39 and 40. Significantly ($P<0.01$) higher dry matter intake was recorded in groups IV and V, in which soy deoiled cake and UMMB was supplemented and lowest in control group, while the difference in dry matter digestibility in other groups were non significant among themselves.

Table 39: The mean nutrient intake (g/day) and digestibility coefficient in adult non pregnant goats of different groups

Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC +UMMB)*	VI (NC + MUMMB)*		
Dry Matter								
Intake	364.69^{c}	622.96^{b}	637.39^{b}	793.04^{a}	730.07^{ab}	606.29^{b}	34.41	**
Voided	178.67^{d}	269.69^{c}	301.74^{bc}	385.32^{a}	362.02^{ab}	293.76^{c}	17.83	**
Digested	186.02^{c}	353.27^{ab}	335.65^{ab}	407.72^{a}	368.06^{ab}	312.53^{b}	19.00	**
DC	51.25	56.75	52.59	51.42	50.6	51.09	1.31	NS
Crude Protein								
Intake	51.36^{d}	101.44^{c}	73.99^{cd}	188.55^{a}	136.31^{b}	97.92^{c}	7.18	**
Voided	17.74^{c}	25.73^{bc}	31.87^{ab}	37.89^{a}	41.09^{a}	32.01^{ab}	3.25	**
Absorbed	33.63^{e}	75.71^{bc}	42.12^{de}	150.66^{a}	95.21^{b}	65.91^{cd}	6.23	**
DC (%)	65.67^{c}	74.71^{ab}	56.92^{d}	79.89^{a}	69.46^{bc}	66.36^{c}	2.17	**
Ether Extract								
Intake	10.41^{e}	14.28^{d}	20.87^{a}	21.45^{a}	18.48^{b}	16.17^{c}	0.48	**
Voided	2.67^{e}	1.99^{d}	4.12^{a}	5.89^{ab}	4.65^{bc}	5.35^{d}	0.45	**
Digested	7.74^{e}	12.29^{cd}	16.75^{a}	15.56^{ab}	13.83^{bc}	10.82^{d}	0.56	**
DC	74.48^{bc}	86.06^{a}	80.27^{ab}	72.52^{bc}	74.88^{bc}	66.76^{c}	2.39	**
Crude Fiber								
Intake	110.47^{b}	119.64^{b}	115.96^{b}	181.36^{a}	189.13^{a}	169.58^{a}	6.75	**
Voided	44.37^{c}	61.47^{b}	68.18^{b}	91.87^{a}	90.74^{a}	74.01^{b}	4.36	**
Digested	66.09^{b}	58.17^{bc}	47.78^{c}	89.49^{a}	98.39^{a}	95.57^{a}	4.76	**
DC	59.98^{a}	48.41^{c}	41.18^{d}	49.34^{c}	52.33^{bc}	56.19^{ab}	1.96	**
Nitrogenfree Extract								
Intake	162.18^{d}	316.09^{ab}	329.33^{a}	298.61^{abc}	271.47^{bc}	255.24^{c}	13.99	**
Voided	91.53^{c}	134.2^{b}	146.26^{b}	187.91^{a}	150.69^{b}	138.35^{b}	8.45	**
Digested	70.65^{c}	181.9^{a}	183.07^{a}	110.71^{b}	120.78^{b}	116.89^{b}	7.76	**
DC	43.89^{b}	57.63^{a}	55.44^{a}	37.05^{c}	44.55^{b}	45.66^{b}	1.54	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: significance, **NS**: Non significance.

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means^{abcde} having different superscripts in row differ significantly, ** (P<0.01)

Fig.8: The digestibility coefficient of DM, CP, EE, CF and NEF in adult non pregnant goats under different groups

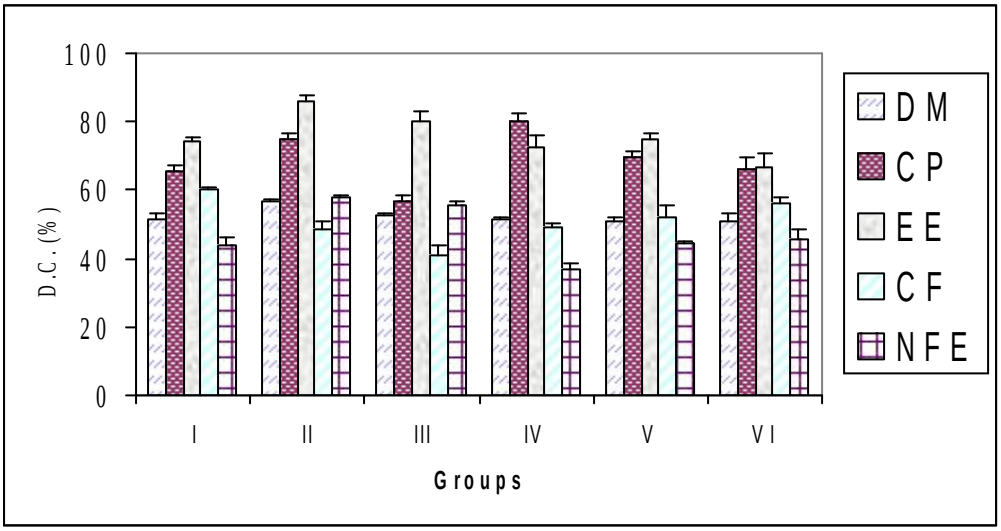
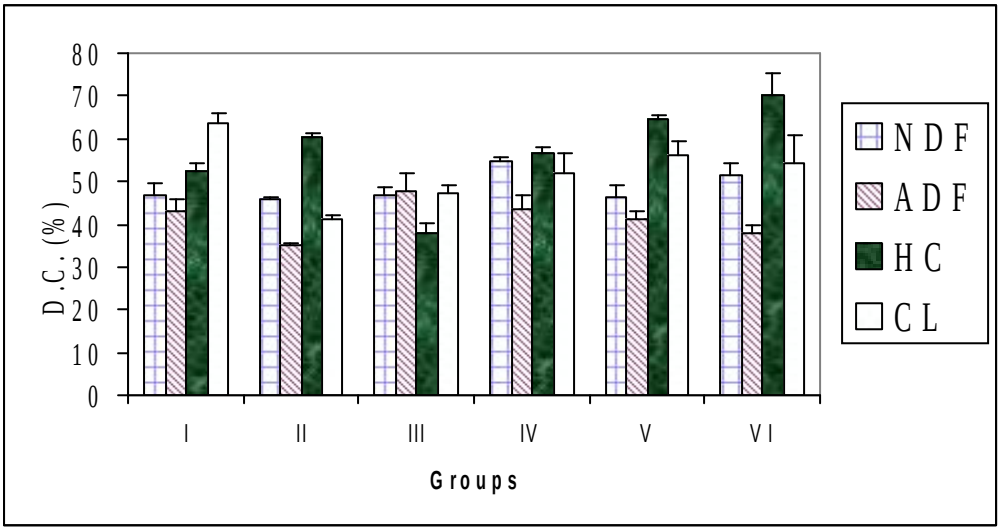


Fig.9: The digestibility coefficient of NDF, ADF, HC and CL in adult non pregnant goats under different groups



The crude protein intake and it digestibility was significantly effected due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, and Med-UMMB in various groups as presented in table 39. The crude protein intake was significantly ($P<0.01$) higher in group IV than V, II, VI, and control groups. The crude protein intake of group III was similar in groups II, VI and control groups. The crude protein digestibility was recorded to be significantly higher in soy deoiled cake than groups VI, I or maize supplemented group. There was no significant difference between groups II and IV, and V, VI and NC groups (Fig.8).

The value of ether extract intake and its digestibility coefficient was significantly affected due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and Sodium selenite in all groups. The intake was highest in groups III and IV and lowest in group I. It was higher in group II than all other groups except group III. Significantly lower value could be noticed in group VI but the difference was non significant between groups I and IV, and I and V.

Significant difference in crude fiber intake and its digestibility coefficient was recorded due to various dietary supplements. It was highest in group V and lowest in group I. The intake of group V was similar to group IV and VI, while group I was similar to groups II and III. CF digestibility was higher in group I than in groups II and IV and lowest in group III in which only maize was supplemented. The digestibility of VI was similar to group I while group V was similar to groups II, IV and VI.

Table 40: The mean fiber intake (g/day) and digestibility coefficient in adult non pregnant goats of different groups

Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
Neutral Detergent Fiber								
Intake	269.31^{c}	381.76^{b}	282.35c	427.02^{abc}	475.13^{a}	415.26^{ab}	19.98	**
Voided	143.49^{c}	207.56^{b}	148.88^{c}	192.85^{b}	256.46^{a}	199.46^{b}	10.44	**
Digested	125.82^{d}	174.2^{bc}	133.47^{cd}	234.17^{ab}	218.67^{ab}	215.8^{ab}	11.95	**
DC	46.99^{b}	45.66^{b}	46.96^{b}	54.8^{a}	46.4^{b}	51.32^{ab}	1.88	**
Acid Detergent Fiber								
Intake	156.66^{c}	212.51^{b}	248.87^{ab}	249.74^{ab}	269.87^{a}	241.63ab	11.65	**
Voided	89.35^{c}	137.54^{ab}	128.9^{b}	141.29^{ab}	158.35^{a}	149.83^{ab}	8.16	**
Digested	67.31^{b}	74.97^{b}	119.97^{a}	108.44^{a}	111.51^{a}	91.81^{ab}	7.93	**
DC	43.22^{ab}	35.28^{b}	47.74^{a}	43.28^{ab}	41.4^{ab}	37.83^{b}	2.34	*
Hemicellulose								
Intake	112.65^{c}	169.25^{b}	133.48^{c}	210.04^{a}	205.27^{a}	173.63^{b}	8.28	**
Voided	54.14^{de}	67.52^{cd}	82.48^{ab}	91.56^{a}	73.11^{bc}	49.64^{c}	4.40	**
Digested	58.51^{c}	101.73^{b}	51^{c}	118.48^{ab}	132.16^{a}	123.99^{ab}	6.84	**
DC	52.2^{c}	60.18^{bc}	37.98^{d}	56.39^{bc}	64.47^{ab}	70.08^{a}	2.20	**
Cellulose								
Intake	104.21^{c}	145.06^{b}	103.74^{c}	174.28^{a}	182.75^{a}	159.75^{ab}	7.04	**
Voided	38^{c}	85.56^{a}	54.56^{bc}	83.52^{a}	81.63^{a}	71.19^{ab}	5.69	**
Digested	66.21^{b}	59.5^{b}	49.17^{b}	90.76^{a}	101.12^{a}	88.56^{a}	5.40	**
DC	63.78^{a}	41.09^{c}	47.18^{bc}	52.01^{bc}	55.95^{ab}	54.43^{ab}	3.20	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: significance

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means^{abcde} having different superscripts in row differ significantly * (P<0.05) , ** (P<0.01)

Digestibility coefficient of NFE was recorded to be highest ($P<0.01$) in groups II and III while lowest was in group IV. The difference was non significant for I, V and VI groups.

Digestibility coefficient of NDF was significantly higher in group IV but difference was non significant as compared to group VI (Table 40 and Fig. 9). The difference between other groups were non significant.

ADF digestibility coefficient was significantly higher in group III than groups VI and II, whereas group II and VI was non significant to each other. The digestibility in groups IV, V and NC were non significant to II, III and VI.

Digestibility coefficient of HC was significantly higher for group VI supplemented with medicated UMMB followed by UMMB and lowest for group III. It was non significant in groups II and III as compared to NC while group V was non significant to group VI.

Cellulose digestibility coefficient was highest for group I, which was similar to group V and VI. Significantly lowest value was recorded in group II, which was non significant to group III and IV.

Though the literature is lacking the effect of feeding single ingredient along with roughage on nutrient digestibilities except few reports (Tiwari *et al.*, 1990) in buffalo calves and (Jain *et a.*,2005) in kids, where digestibilities of OM, CF, CL and HC were significantly higher when diet was supplemented either with UMMB or urea molasses granules. In the present investigation the treatments groups exerted a highly significant difference amongst the groups due to single feed ingredient supplement in NC diet. The DM and EE digestibilities were highest in PC while CP and crude fiber fractions digestibilities were

significantly higher in either in group IV where soy DOC alone or UMMB was supplemented in the diet. The NFE digestibility was significantly higher in group III due to supplementation of maize alone or concentrates mixture in the diets, which might have spared the easily digestible fraction of starch and thereby improved the digestibility in the respective treatments.

4.3.3 Balance study

The effect of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and Sodium selenite in various groups has been summarized in table 41 and fig 10. Perusal of data revealed significant effect on N, Ca and P balances among various groups.

N intake and balance was significantly higher in group IV followed by group V and least in NC. However, NC did not differ significantly from group III. Group II, V and VI also did non differ significantly among themselves.

Ca intake was highest in group V and lowest in NC, however NC did not differ significantly from groups II and III. Also no significant difference was noticed amongst II, III and VI, or between IV and V or groups IV and VI. Ca balance was recorded to be significantly higher in group V as compared to II, IV or VI. Similarly groups I, II and III were non significant among themselves.

P intake and balance were highest in group V and lowest in NC. However, difference for P intake between groups I and II as well as III, IV, V and VI were not significant from each other. Regarding Ca balance the differences between III and IV, as well as among I, II, IV and VI, and between III and V were non significant from each other.

Table 41: The mean N, Ca and P balances in adult non pregnant goats of different groups

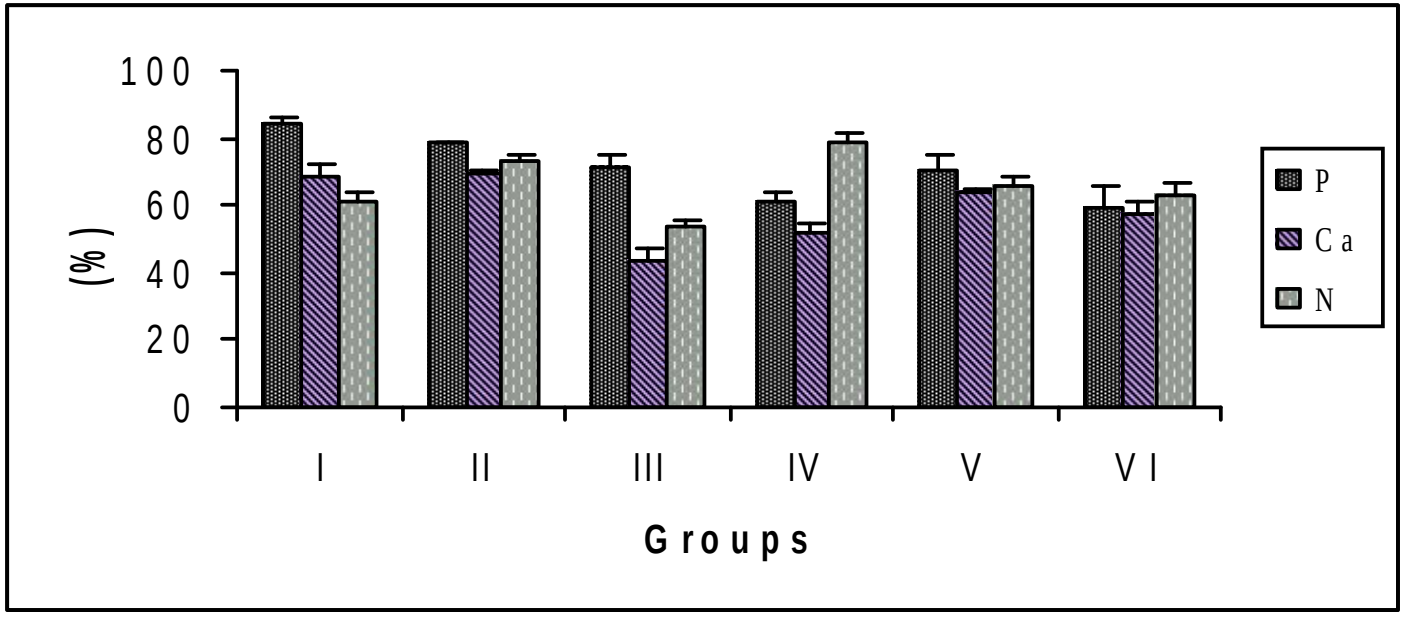
Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
Nitrogen (g/day)								
Intake	3.21^{d}	6.34^{c}	4.63^{dc}	11.78^{a}	8.52^{b}	6.12^{c}	0.45	**
Faecal outgo	1.11^{c}	1.61^{bc}	1.99^{ab}	2.37^{a}	2.57^{c}	2.00^{ab}	0.2	**
Urinary outgo	0.14	0.08	0.16	0.19	0.27	0.19	0.03	NS
Balance	1.97^{e}	4.66^{bc}	2.47^{ed}	9.23^{a}	5.68^{b}	3.93^{cd}	0.39	**
Balance (%)	61.49^{c}	73.51^{ab}	53.45^{d}	78.28^{a}	66.13^{bc}	62.96^{c}	2.61	**
Calcium (g/day)								
Intake	5.01^{d}	7.91^{cd}	8.03^{cd}	12.85^{ab}	15.89^{a}	10.87^{bc}	0.74	**
Faecal outgo	1.37^{c}	2.01^{c}	3.78	5.19^{b}	5.23^{a}	4.28^{a}	0.24	**
Urinary outgo	0.20^{c}	0.45^{bc}	0.77^{ab}	0.99^{a}	0.48^{bc}	0.21^{c}	0.13	*
Balance	3.43^{c}	5.45^{bc}	3.4^{c}	6.68^{b}	10.18^{a}	6.39^{b}	0.63	**
Balance (%)	68.94^{a}	68.99^{a}	43.20^{d}	51.92^{cd}	63.63^{ab}	57.24^{bc}	2.82	**
Phosphorus (g/day)								
Intake	2.87^{c}	3.74^{c}	8.15^{ab}	7.43^{b}	10.27^{a}	6.77^{b}	0.61	**
Faecal outgo	0.39^{b}	0.66^{b}	1.91^{a}	2.43^{a}	2.58^{a}	2.13^{a}	0.21	**
Urinary outgo	0.06^{c}	0.14^{bc}	0.43^{ab}	0.46^{a}	0.27^{ab}	0.40^{ab}	0.08	*
Balance	2.42^{c}	2.94^{c}	5.82^{ab}	4.54^{bc}	7.42^{a}	4.24^{bc}	0.58	**
Balance (%)	84.43^{a}	78.5^{ab}	71.59^{bc}	61.19^{cd}	70.82^{bc}	59.26^{d}	3.15	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: significance, **NS**: Non significance.

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means^{abc} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Fig. 10: The Overall phosphorus (P), calcium (Ca) and nitrogen (N) balances (%) in adult non pregnant goats under different groups



As such no long feeding trials were conducted in small ruminants to see the effect of feed ingredient on nutrient balance study. Again the earlier reports of Tiwari *et al.* (1990) and Jain *et al.* (2005) supported the finding of present investigation where UMMB was supplemented in the diet and as a result there was significant improvement in N, Ca and P balance in growing buffalo calves or kids. In the present investigation other feed ingredients like maize, soy DOC and concentrate mixture also affected the nutrient balance due to variation in their chemical composition with respect to N, Ca and P. The soy DOC supplementation resulted in increased N balance while maize and concentrate mixture resulted in increased P and Ca balances respectively. This was due to the fact that soy DOC spared good quality essential amino acids for its better utilization in goats. On the other hand maize being rich in P resulted in more P balance and concentrate mixture which is optimum in Ca and P improved the Ca balance as compared to other groups.

4.3.4 Hematological study

Significant change in the Hb was obtained due to dietary supplementation of MUMMB and UMMB in the basal diet. It was more in the former than the later ones on 30^{th} day (Table 42). The value was significantly higher in group VI as compared to other groups but the difference was non significant when compared it with group II. Lowest value was observed in group I. Groups III, IV and V were significantly similar to each other.

Lowest overall Hb value could be recorded in NC but the difference was not significant when compared with control, maize, soy deoiled cake and UMMB

Table 42: The mean haemoglobin (g/dl) in adult non pregnant goats of different groups

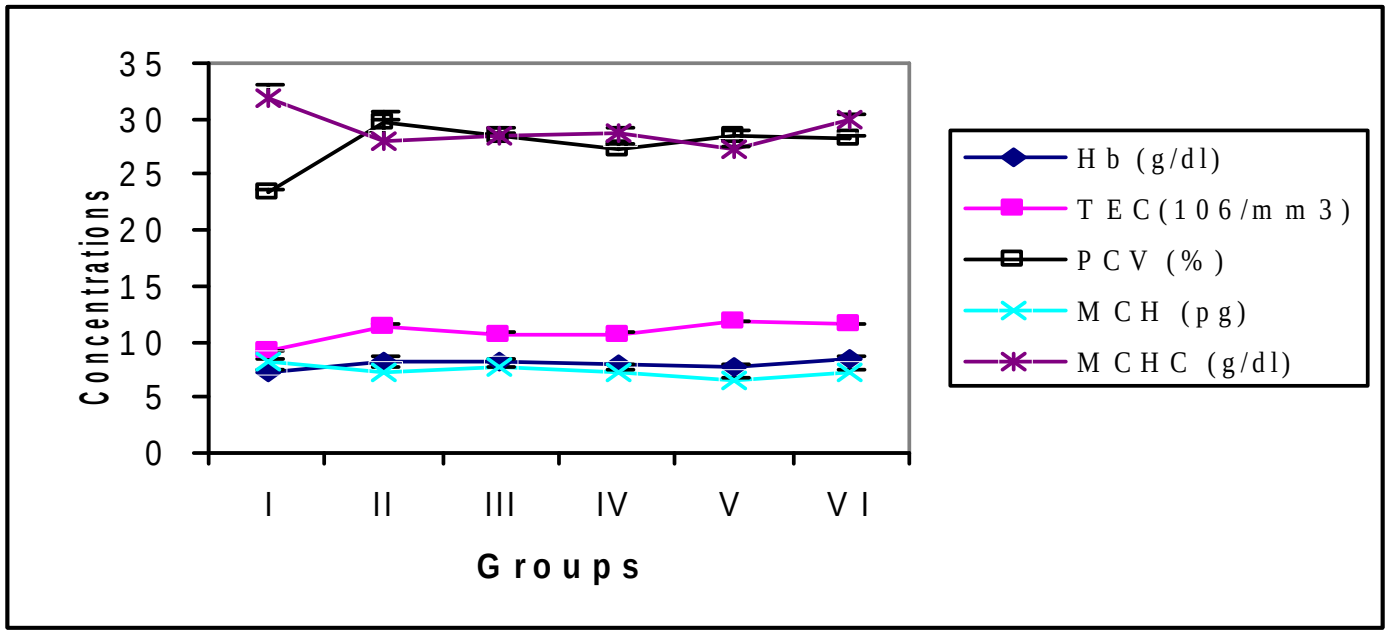
Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC +M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	6.5	6.34	6.42	6.15	5.93	6.69	0.55	NS
15	7.67	8.9	8.96	8.43	8.5	8.68	0.27	NS
30	7.8^{c}	9.75^{ab}	9.2	9.03^{b}	8.93^{b}	10.13^{a}	0.26	**
Overall	7.32^{b}	8.33^{a}	8.19^{a}	7.86^{ab}	7.78^{ab}	8.49^{a}	0.22	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means^{abc} having different superscripts in row differ significantly ** ($P<0.01$)

Fig. 11: The overall haematological parameter (Hb) and RBC (TEC, PCV, MCH and MCHC) indices in adult non pregnant goats under different groups



supplemented group. Hb (%) in group IV and V was significantly ($P<0.05$) similar to each other (Fig. 11).

Influence of dietary supplements on total erythrocytes count has been presented in table 43. Significant higher value was recorded in group V and VI, however, the difference was non significant as compared to group II. Lower value was observed in group I than groups III and IV, respectively.

Significantly ($P<0.01$) lowest TEC value was recorded in NC as compared to other groups when period was not considered. Groups II, V and VI had higher value when compared to groups III and IV. However, groups II and IV did not differ significantly with each other.

Packed cell volume was significantly lowest in group I followed by group IV on 15^{th} day. However, on 30^{th} day non significant difference was observed among all groups except group I where it was significantly lower than other groups.

Overall PCV value was significantly ($P<0.01$) higher in control as compared to NC followed by group IV. Groups II, III, V and VI as well as groups III, IV, V and VI did not vary among themselves (Table 44).

Influence of dietary supplementation on mean corpuscular heamoglobin on 15^{th} and 30^{th} day has been presented in table 45. Perusal of the table revealed that the mean value was highest in group I and lowest in group V. However, the differences among groups I, III and IV or groups II, IV, V and VI were non significant on 15^{th} day. The values on 30^{th} day in groups I, II, III, IV and VI were non significant among themselves.

Table 43: The mean total erythrocyte count (10^6/mm^3) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	10	10.1	10	10.5	10.53	10.11	0.29	NS
15	8.59^{c}	12^{a}	10.58^{b}	10.62^{b}	12.18^{a}	12.17^{a}	0.30	**
30	8.59^{c}	11.86^{ab}	11.17^{b}	11.06^{b}	12.51^{a}	12.41^{a}	0.35	**
Overall	9.06^{d}	11.32^{ab}	10.58^{c}	10.72^{bc}	11.74^{a}	11.56^{a}	0.19	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abc} having different superscripts in row differ significantly ** ($P<0.01$)

Table 44: The mean packed cell volume (%) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	26.34	26.84	26.42	25.32	26.55	26.14	0.61	NS
15	23.32^{c}	29.62^{a}	29.02^{a}	26.94^{b}	29.23^{a}	28.72^{a}	0.54	**
30	20.74^{b}	32.56^{a}	30.05^{a}	29.8^{a}	29.5^{a}	30.03^{a}	0.89	**
Overall	23.46^{c}	29.67^{a}	28.50^{ab}	27.35^{b}	28.43^{a}	28.30^{ab}	0.46	*

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abc} having different superscripts in row differ significantly ** ($P<0.01$)

Table 45: The mean corpuscular haemoglobin (pg) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	6.48	6.28	6.43	5.91	5.65	6.62	0.53	NS
15	9.05^{a}	7.45^{bc}	8.47^{ab}	7.95^{abc}	6.99^{c}	7.15^{bc}	0.38	*
30	9.07^{a}	8.27^{a}	8.27^{a}	8.2^{a}	7.15^{b}	8.18^{a}	0.33	*
Overall	8.2^{a}	7.33^{ab}	7.72^{a}	7.35^{ab}	6.59^{b}	7.32^{ab}	0.25	*

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abc} having different superscripts in row differ significantly * ($P<0.05$)

The overall MCH was recorded higher in NC and group III as compared to group V. However, groups II, IV and V were non significant to groups I, III and V, respectively.

Similarly the value of MCHC due to different dietary supplements was highest in group I and other groups did not differ significantly among themselves (Table 46).The overall MCHC was found to be non significant among the groups irrespective of periods.

Zhang *et al*., (1998) reported significantly higher Hb in goats supplemented with multinutrient blocks than without blocks. Similarly higher values ($P<0.01$) of Hb and TEC were recorded in Med-UMMB treated calves in comparison to untreated (Sanyal and Singh, 1993a).

Though many feeding trials have been conducted in various species of the animals to see the effect of balance diet on Hb and other haematological parameters however except or two feed supplements (Tiwari *et al.*, 1990 and Jain *et al*., 2005) no other feed ingredient as supplements have been tried for such studies. In the current investigation besides UMMB and MUMMB other feed ingredients like soy DOC, maize and concentrate mixture have been tried to study their effect on such parameters. It has been found that maize, concentrate mixture and MUMMB alone helped in the synthesis of more Hb in the goats as compared to other groups though the overall TEC was more in UMMB and MUMMB supplemented diets. Accordingly the PCV values were toward the higher side in the treatments groups than the NC. MCH and MCHC were not significantly affected amongst the treatments groups however these were more in NC.

Table 46: The mean cell haemoglobin concentration (g/dl) in adult non pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC +M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	24.65	23.7	24.25	24.22	22.44	25.61	2.07	NS
15	32.93	30.09	30.87	31.51	29.08	30.26	1.25	NS
30	37.79^{a}	30.17^{b}	30.63^{b}	30.31^{b}	30.28^{b}	33.76^{b}	1.03	**
Overall	31.79	27.98	28.58	28.68	27.27	29.88	0.85	NS

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means^{ab} having different superscripts in row differ significantly ** ($P<0.01$)

4.3.5 Biochemical study

The level of total serum protein, serum albumin and serum globulin due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite in the respective treatments at various periods were found to be non significant amongst groups (Table 47, 48 and 49). Similar results were found when periods were not considered (Fig 12).

Changes in blood glucose due to various dietary supplements in the respective groups have been presented in table 50. The value was highest in group I and lowest in group VI (on 15^{th} day) and V (on 30^{th} day). However the difference, among groups II, III, IV and V or between II and IV and II and VI were non significant. Overall blood glucose value was significantly highest in NC group, other groups being non significantly different among themselves (Table 50).

Insulin concentration was higher in V group on 15^{th} day, however, the difference was non significant when compared with group I (Table 51). This was followed by VI which was non significant when compared to groups II, III and IV. On 30^{th} day of trial lower value could be recorded in group I and all other groups did not differ significantly. Overall value of insulin concentration was significantly higher in control and group V as compared to NC, III and IV. However, the difference of group VI was non significant in respect to all other groups.

Table 47: The mean total serum protein (mg/dl) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	5.54	4.98	5.65	5.4	5.6	4.89	0.38	NS
15	5.54	5.64	4.98	6	5.12	4.2	0.63	NS
30	5.67	9.94	7.11	7.68	7.37	7.57	1.31	NS
Overall	5.58	6.85	5.91	6.36	6.03	5.55	0.55	NS

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Table 48: The mean total serum albumin (mg/dl) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	2.38	2.38	2.52	2.36	2.65	2.4	0.08	NS
15	2.41	2.71	2.53	2.94	3.01	2.17	0.31	NS
30	2.56	3.91	3.42	3.59	2.64	3.16	0.37	NS
Overall	2.45	3	2.82	2.96	2.77	2.57	0.15	NS

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Table 49: The mean total serum globulin (mg/dl) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	3.16	2.6	3.13	3.05	2.95	2.49	0.38	NS
15	3.13	2.93	2.45	3.07	2.11	2.03	0.56	NS
30	3.11	6.03	3.69	4.09	4.72	4.41	1.50	NS
Overall	3.13	3.85	3.09	3.40	3.26	2.98	0.56	NS

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Table 50: The mean blood glucose (mg/dl) concentrations in adult non pregnant goat of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	54.97	54.57	54.48	54.79	55.45	55.50	0.56	NS
15	58.25^{a}	54.50^{bc}	55.00^{bc}	55.00^{bc}	55.50^{bc}	53.25^{c}	0.53	**
30	59.25^{a}	56.75^{bc}	57.75^{ab}	57.75^{ab}	55.75^{b}	57.00^{bc}	0.54	**
Overall	55.30^{a}	53.69^{b}	53.49^{b}	53.60^{b}	52.83^{b}	52.50^{b}	0.37	**

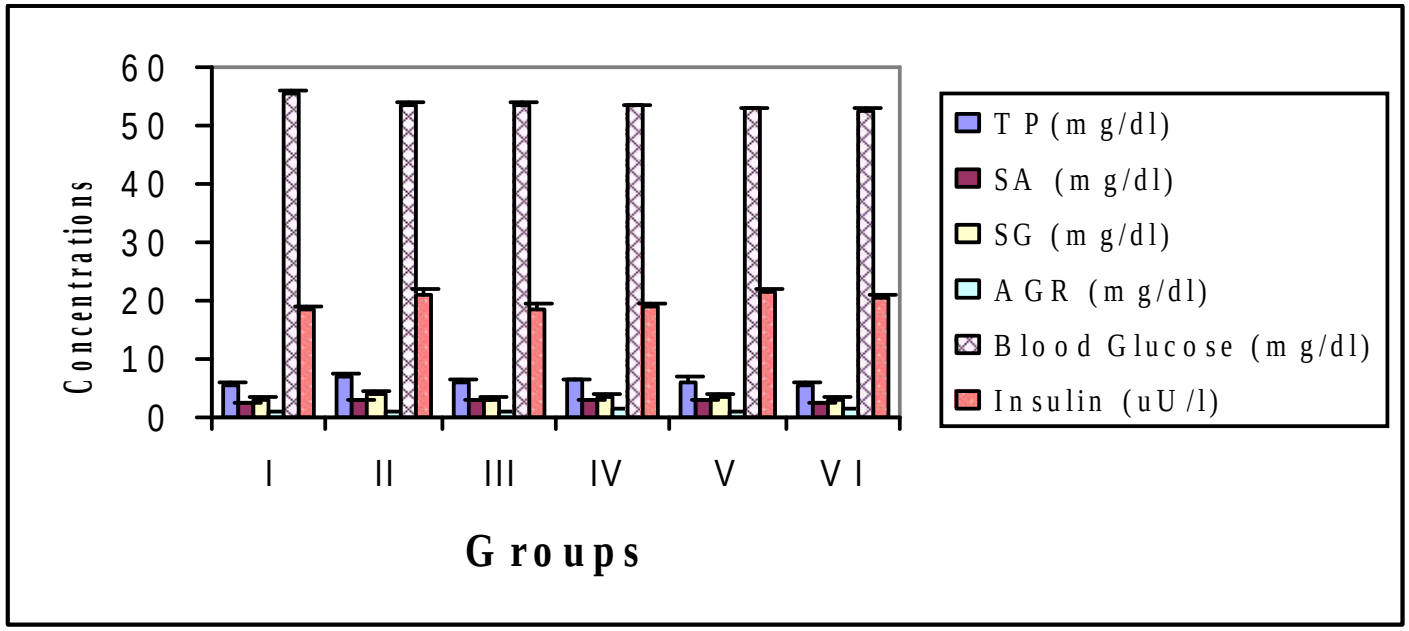
NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abc} having different superscripts in row differ significantly ** (P<0.01)

Table 51: The mean insulin (uU/l) concentrations in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	16.50	17.50	17.75	15.75	16.75	16.50	1.32	NS
15	20.00^{ab}	16.00^{c}	15.50^{c}	16.50^{bc}	21.75^{a}	18.00^{bc}	1.13	**
30	18.75^{b}	23.50^{a}	22.75^{a}	24.50^{a}	26.50^{a}	26.50^{a}	1.22	**
Overall	18.42^{b}	21.00^{a}	18.67^{b}	18.91^{b}	21.66^{a}	20.33^{ab}	0.62	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{abc} having different superscripts in row differ significantly ** (P<0.01)

Fig. 12: The overall serum total protein (TA), albumin (SA), globulin (SG), albumin: globulin ratio (AGR), blood glucose and serum insulin in adult non pregnant goats under different groups



No significant difference was obtained amongst groups for the concentration of serum albumin globulin ratio due to various dietary (Table 52). Overall value of albumin globulin ratio was also found to be non significant among the groups

The activity of alkaline phosphatase during different periods or a group as a whole was found to be non significant amongst groups due to supplementation of concentrate, minerals, medicated and un medicated UMMB and other feed ingredients (Table 53).

Jain *et al.* (2005) reported that feeding of urea molasses mineral block increased the blood glucose, plasma calcium, inorganic phosphorus, total protein, albumin, globulin and albumin globulin ratio in kids. Similarly higher values ($P<0.01$) of Hb, PCV and TEC were recorded in Med-UMMB treated calves in comparison controls (Sanyal and Singh, 1993b). The results of present investigation were in accordance to the earlier reports. The ingredient feeding of maize, soy DOC and concentrate mixture have no effect on total serum protein, albumin, globulin, albumin:globulin ratio and alkaline phosphatase activity. However blood glucose level was significantly lower in feed supplemented groups due to combined mineral supplement of Cr, Zn and Se. This might have led to increased utilization of glucose in such groups. It was supported by the higher insulin level in goats of these groups.

4.3.6 Mineral study

Serum zinc was found lowest in group I on 30^{th} day than other supplemented groups, however other groups were non significant to each other

Table 52: The mean albumin:globulin ratio (mg/dl) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	0.8	0.96	0.93	0.8	1.04	0.97	0.14	NS
15	0.82	1.17	1.27	1.07	1.53	1.32	0.28	NS
30	0.95	0.71	1.49	2.17	1.18	2.19	0.67	NS
Overall	0.85	0.94	1.23	1.34	1.25	1.49	0.22	NS

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Table 53: The mean alkaline phophatase activity (IU/100 ml) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (NC + C. mix)	III (NC + M)	IV (NC + SDC)	V (NC + UMMB)	VI (NC + MUMMB)		
0	146.18	150.85	156.22	145.78	149.28	162.14	4.39	NS
15	156.38	162.23	159.17	161.78	166.01	147.39	3.39	NS
30	174.41	166.25	164.59	164.01	168.25	182.50	7.67	NS
Overall	158.99	159.78	159.99	157.19	161.18	164.01	3.22	NS

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

(Table 54). Overall value of Zn was lower in NC than all other groups. Except NC remaining groups found to non significant among themselves (Fig. 13).

Serum chromium at different periods and as a whole was significantly lower in NC than supplemented groups Table 55). Supplemented grouped did not differ among themselves.

Influence of dietary supplements on serum selenium has been presented in table 56. The differences were found to be non significant among the groups. Overall level of Se was higher in UMMB supplemented and control group as compared to NC, IV and VI. Group III was found to be non significant to all the groups.

Serum iron level was highest in group V and lowest in group I. However the difference of group V was non significant when compared with II, IV, and VI groups or when group I compared to II, III and IV on 15^{th} day and groups II, IV and VI or II , V and VI on 30^{th} day of trial. Overall Fe concentration was highest in UMMB supplemented group and lowest in NC. However, difference between groups II, V and VI, groups I and III; groups III and IV as well as groups II, IV and VI were found to be non significant from one another (Table 57).

There was significant effect of diet due to supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite in goat. The level was lowest in group I, however it was non significant when compared with groups II and III on 15^{th} day. Other groups did not differ significantly among themselves. On 30^{th} day the differences among all the groups except group I were non significant. Overall value of Cu was lower in

Table 54: The mean serum zinc (ppm) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	3.34	4.07	4.37	4.21	4.43	4.26	0.24	NS
15	3.7	4.11	4.16	4.18	4.83	3.57	0.31	NS
30	3.41^{b}	5^{a}	4.61^{a}	5.09^{a}	4.57^{a}	4.77^{a}	0.33	*
Overall	3.48^{b}	4.39^{a}	4.38^{a}	4.49^{a}	4.61^{a}	4.19^{a}	0.15	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means[ab] having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 55: The mean serum chromium (ppm) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	4.92	4.98	5.48	5.84	5.24	5.9	0.33	NS
15	10.35^{a}	8.21^{b}	7.3^{b}	8.07^{b}	7.22^{b}	8.18^{b}	0.45	**
30	10.89^{a}	7.79^{b}	7.58^{b}	7.6^{b}	7.75^{b}	8.23^{b}	0.42	*
Overall	5.028^{b}	6.99^{a}	6.79^{a}	7.17^{a}	6.73^{a}	7.44^{a}	0.23	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means[ab] having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 56: The mean serum selenium (ppm) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	2.28	2.31	2.33	2.36	2.42	2.4	0.12	NS
15	2.39	2.52	2.92	2.16	2.53	1.94	0.31	NS
30	2.56	3.67	2.98	3.11	3.28	2.79	0.35	NS
Overall	2.30^{b}	2.83^{a}	2.74^{ab}	2.31^{b}	2.83^{a}	2.37^{b}	0.14	*

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means[ab] having different superscripts in row differ significantly * (P<0.05)

Table 57: The mean serum iron (ppm) in adult non pregnant goat under various groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	3.69	3.29	3.25	3.51	3.66	3.68	0.38	NS
15	3.77^{b}	4.33^{ab}	3.82^{b}	4.71^{ab}	4.86^{a}	4.77^{a}	0.25	*
30	4.29^{c}	7.3^{ab}	5.93^{b}	6.12^{b}	7.84_{a}	7.26^{ab}	0.50	**
Overall	3.92^{d}	5^{ab}	4.33^{cd}	4.78^{bc}	5.45^{a}	5.25^{ab}	0.19	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{ab} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 58: The mean serum copper (ppm) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	2.67	2.78	2.91	2.66	2.69	2.4	0.13	NS
15	2.52^{b}	3.37^{ab}	3.3^{ab}	3.58^{a}	3.95^{a}	3.9^{a}	0.27	*
30	2.73^{b}	5.81^{a}	5.2^{a}	5.44^{a}	5.27^{a}	5.09^{a}	0.35	**
Overall	2.50^{b}	3.98^{a}	3.80^{a}	3.72^{a}	3.97^{a}	3.79^{a}	0.20	**

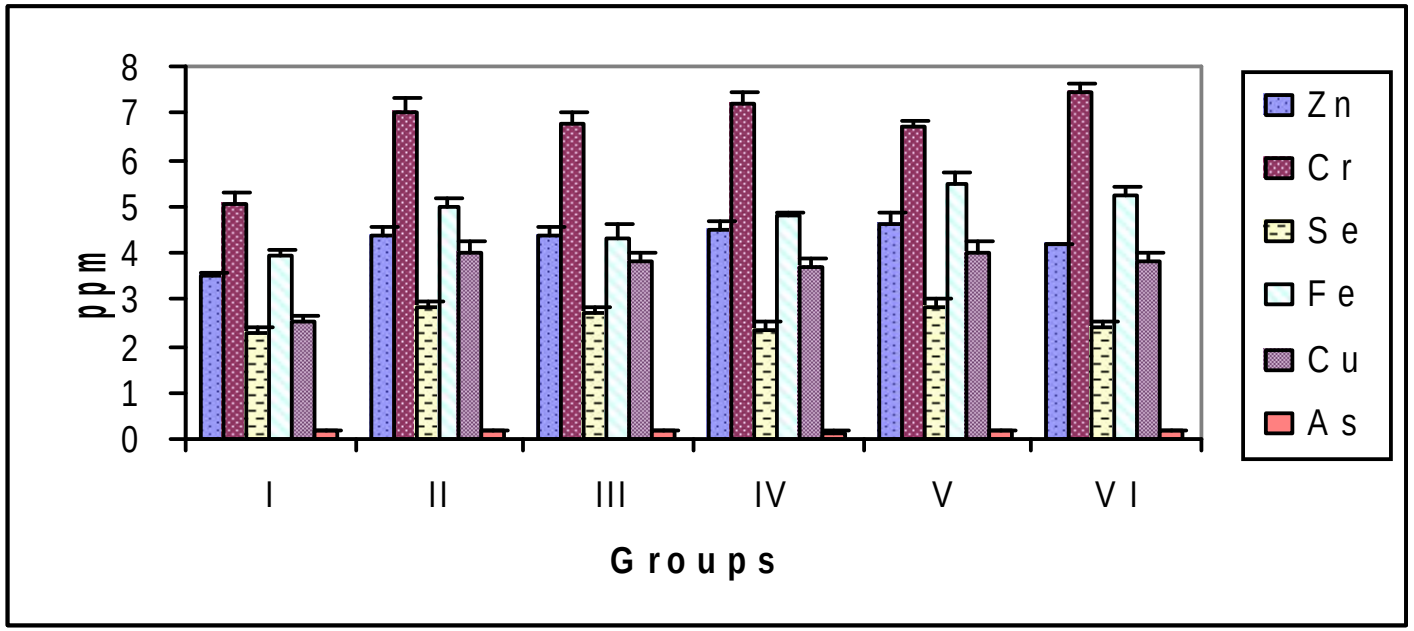
NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{ab} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Table 59: The mean serum arsenic (ppm) in adult non pregnant goats of different groups

Periods (days)	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC + UMMB)*	VI (NC + MUMMB)*		
0	0.18	0.19	0.17	0.15	0.16	0.18	0.08	NS
15	0.19^{b}	0.17^{ab}	0.2^{a}	0.14^{b}	0.17^{ab}	0.18^{a}	0.01	*
30	0.2^{b}	0.2^{a}	0.18^{a}	0.15^{a}	0.18^{a}	0.17^{a}	0.01	*
Overall	0.19^{a}	0.18^{a}	0.18^{a}	0.15^{b}	0.17^{a}	0.17^{a}	0.01	**

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.
***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)
Means^{ab} having different superscripts in row differ significantly * (P<0.05), ** (P<0.01)

Fig. 13: The overall serum Zn, Cr, Se, Fe, Cu and As in adult non pregnant goats under different groups



NC than all the groups, other groups did not differ significantly among themselves (Table 58).

Influence of dietary supplements on serum arsenic has been presented in table 59. Perusal of data revealed non significant difference among groups I, II, III, V and VI or among groups II, IV and V, respectively. On 30^{th} day higher values could be recorded in groups II and II which was non significantly different than III, V and VI. The difference among groups III, IV, V and VI was also non significant. Overall lower As value was recorded in group IV than all groups. Other groups were not affected due to dietary treatments.

No reports could be found out with respect to the level of trace minerals in serum due to supplementation of UMMB or single feed ingredient in the diet. However the present investigation envisaged that there was no significant difference amongst the treatments groups however the values of zinc, chromium and copper were significantly higher than NC due to supplementation of combined mineral supplements in such groups. It means the difference was not due to single feed ingredient rather it was due to mineral supplements. The feed ingredients affected the level of Se and Fe in the serum which was more in PC and UMMB groups as compared to others due to associative affect of diet. The level of As was marginally higher in soy DOC supplemented diet though it was within the required level for the growth and production of animal.

Table 60: Nutritional plane of adult non pregnant goats of different groups

Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)*	III (NC + M)*	IV (NC + SDC)*	V (NC+ UMMB)*	VI (NC + MUMMB)*		
Initial B. wt. (kg)	13.10	13.28	12.93	13.25	13.06	13.31	0.42	NS
Final b. wt (kg)	13.59	13.90	13.50	13.90	13.67	14.08	0.42	NS
Weight gain (kg)	0.49^{b}	0.62^{ab}	0.58^{b}	0.65^{ab}	0.61^{a}	0.77^{a}	0.04	*
Av. daily gain (g/d)	16.33^{b}	20.68^{ab}	19.13^{b}	21.54^{ab}	20.25^{ab}	25.66^{a}	1.33	*
Experimental Periods (days)	30	30	30	30	30	30	-	-
Body wt. (M T period)	13.48	13.73	13.35	13.72	13.52	13.93	0.42	NS
$W^{0.75}$ (Kg)	7.03	7.13	6.98	7.13	7.05	7.21	0.17	NS
DM intake								
g/day	364.69^{c}	622.96^{b}	637.39^{b}	793.04^{a}	730.07^{ab}	606.29^{b}	34.41	**
kg/100kg b wt	2.72^{c}	4.56^{b}	4.79^{b}	5.80^{a}	5.41^{ab}	4.33^{b}	0.28	**
g/kg $W^{0.75}$	52.04^{c}	87.62^{b}	91.41^{b}	111.40^{a}	103.70^{ab}	83.61^{b}	5.04	**
Crude protein intake								
g/day	51.36^{d}	101.44^{c}	73.99^{cd}	188.55^{a}	136.31^{b}	97.92^{c}	7.18	**
g/100kg b wt	301.49^{d}	586.69^{c}	417.50^{cd}	1075.76^{a}	771.65^{b}	557.12^{c}	42.27	**
g/kg $W^{0.75}$	6.13^{d}	11.96^{c}	8.57^{cd}	22.01^{a}	15.82^{b}	11.41^{c}	0.85	**
Digestible crude protein intake								
g/day	33.63^{e}	75.71^{bc}	42.12^{de}	150.66^{a}	95.21^{b}	65.90^{cd}	6.23	**
g/100kg b wt	250.45^{e}	553.36^{bc}	316.41^{de}	903.60^{a}	705.07^{b}	467.57^{cd}	50.00	**
g/kg $W^{0.75}$	4.79^{e}	10.64^{bc}	6.04^{de}	21.20^{a}	13.51^{b}	9.04^{cd}	0.94	**
Total digestible nutrient intake								
g/day	177.24^{c}	338.33^{ab}	316.08^{b}	396.05^{a}	344.23^{ab}	285.86^{b}	16.68	**
kg/100kg b wt	1.32^{c}	2.48^{ab}	2.38^{b}	2.89^{a}	2.55^{ab}	2.04^{b}	0.14	**
g/kg $W^{0.75}$	25.29^{c}	47.59^{ab}	45.33^{b}	55.63^{a}	48.89^{ab}	39.42^{b}	2.47	**
Nutrients in the diet (%)								
CP	13.01	16.17	11.41	28.39	26.97	26.97		
DCP	8.54	12.08	6.49	22.68	18.73	17.90		
TDN	48.60	54.31	49.59	49.94	47.15	47.15		
Nutrient Requirement (NRC, 1981)								
DM (g/d)	485.28	494.28	480.60	493.92	486.72	501.48		
CP (g/d)	62.01	63.16	61.41	63.11	62.19	64.08		
TDN (g/d)	268.25	273.23	265.67	273.03	269.05	277.21		
Intake (percent of NRC requirement, 1981)								
DM	75.15	126.03	132.62	160.56	150.00	120.90		
CP	82.83	160.61	120.49	298.75	219.18	152.81		
TDN	66.07	123.83	118.98	145.06	127.94	103.12		

NC: Negative control (roughage), **PC**: (positive control), **M**: maize**, SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **MUMMB**: medicated urea molasses mineral block, **SEM**: Standard error mean, **Sig.**: Significance, **NS**: Non significance.

***** Zn methionine (60, ppm), Cr propionate and sodium selenite (1.5, ppm) was supplemented in all the groups (II, III, IV, V and VI) except NC (I)

Means[ab] having different superscripts in row differ significantly * ($P<0.05$), ** ($P<0.01$)

4.3.7 Growth performance and nutritional plane of adult non pregnant goats

There was significant difference on ADG due to various treatments as shown in table 60. The group supplemented with MUMMB was found to have significantly higher body weight gain as compared to negative control and maize supplemented groups. However groups II, IV and V were similar to group I and VI.

Overall gain was recorded highest and found significant in MUMMB supplemented group. However, it did not differ significantly from control, IV and UMMB supplemented groups. In the present investigation the goat in all the treatment groups were fed more than the NRC (1981) requirement due to higher DMI which in turn affected the CP and TDN intake accordingly, however it was below the requirement in the NC group. It suggests better growth performance amongst the treatment groups. However the performance varies depending upon the quality of nutrient available to the goats.

4.4 Pregnant goat

4.4.1. Dry matter intake

Significant effect due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and Sodium selenite on dry matter intake has been presented in table 61.

Average DMI of various groups was recorded during entire experimental periods. The average DMI between 0-60 days was significantly higher in groups III and IV as compared to NC, however, groups II and V, and III and IV did not differ significantly.

During 60-90 days groups I and VI had significantly lower value than all other groups. During 91-120 days groups III and IV had highest value followed by II and V and lowest in I and VI. These two groups did not differ significantly. During 121-150 days highest value of DMI was observed in group IV, followed by III and lowest in I and VI. Groups II and V, and I and VI did not vary significantly.

DMI (kg/100 body weight) and DMI (g/ kg $W^{0.75}$) were higher in groups III and IV throughout the experiment as compared to NC and group VI (Table 62 and 63). During 0-60 days difference between groups III and IV, II and V and I and VI, during 60-90 days groups I and VI, II, III, IV and V, during 90-120 days groups III and IV, II and V, I and VI and during 120-150 days groups I and VI, II and V, and groups III and IV did not differ significantly.

Overall dry matter intake (g/kg $W^{0.75}$) in pregnant goat was significantly ($P<0.01$) higher in groups III and IV as compared to other groups (Fig. 14).

Table 61: The mean dry matter intake (g/day) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0-60	296.00^{b}	418.25^{b}	515.50^{a}	514.75^{a}	437.00^{b}	339.75^{c}	11.93	**
61-90	376.75^{b}	568.25^{a}	572.50^{a}	629.50^{a}	544.50^{a}	414.00^{b}	11.78	**
91-120	461.50^{c}	622.25^{b}	728.75^{a}	769.50^{a}	644.75^{b}	491.50^{c}	8.92	**
121-150	453.50^{d}	602.25^{c}	700.75^{b}	734.50^{a}	620.50^{c}	446.25^{d}	6.82	**
Overall	360.73^{c}	616.29^{b}	764.81^{a}	784.68^{a}	635.12^{b}	334.57^{c}	28.21	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean
* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.
Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 62: The mean dry matter intake (kg/100 kg body weight) in pregnant goat of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+ M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0-60	2.42^{c}	2.91^{b}	2.94^{a}	2.47^{a}	1.94^{b}	0.07^{c}	1.74	**
61-90	3.10^{b}	3.07^{a}	3.42^{a}	2.93^{a}	2.26^{a}	0.11^{b}	2.10	**
91-120	3.07^{c}	3.63^{b}	3.85^{a}	3.28^{a}	2.50^{b}	0.06^{c}	2.44	**
121-150	2.71^{c}	3.23^{b}	3.38^{a}	2.83^{a}	2.08^{b}	0.05^{c}	2.18	**
Overall	2.12^{c}	3.57^{b}	4.32^{a}	4.48^{a}	3.59^{b}	1.91^{c}	0.19	**

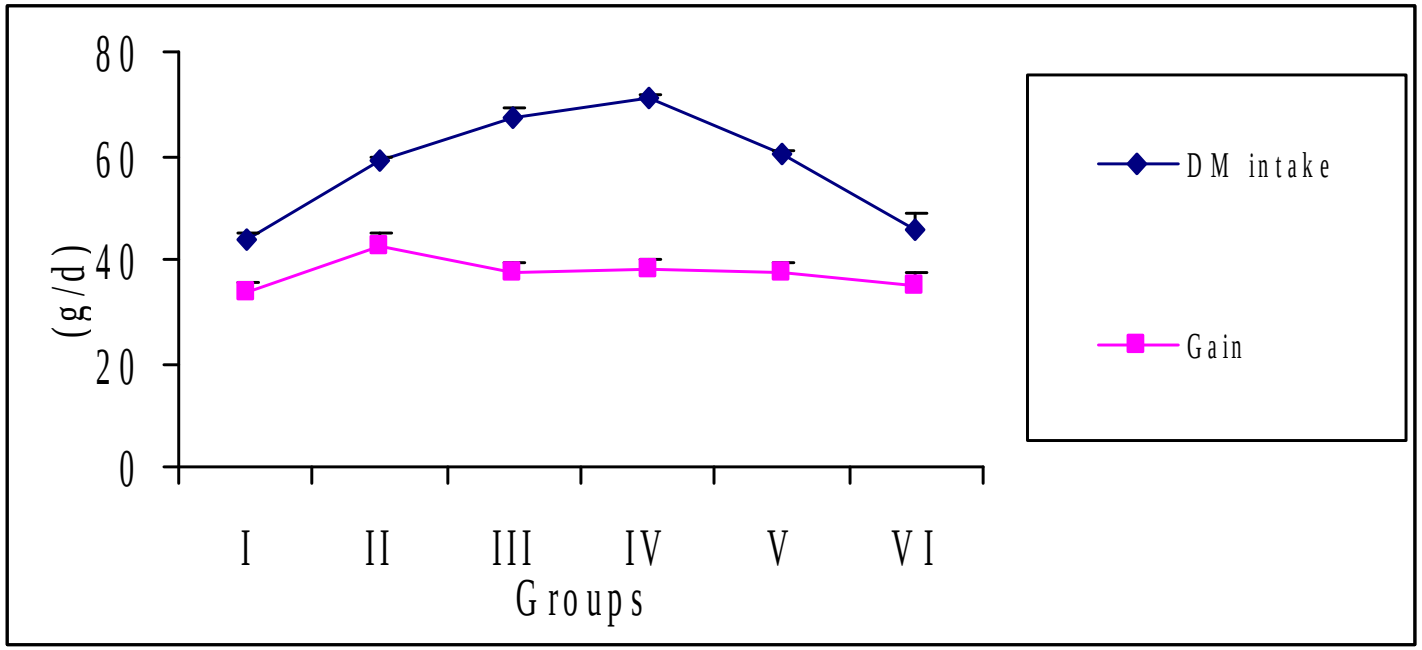
NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean
* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.
Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 63: The mean dry matter intake (g/ kg $W^{0.75}$) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0-60	49.34^{c}	59.67^{b}	60.10^{a}	50.60^{a}	39.63^{b}	35.27^{c}	1.44	**
61-90	64.12^{b}	63.85^{a}	70.74^{a}	60.90^{a}	46.67^{a}	43.26^{b}	2.3	**
91-120	65.08^{c}	76.75^{b}	81.32^{a}	68.96^{a}	52.69^{b}	50.89^{c}	1.21	**
121-150	58.83^{c}	69.65^{b}	72.90^{a}	61.26^{a}	44.68^{b}	46.50^{c}	1.02	**
Overall	43.03^{c}	72.72^{b}	88.55^{a}	91.64^{a}	73.65^{b}	39.08^{c}	3.64	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean
* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.
Means^{abcde} having different superscripts in row differ significantly ** (P<0.01)

Fig. 14: The overall dry matter intake (g/d/kgW$^{0.75}$) and gain (g/d) in pregnant goats of different groups



Lowest value was recorded in NC and group VI. Groups I and VI, II and V, and III and IV did not differ significantly.

Most of the studies conducted in the past in pregnant goats were based on dietary treatments consisting of balanced diet as per the requirement during the different stages of pregnancy which is quiet different from the present investigation where single feed ingredient feeding system was followed and no partitioning of nutrients were made at different stages of pregnancy. It is therefore very difficult to compare the findings of present investigation with that of the findings reported earlier. However in the present study the maximum DMI was obtained in group IV where soy DOC along with combined mineral of Cr, Zn and Se were added in the NC diet followed by group III where maize along with minerals were supplemented. The differences were highly significant. This was due to the fact that in these two groups the goats tried to meet out the protein or energy requirements in group III and IV respectively, therefore increasing the DMI. In the past it has been noted that during last stage of pregnancy the DMI was decreased and protein and energy requirements were increased for development of foetus (Rastogi, *et al*., 2006: Addah and Karikari, 2008).

4.4.2 Body weight changes

The effect of dietary treatments on change in body weight has been presented in table 64. The change in body weights were non significant amongst groups during the entire growth period except during 90-120 day where NC attained lowest gain. However, it did not differ significantly to group VI.

Weight after kidding was highest in group II (PC) and lowest in NC, however the difference amongst I, III, IV and VI groups were not significant. Also

groups II and V were not significant. Total weight gain was highest in group II (PC) followed by V and lowest in group VI. However, the difference amongst I, III, IV and V, and I, III, IV and VI were not significant.

Though in the present investigation there was no clear cut demarkation between the stages of pregnancy but it seems from the perusal of data that the maximum growth in the different treatments groups were recorded during the last quarter of pregnancy which were in accordance to the earlier reports (Bawala *et al*., 2006). It was due to fact that the maximum foetal growth takes place during this stage which significantly increases the overall gain in goats. With regards to the effect of dietary treatments, it was highly significant and maximum gain was recorded in concentrate and UMMB supplemented groups and the least was noticed in group I and VI, where diet was supplemented with or without minerals.

4.4.3 Average weight gain

The effect of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite on average weight gain was non significant at all periods except during 90-120 days where it was highest in group II and lowest in NC. However, groups II, III and IV, and I, III, IV, V and VI did not differ significantly. The overall gain was also non significant amongst the groups (Table 65). No concrete findings are available in the literature based on ingredient feeding to predict the average weight gain of pregnant goats.

Table 64: The body weight changes (kg) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0-60	17.06	17.29	17.75	17.53	17.71	17.54	0.22	NS
61-90	17.94	18.34	18.59	18.45	18.57	18.35	0.2	NS
91-120	18.93^{b}	20.30^{a}	20.12^{a}	20.03^{a}	19.70^{a}	19.63^{ab}	0.24	*
121-150	20.85	22.25	21.73	21.78	21.92	21.53	0.3	NS

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * ($P<0.05$)

Table 65: The mean weight gain (kg) in pregnant goat of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0-60	1.24	1.44	1.68	1.41	1.44	1.29	0.08	NS
61-90	0.88	1.05	0.84	0.92	0.86	0.82	0.06	NS
91-120	0.99^{b}	1.96^{a}	1.53^{ab}	1.58^{ab}	1.14^{b}	1.27^{b}	0.17	*
121-150	1.92	1.95	1.61	1.75	2.22	1.90	0.17	NS
Overall	1.55^{bc}	3.15^{a}	1.70^{bc}	1.73^{bc}	2.20^{b}	1.33^{c}	0.23	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * ($P<0.05$)

Table 66: The mean pregnancy variables in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
Initial body weight (kg)	15.83	15.85	16.08	16.13	16.28	16.25	0.18	NS
Final body weight (kg)	17.38^{c}	19.00^{a}	17.78^{bc}	17.85^{bc}	18.48^{ab}	17.58^{bc}	0.27	**
Total weight gain (kg)	1.55^{bc}	3.15^{a}	1.70^{bc}	1.73^{bc}	2.20^{b}	1.33^{c}	0.23	**
PGADG (g/d)	33.89	42.77	37.76	37.92	37.78	35.01	1.99	NS
Pregnancy weight (kg)	5.02	6.40	5.66	5.65	5.65	5.28	0.3	NS
AGL (days)	148.25	149.50	149.75	149.00	149.50	150.75	0.99	NS
Kid weight (kg)	1.23	2.10	2.04	1.84	1.41	1.17	0.27	NS

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

PGADG: pregnancy average daily gain, AGL: average gestation length,

Means^{abcde} having different superscripts in row differ significantly ** ($P<0.01$)

4.4.4 Pregnancy gain, gestation length and kids weight (pregnancy variables)

Weight of goat (final weight) after kidding was highest in group II (PC) and lowest in NC, however the difference amongst I, III, IV and VI was not significant. Also groups II and V were not significant. Total weight gain was highest in group II followed by V and lowest in VI. However, the difference amongst I, III, IV and V, and I, III, IV and VI were not significant. Similarly the effect of dietary treatments on various pregnancy parameters viz., pregnancy average daily gain (PGADG, g/d), pregnancy weight (kg), average gestation length (AGL) days and kid weight (kg) were non significant amongst groups (Table 66). Feeding of goats with additional allowance of concentrate mixture during last stage of pregnancy resulted in the overall increase of pregnancy gain and birth weight of kids, however the pregnancy periods was not affected by dietary treatments (Rastogi, *et al*., 2006). In the present investigation too the concentrate feeding in PC group resulted in more pregnancy gain and kid birth weight, however, other treatment groups did not affect much these parameters.

4.4.5 Nutrient utilization

The effect of dietary treatments on average nutrient intake (g/day) and digestibility of nutrients have been presented in table 67 and 68. Perusal of the data revealed highest DMI in III and IV followed by II and V and lowest in control and VI. These two later groups were non significant. DM digestibility was higher in group VI as compared to other groups. The difference between groups VI and control was non significant.

CP intake was highest in group IV and lowest in group VI. However, the difference between group VI and NC was non significant. Groups II, III and V were non significant. Digestibility coefficient of CP was higher in groups II, IV and VI as compared to other groups. However they did not differ significantly among themselves. It was followed by groups V and control and lowest in III.

EE intake was significantly higher in group III and IV and these groups were non significant to group V**.** No significant effect on intake was observed among groups I, II and VI. Digestibility of EE was non significant among themselves (Fig. 15).

Crude fiber intake was highest in group V and did not differ significantly from group IV. Lowest value was observed in NC. However the difference was non significant when compared with groups II and VI. Its digestibility was higher in group VI, however the values did not differ significantly when compared to groups I, II, IV and V. Lowest value could be recorded in group III but the difference was non significant as compared to groups II , III and IV, respectively.

NFE intake also differed significantly due to dietary treatments. Highest intake was recorded in group III followed by II and IV. The lowest value was recorded in NC. Digestibility coefficient of NFE was lowest in NC. There was no significant difference amongst other supplemented groups.

NDF intakes differed significantly amongst groups due to dietary treatments while treatment effect on digestibility was non significant. Highest intake was recorded in group V followed by IV and III and the lowest was recorded in NC. However the difference among control, II and VI was non significant.

Table 67: The mean nutrient intake (g/day) and digestibility coefficient in pregnant goats of different groups

Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+UMMB)	VI (NC+ Min*)		
Dry Matter								
Intake	360.73^{c}	616.29^{b}	764.81^{a}	784.68^{a}	635.12^{b}	334.57^{c}	28.21	**
Voided	165.15^{c}	359.49^{ab}	397.89^{a}	413.3^{a}	316.84^{b}	144.5^{c}	17.32	**
Digested	195.59^{c}	256.8^{b}	366.92^{a}	371.38^{a}	318.2^{a}	190.06^{c}	16.95	**
DC	54.04^{ab}	41.75^{d}	48.04^{c}	47.28^{c}	50.29^{bc}	56.76^{a}	1.51	**
Crude protein								
Intake	50.16^{c}	100.39^{b}	92.19^{b}	184.08^{a}	108^{b}	47.25^{c}	4.98	**
Voided	14.04^{b}	17.82^{b}	35.3^{a}	33.93^{a}	29.15^{a}	10.59^{b}	2.06	**
Digested	36.12^{d}	82.57^{b}	56.89^{c}	150.16^{a}	78.86^{b}	36.67^{d}	4.31	**
DC	71.89^{b}	82.26^{a}	61.72^{c}	81.62^{a}	72.43^{b}	77.63^{a}	1.65	**
Ether extract								
Intake	11.29^{c}	13.55^{bc}	21.64^{a}	21.36^{a}	17.5^{ab}	12^{c}	1.24	**
Voided	2.35^{c}	1.8^{c}	4.66^{ab}	5.43^{a}	4.53^{ab}	3.41^{bc}	0.52	**
Digested	8.94^{cd}	11.75^{bcd}	16.98^{a}	15.92^{ab}	12.98^{abc}	8.59^{d}	1.19	**
DC	79.09	87.08	77.62	74.58	73.32	72.08	3.43	NS
Crude fiber								
Intake	107.68^{c}	110.8^{c}	143.27^{b}	170.28^{a}	180.77^{a}	126.04^{bc}	7.63	**
Voided	49.26^{b}	55.48^{b}	88.61^{a}	88.19^{a}	76.59^{a}	49.35^{b}	4.90	**
Digested	58.41^{b}	55.32^{b}	54.66^{b}	82.09^{ab}	104.19^{a}	76.68^{ab}	9.18	*
DC	54.09^{a}	49.13^{ab}	37.95^{b}	47.94^{ab}	56.76^{a}	60.5^{a}	4.52	*
Nitrogenfree extract								
Intake	146.56^{c}	294.52^{b}	364.5^{a}	320.36^{ab}	292.44^{b}	159.88^{c}	14.07	**
Voided	90.01^{c}	134.4^{b}	174.67^{a}	152.59^{ab}	142.05^{b}	85.21^{c}	7.50	**
Digested	56.55^{b}	160.12^{a}	189.84^{a}	167.77^{a}	150.4^{a}	74.67^{b}	12.68	**
DC	38.49^{b}	54.32^{a}	51.57^{a}	51.76^{a}	51.5^{a}	46.52^{ab}	2.51	*

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **DC**: Digestibility coefficient, **NS**: non significant

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Fig.15: The digestibility coefficient of DM, CP, EE, CF and NEF in pregnant goats of different groups

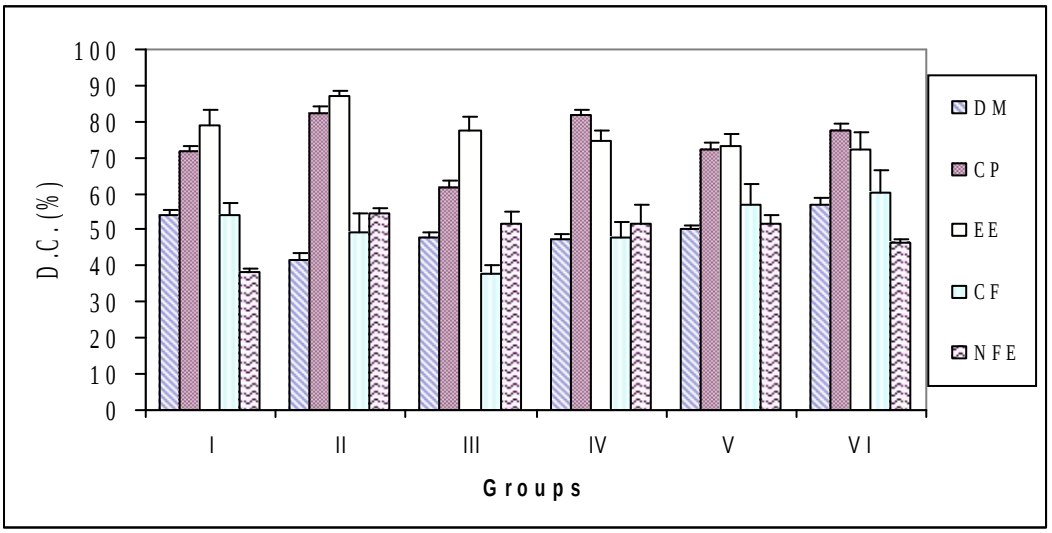
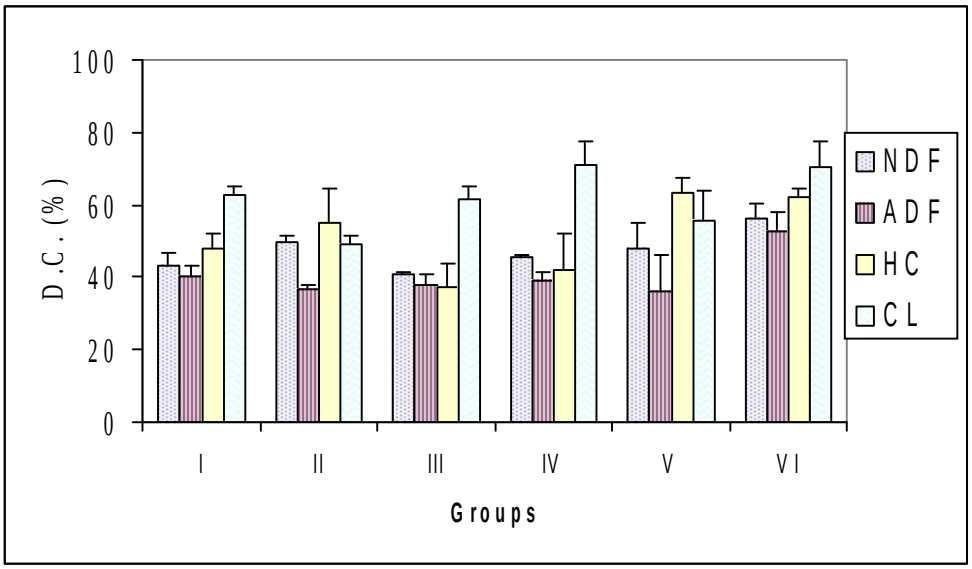


Fig.16: The digestibility coefficient of NDF, ADF, HC and CL in pregnant goats of different groups



Significant difference in ADF intake was recorded due to effect of dietary supplementation while its digestibility were non significant among groups. Its intake was highest in group V followed by groups IV, III, II and VI. Lowest was recorded in NC. The difference between groups IV and V, III and IV, and II and III were not significant. The difference among control, group II and VI was also observed to be non significant.

HC intake was highest in group V and lowest in NC due to the dietary treatments. However, the difference between groups I and VI were non significant. Also no significant difference was obtained amongst groups II, III and VI. Its digestibility was non significant amongst groups.

Cellulose intake differed significantly amongst groups due to dietary treatments (table 68). It was highest in group V followed by IV. However they did not differ significantly. Lowest intake was recorded in NC. No significant difference was obtained between NC and VI, II and III, and amongst II, III and VI. Similarly its digestibility was non significant among groups, being highest IV and lowest in II (Fig. 16).

The digestibility of nutrients plays a significant role in the overall availability of nutrient during the foetal growth. The goat has to adjust herself according to the physiological norms failing which the growth of the foetal gets affected due to physiological stress of goat. It has been reported by several workers (Ajayi, *et al*., 2005; Rastogi, *et al*., 2006; Bawala *et al*., 2006;) that the protein and energy digestibility increased during the last of pregnancy however the other nutrients are not much affected. These findings were in accordance to the present investigation where concentrate or soy DOC feeding improved the

Table 68: The mean fiber intake (g/day) and digestibility coefficient in pregnant goats of different groups

Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+UMMB)	VI (NC+ Min*)		
Neutral detergent fiber								
Intake	272.89^{c}	342.24^{bc}	376.64^{ab}	409.5^{ab}	446.76^{a}	302.73^{c}	20.89	**
Voided	154.33^{b}	172.09^{b}	223.96^{a}	223.67^{a}	227.87^{a}	131.64^{b}	12.82	**
Digested	118.56	170.15	152.68	185.83	218.89	171.1	17.33	NS
DC	43.41	49.91	40.54	45.35	47.79	56.41	2.88	NS
Acid detergent fiber								
Intake	161.3^{d}	191.55^{cd}	205.92^{bc}	237.24^{ab}	256.93^{a}	177.12^{cd}	11.94	**
Voided	96.23^{bc}	121.56^{bc}	127.53^{abc}	145.48^{ab}	159.5^{a}	84.67^{d}	9.57	**
Digested	65.07	69.98	78.4	91.76	97.43	92.45	11.16	NS
DC	40.2	36.4	37.79	38.86	36.27	52.53	4.25	NS
Hemicellulose								
Intake	111.6^{d}	150.69^{bc}	170.71^{ab}	172.26^{ab}	189.83^{a}	125.62^{cd}	9.47	**
Voided	58.11^{b}	63.02^{b}	106.44^{a}	98.19^{a}	68.37^{b}	46.97^{b}	6.62	**
Digested	53.49	87.67	64.28	74.07	121.47	78.65	13.62	NS
DC	48.06	54.91	37.33	42.28	63.36	61.84	6.04	NS
Cellulose								
Intake	105.83^{d}	139.56^{bc}	143.05^{bc}	162.18^{ab}	173.87^{a}	117.64^{cd}	8.97	**
Voided	39.09^{b}	71.22^{a}	54.96^{ab}	48.03^{ab}	75.36^{a}	37.2^{b}	8.77	*
Digested	66.74^{c}	68.33^{c}	88.09^{abc}	114.15^{ab}	98.52^{ab}	80.44^{c}	7.60	*
DC	62.93	49.36	61.28	71.11	55.61	70.5	4.94	NS

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **DC**: Digestibility coefficient, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

digestibility of these nutrients for the want of more protein and energy during this stage.

4.4.6 Balance study

The effect of dietary treatments on N, Ca and P intake and balance were highly significant amongst groups (Table 69 and fig 17). Nitrogen intake and balance was highest in group IV and lowest in groups VI and NC. The difference between groups I and VI, and II, III and V were not significant.

Calcium intake and balance was highest in group IV and lowest in VI, however the intake in group IV was non significant to group V. Similarly group VI did not differ from NC. The Ca balances among I, IV and V, between II and III, and I and III was non significant.

Phosphorus intake and balance were significantly affected due to dietary treatments among the groups. The intake and the balance were highest in group III and lowest in group VI. Intake of P in group III did not differ from IV and V, while group VI was similar to I and II groups. The P balance also did not differ amongst III, IV and V, while group VI was similar to NC. Similarly groups II and IV did not differ from each other.

No exhaustive studies were carried out in the past to record the balance of N, Ca and P during pregnancy though certain predictions were made, which are incomparable with present findings. In the present investigation, it has been observed that N, Ca and P balances were more during the last stage of pregnancy due to feeding of soy DOC and combined mineral supplements in group IV. This was due to availability of more amino acid for the foetal development which significantly increased the balance. Similar is the case with Ca and P balances.

Table 69: The mean N, Ca and P balances in pregnant goats of different groups

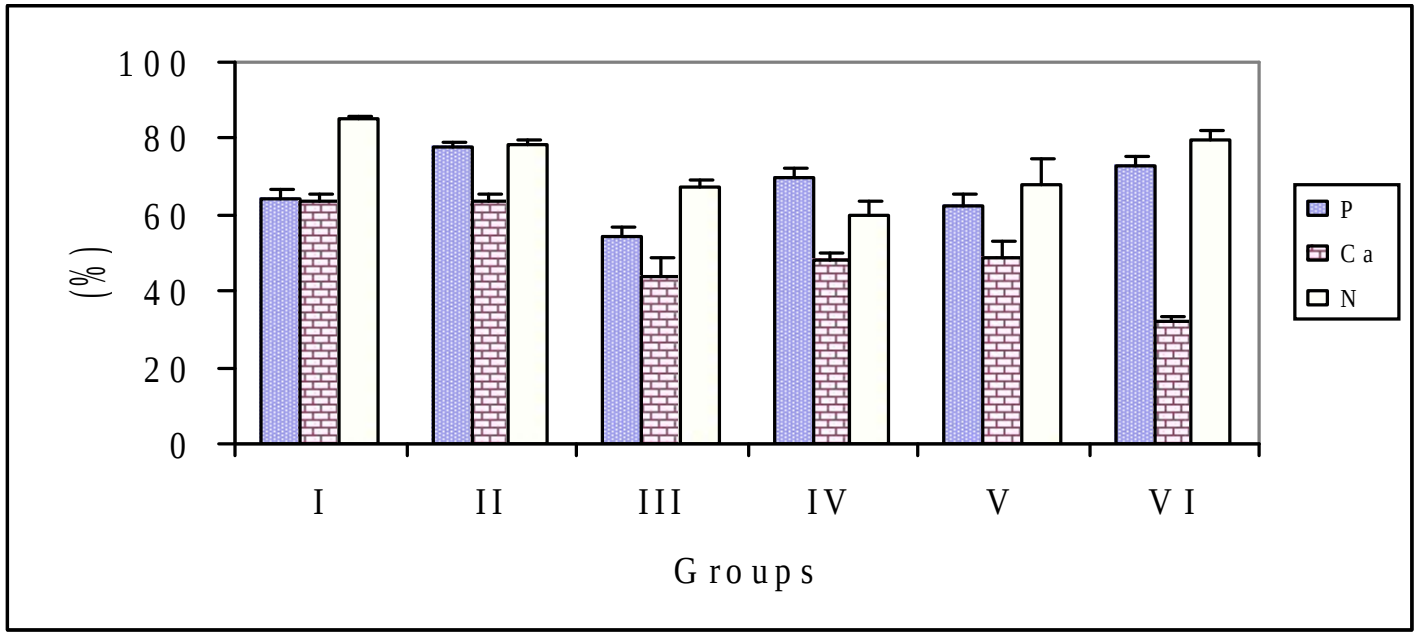
Particulars	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+UMMB)	VI (NC+ Min*)		
Nitrogen (g/day)								
Intake	3.14^{c}	6.28^{b}	5.76^{b}	11.51^{a}	6.75^{b}	2.96^{c}	0.31	**
Faecal outgo	0.88^{b}	1.12^{b}	2.21^{a}	2.12^{a}	1.82^{a}	0.67^{b}	0.13	**
Urinary outgo	0.23^{cd}	0.28^{cd}	0.40^{c}	1.39^{a}	0.65^{b}	0.13^{b}	0.07	**
Balance	2.03^{d}	4.88^{b}	3.15^{cd}	8.00^{a}	4.28^{bc}	2.16^{d}	0.29	**
Balance (%)	64.50^{cd}	77.67^{a}	54.62^{e}	69.6^{bc}	62.19^{d}	73.12^{ab}	2.30	**
Calcium (g/day)								
Intake	4.92^{d}	7.72^{c}	9.78^{b}	12.75^{a}	11.98^{a}	4.58^{d}	0.43	**
Faecal outgo	1.35^{c}	2.04^{bc}	4.44^{a}	5.03^{a}	4.20^{a}	2.46^{b}	0.27	**
Urinary outgo	0.46^{c}	0.78^{bc}	1.09^{b}	1.59^{a}	1.84^{a}	0.67^{c}	0.12	**
Balance	3.11^{c}	4.91^{ab}	4.25^{bc}	6.14^{a}	5.94^{a}	1.46^{d}	0.36	**
Balance (%)	63.33^{a}	63.63^{a}	43.57^{b}	48.23^{b}	48.57^{b}	31.85^{c}	2.86	**
Phosphorus (g/day)								
Intake	2.89^{b}	3.78^{b}	9.19^{a}	7.28^{a}	8.01^{a}	2.72^{b}	0.39	**
Faecal outgo	0.35^{c}	0.74^{c}	2.68^{a}	2.63^{a}	2.00^{b}	0.52^{c}	0.15	**
Urinary outgo	0.08	0.09	0.35	0.32	0.31	0.06	0.06	NS
Balance	2.46^{bc}	2.95^{bc}	6.17^{a}	4.33^{ab}	5.70^{a}	2.14^{c}	0.36	**
Balance (%)	84.88^{a}	78.13^{a}	67.1^{b}	59.74^{b}	67.97^{b}	79.41^{a}	2.85	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly ** ($P<0.01$)

Fig.17: The overall phosphorus (P), calcium (Ca) and nitrogen (N) balances (%) in pregnant goats of different groups



4.4.7 Hematological study

Influence of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite on hematological parameter in pregnant goat under various groups has been presented in tables 70 to 74 and depicted in fig. 18.

4.4.7.1 Haemoglobin (Hb)

Perusal of data revealed no significant difference amongst groups up to 60 days due to the various treatments however significant observations were recorded during 90, 120 and 140 days. On 90^{th} and 120^{nd} day higher values were obtained in groups II, III, IV and V as compared to control and group V. At 140 days highest value was recorded in group II and lowest in NC. However, the values between NC and groups V and VI were similar. Similarly the values of groups III, IV, V and VI were non significant.

The overall Hb concentration was significantly lower in NC and VI as compared to other groups. However the other groups did not differ significantly from one another (Fig. 18).

There is heavy demand of Hb during last stage of pregnancy as there is constant flow of blood between the fetus and doe. To maintain the normal level of Hb additional allowance of concentrate rich in high quality protein along with certain mineral elements like Cu and Fe with vitamin premix having adequate quantity of folic acid is given. In the past several experiments with different feeding regimes have been carried out where the normal level of Hb could be maintained (Azab and Abdel, 1999). Since, there may be significant change in Hb of goats during pregnancy due to feeding of different ingredients. The present

Table 70: The mean haemoglobin concentration (g/dl) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	6.46	6.73	6.57	6.07	5.83	6.33	0.48	NS
30	7.83	8.54	8.38	8.27	8.23	8.31	0.16	NS
60	7.92	8.19	8.43	8.55	8.62	8.38	0.16	NS
90	8.4^{b}	9.08^{a}	9.03^{a}	9.11^{a}	9.11^{a}	8.57^{b}	0.15	*
120	9.1^{b}	10.32^{a}	10.24^{a}	10.08^{a}	10.33^{a}	8.92^{b}	0.15	**
140	8.13^{c}	9.13^{a}	8.7^{b}	8.73^{b}	8.5^{bc}	8.39^{bc}	0.11	**
Overall	7.97^{b}	8.66^{a}	8.56^{a}	8.47^{a}	8.44^{a}	8.15^{b}	0.08	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 71: The mean total erythrocyte count (10^6/mm^3) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	6.69	6.73	7.24	6.33	6.42	5.87	0.63	NS
30	6.95^{c}	8.38^{b}	8.68^{ab}	8.55^{b}	9.16^{a}	8.5^{b}	0.15	**
60	7.76^{c}	9.34^{ab}	9.42^{a}	9.57^{a}	9.26^{ab}	8.78^{b}	0.17	**
90	9.23^{a}	10.18^{a}	10.26^{a}	10.33^{a}	10.39^{a}	9.38^{b}	0.13	**
120	9.65^{b}	11.4^{a}	10.67^{a}	10.86^{a}	11.04^{a}	9.6^{b}	0.28	**
140	8.13^{b}	9.23^{a}	8.94^{a}	9.15^{a}	9.17^{a}	9.16^{a}	0.17	**
Overall	8.07^{c}	9.21^{a}	9.21^{a}	9.13^{a}	9.24^{a}	8.55^{b}	0.13	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly ** (P<0.01)

Table 72: The mean packed cell volume (%) in pregnant goats of different groups

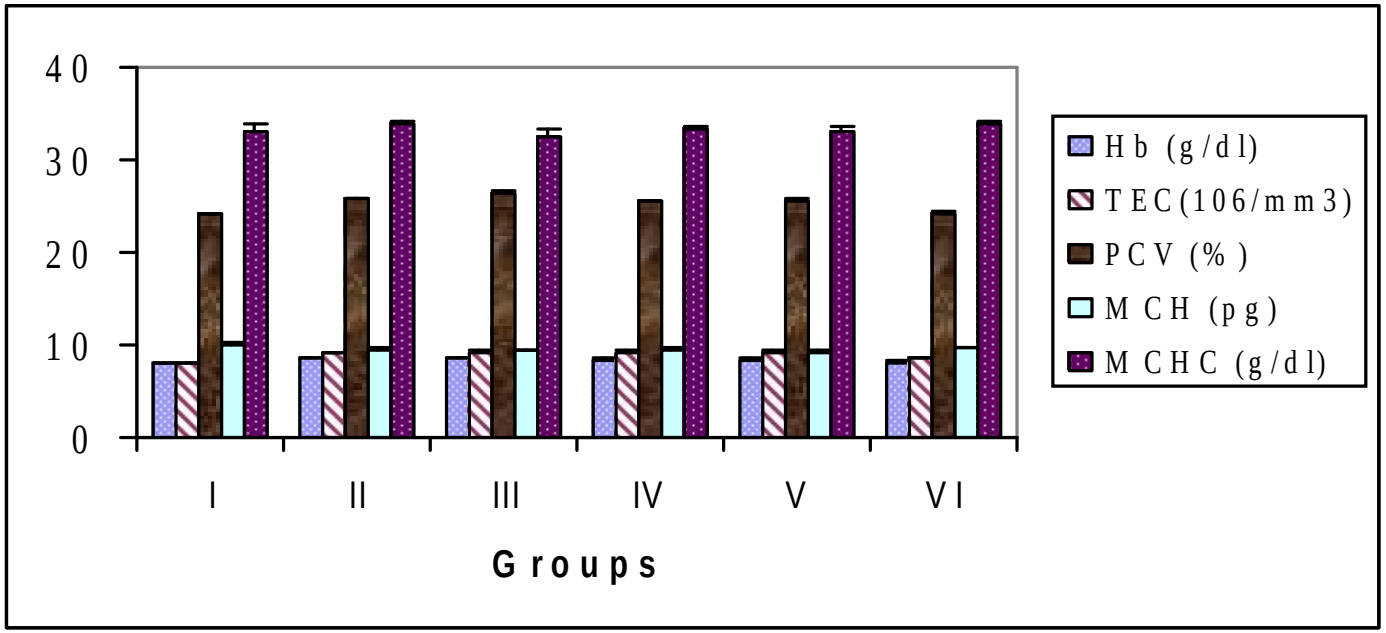
Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	19.51	20.12	19.17	20.21	19.11	19.31	0.63	NS
30	23.51^{b}	23.12^{b}	27.67^{a}	$22.^{21bc}$	21.86^{bc}	21.31^{c}	0.50	**
60	24.34^{d}	27.05^{a}	25.87^{abc}	24.91^{cd}	26.54^{ab}	25.58^{bcd}	0.34	**
90	25.04^{b}	27.33^{ab}	27.61^{a}	27.39^{a}	27.73^{a}	25.71^{b}	0.48	**
120	26.56^{b}	30.97^{a}	30.68^{a}	29.91^{a}	30.19^{a}	27.11^{b}	0.39	**
140	25.56^{b}	25.96^{ab}	27.6^{ab}	28.17^{a}	28.16^{a}	25.98^{ab}	0.62	*
Overall	24.09^{c}	25.76^{ab}	26.43^{a}	25.47^{b}	25.60^{b}	24.17^{c}	0.23	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Fig.18: The overall mean serum haematological (Hb) and RBC (TEC, PCV, MCH and MCHC) indices in pregnant goats of different groups



investigation was carried to explore the possibilities of supplementing the best feed ingredient in the field condition where the balance concentrate mixture is the constraint. It has been found in the present study that the feeding of soy DOC or maize as single ingredient with Cr, Zn and Se could support the normal Hb level as in group PC where concentrate mixture was fed.

4.4.7.2 Total erythrocyte count (TEC)

There was significant influence of dietary supplements on TEC during the entire period of study. Higher values were obtained in supplemented groups as compared to control except on 90^{th} and 120^{th} day where control group showed higher value than other groups. On 30^{th} day highest value was recorded in group V followed by III though they did not differ significantly. The lowest value was recorded in control. On 140^{th} day lowest value was recorded in NC and all other supplemented groups did not differ significantly among themselves.

The overall TEC values was found to be significantly lowest ($P<0.01$) in NC followed by group VI. Other groups were significantly higher than the former, however, these groups were non significant from each other.

Though the normal level of Hb was maintained during the mid and last stage of pregnancy but TEC were significantly higher in concentrate, maize and soy DOC supplemented groups. This was due to the fact that the animals received more CP and energy than what is required by the goats as indicated in table 71. However, some workers (Azab and Abdel, 1999: Iriadam, 2007) reported low TEC during pregnancy due to inadequate supply of amino acid and energy through diets to goats during pregnancy.

4.4.7.3 Packed cell volume (PCV)

Significant difference among the groups were recorded for PCV due to the influence of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite as presented in table 72.

On 30th day higher value was recorded in group III as compared to other groups. Non significant difference could be noticed amongst NC, PC, UMMB and mineral supplemented groups. Group VI was significantly lower than NC and other supplemented groups, while values in groups IV and V were non significant to each other. On 60th day highest value was recorded in concentrate supplemented group and lowest in NC. However, groups II, III, and V were non significant among themselves. On 90th and 120th day supplemented groups had higher values except in VI which was similar to NC. The other groups were similar to each other. On 140th day groups IV and V differed significantly than control, while difference among other groups were non significant.

Significantly ($P<0.01$) highest overall value of PCV was observed in group III and lowest in NC and VI. However, group II was non significant to groups III, IV and V.

The PCV recorded reported significantly higher in goats during last stage of pregnancy due to increase TEC (Hoversland, *et al*., 1992). The findings of present investigation were in accordance with earlier reports.

4.4.7.4 Mean corpuscular haemoglobin (MCH)

Influence of dietary treatments on mean corpuscular haemoglobin (pg) in pregnant goat have been presented in table 73. Perusal of data revealed significant

Table 73: The mean corpuscular haemoglobin (pg) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+Min*)		
0	9.97	10.25	9.27	10.59	9.33	10.82	1.26	NS
30	11.35[a]	10.2[b]	9.66[c]	9.68[c]	8.99[c]	9.78[bc]	0.21	**
60	10.23[a]	8.78[b]	8.95[b]	8.94[b]	9.3[b]	9.57[a]	0.21	**
90	9.1	8.95	8.8	8.82	8.79	9.13	0.20	NS
120	9.43	9.09	9.6	9.31	9.42	9.29	0.27	NS
140	10.08	9.9	9.74	9.54	9.28	9.17	0.24	NS
Overall	10.03	9.53	9.34	9.48	9.18	9.62	0.19	NS

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means[abcde] having different superscripts in row differ significantly ** (P<0.01)

Table 74: The mean cell haemoglobin concentration (g/dl) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+Min*)		
0	33.15	33.84	34.56	29.93	30.57	32.77	2.54	NS
30	33.38[b]	36.98[a]	30.34[c]	37.23[a]	37.64[a]	39.05[a]	0.94	**
60	32.54	30.3	32.6	34.36	32.48	32.87	0.84	NS
90	33.57	33.25	32.71	33.3	32.87	33.37	0.81	NS
120	34.27	33.34	33.41	33.7	34.22	32.9	0.59	NS
140	31.85[b]	35.16[a]	31.66[b]	31[b]	30.22[b]	32.34[b]	0.70	**
Overall	33.13	33.81	32.55	33.25	33.00	33.88	0.46	NS

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means[abcde] having different superscripts in row differ significantly ** (P<0.01)

difference on 30th and 60th day while the differences were non significant at other periods. On 30th day the value was significantly higher in NC as compared to other groups. Lowest value was recorded in group V which did not differ to groups III, IV and VI. On 60th day it was significantly higher in VI than other supplemented groups except NC. Significant difference among treatments of overall values of MCH could not be established.

The level of MCH was reported higher in low protein diet (Mbassa and Poulsen, 1991; Azab and Abdel, 1999) which was in accordance with the present findings where it was higher in NC group having lowest level of dietary protein. The other treatments groups did not differ significantly as the level of dietary protein in these groups were almost similar (Hoversland, *et al*., 1992).

4.4.7.5 Mean corpuscular haemoglobin concentration (MCHC)

Significant effect on 30th and 140th day could be recorded due to the effect of dietary treatments (table 74). On 30th day it was significantly lower in group III than NC and other groups. The difference amongst II, IV, V and VI was non significant. On 140th day it was significantly higher in group II than other groups. The other group were non significant to each other. Significant difference among overall value of MCHC could not be established.

The values of MCHC were found constant as per the earlier reports (Azab and Abdel, 1999) when diet of doe was supplemented with different levels of concentrate mixture. Similarly in the present investigation no significant difference was recorded amongst the groups due to the feeding of concentrate, UMMB or single feed ingredients throughout the experiment except during certain periods.

4.4.8 Biochemical study

4.4.8.1 Total serum protein

Influence of dietary supplements on total serum protein has been presented in table 75. Significant difference could be noticed in all periods except on 30th day. Lowest value was recorded in NC as compared to other groups except on 60th day where it was lower in group V however the difference was non significant. No significant difference was obtained among control, II, V and VI groups on 60th day. On 90th day also no significant difference was obtained among groups except control which was significantly lower than others. On 120th day it was significantly lower in group I than groups III, IV and V. On 140th day highest value was recorded in group IV, though it was non significant. It was also non significant when NC was compared to groups III and V.

The overall total serum protein was found to be significantly lower ($P<0.01$) in NC as compared to other groups (Fig. 19).

Sahlu *et al*. (1995) reported no significant difference in serum protein due to feeding of standard diet to the doe while Iriadam, (2007) reported significant reduction in the level of total serum protein. This was due to the difference in protein content of the diet as well as the stage of pregnancy while in the present investigation the total serum protein was found higher in concentrate, UMMB or single feed ingredient fed goats. This could be reflected by the level of dietary proteins. Total protein was found constant throughout the pregnancy periods in goat maintained on normal feeding (Sahlu *et al*. 1995; Amal *et al.*, 2008). However, Juma *et al* (2009) reported higher total protein in advanced stage of pregnancy in goat.

Table 75: The mean total serum protein (mg/dl) in pregnant goats of various groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	6.68	7.18	6.6	7.35	7.34	6.51	0.21	NS
30	6.03	7.79	7	7.24	6.43	6.86	0.49	NS
60	6.23^{b}	7.06^{ab}	7.52^{a}	7.51^{a}	6.01^{b}	$6.^{33ab}$	0.31	*
90	6.55^{b}	8.29^{a}	7.54^{a}	7.44^{a}	7.85^{a}	7.61^{a}	0.25	**
120	5.85^{c}	7.48^{ab}	7.67^{a}	7.56^{a}	7.88^{a}	6.74^{b}	0.25	**
140	6.15^{c}	7^{b}	6.78^{cb}	7.84^{a}	7.35^{abc}	6.69^{b}	0.25	**
Overall	6.25^{c}	7.47^{a}	7.18^{a}	7.49^{a}	7.14^{a}	6.79^{b}	0.11	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 76: The mean total serum albumin (mg/dl) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	2.56	2.65	2.77	2.64	2.58	2.85	0.14	NS
30	2.99	3.2	3.18	2.83	3.1	3	0.13	NS
60	2.42^{b}	3.27^{a}	3.35^{a}	3.18^{a}	3.37^{a}	2.53^{b}	0.17	**
90	2.57^{b}	3.36^{a}	3.41^{a}	3.26^{a}	3.49^{a}	2.83^{b}	0.12	**
120	2.62^{c}	3.19^{ab}	3.39^{a}	2.98^{abc}	3.29^{ab}	2.79^{bc}	0.16	*
140	2.47^{c}	3.43^{a}	3.13^{ab}	2.8^{bc}	3.15^{ab}	3.02^{abc}	0.14	*
Overall	2.61^{c}	3.18^{a}	3.20^{a}	2.95^{b}	3.17^{a}	2.84^{b}	0.04	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 77: The mean total serum globulin (mg/dl) in pregnant goats of different groups

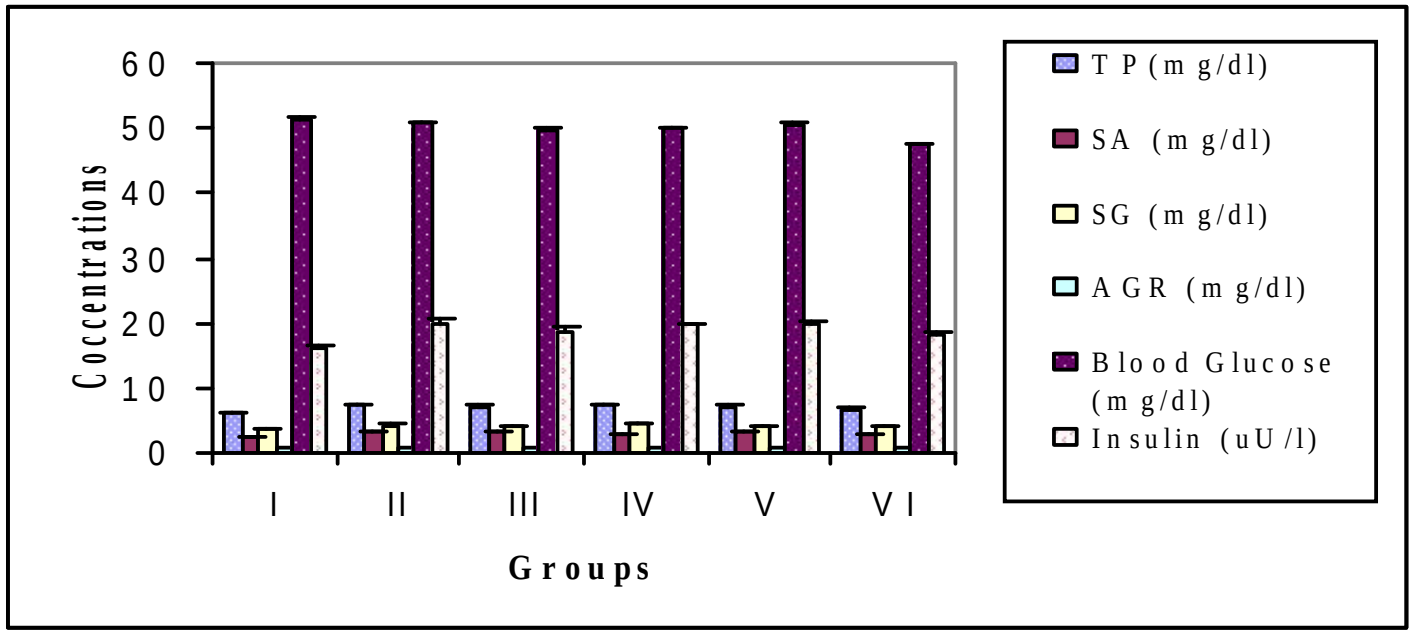
Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	4.13	4.53	3.84	4.72	4.76	3.66	0.26	NS
30	3.04	4.58	3.82	4.41	3.33	3.86	0.48	NS
60	3.81	3.78	4.17	4.33	2.64	3.8	0.35	NS
90	3.98	4.93	4.13	4.17	4.36	4.79	0.22	NS
120	3.24	4.29	4.29	4.59	4.59	3.96	0.29	NS
140	3.67^{b}	3.57^{b}	3.64^{b}	5.04^{a}	4.2^{ab}	3.67^{b}	0.27	*
Overall	3.65^{c}	4.28^{ab}	3.98^{bc}	4.54^{a}	3.98^{bc}	3.96^{bc}	0.13	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Fig.19: The overall serum total protein (TA), albumin (SA), globulin (SG), albumin: globulin ratio (AGR), blood glucose and serum insulin in pregnant goats of different groups



4.4.8.2Total serum albumin

Total serum albumin level was significantly different in various groups due to the influence of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite from 60 days till end of experiment (Table 76). At 60 and 90 days of experiment significantly lower value was recorded in control and group VI than all other groups, however the difference was non significant among the other groups. Similarly lower value was also recorded in negative control group at 120 and end of experiment.

Overall serum albumin values were found to be significantly lowest ($P<0.01$) in NC after group VI, whereas other groups were significantly higher than the former.

The level of serum protein affected the level of serum albumin due to change in the overall proportion of protein fraction in the body pool. The reports are scares in the literature regarding the change of serum albumin in doe due to feeding of concentrate, UMMB or single feed ingredients. Serum albumin level was found constant throughout the pregnancy periods in goat maintained on normal feeding (Amal *et al.,* 2008). However, Juma *et al* (2009) reported higher albumin in advanced stage of pregnancy in goat.

4.4.8.3 Serum globulin

The total serum globulin level due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite (Table 77) was non significantly different among various groups during the experimental period except at the end of the trial. The level in group IV was recorded to be highest than all the groups. However, the difference was

non significant with group V and other groups were significantly similar to each other.

Overall serum globulin value was significantly lower in NC. Other groups were non significant.

As reported earlier in the section of serum protein the level of serum globulin also affected due to variation in the content of dietary protein. However a constant serum globulin level was found throughout the pregnancy periods in goat maintained on normal feeding (Amal *et al.,* 2008).

4.4.8.4 Blood glucose

The blood glucose concentration has significant effect due to influence of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite (Table 78) from 60 -90 days. On 90 day highest value of blood glucose was recorded in group I and lowest in group VI, however, the difference among the groups II, IV, V and VI was non significant. Higher value was recorded in group I and VI followed by group II, however other groups were non significant among themselves on 120 days. At the end of trail, highest value could be recorded in group I and lowest in group VI, whereas other groups were non significant among themselves.

Overall blood glucose level was significantly ($P<0.01$) higher in NC followed by groups II, III and VI.

Khan and Ludri (2002) reported higher blood glucose in early stage and lower in late pregnancy in goats maintained on berseem hay and concentrate mixture. Similar findings were obtained in the present investigation during early and late stage of pregnancy. The higher level was recorded in the roughage based

Table 78: The mean blood glucose (mg/dl) concentrations in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	48.00	46.50	46.50	47.50	47.00	46.25	0.88	NS
30	51.25	50.00	48.75	48.75	49.50	47.75	0.32	NS
60	52.50	50.00	50.00	50.00	50.50	47.75	0.68	NS
90	57.00^{a}	52.50^{b}	50.25^{cd}	50.25^{cd}	51.00^{c}	49.00^{d}	0.40	**
120	59.00^{a}	56.00^{b}	53.75^{bc}	53.75^{bc}	54.50^{bc}	49.00^{a}	0.41	**
140	54.00^{a}	49.00^{b}	48.25^{b}	48.25^{b}	48.25^{b}	45.50^{c}	0.48	*
Overall	51.50^{a}	50.75^{b}	49.75^{c}	50.0^{bc}	50.50^{bc}	47.50^{a}	0.22	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * ($P<0.05$),** ($P<0.01$)

Table 79: The mean insulin (uU/l) concentrations in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	15.5	15.75	15	14.5	14.75	14.25	0.76	NS
30	15	16.5	15	15.75	15	15.25	0.75	NS
60	15	21.25	20.25	22	21.5	17.75	1.16	NS
90	18	23.25	23.5	24.75	22.5	23.5	0.84	NS
120	19.75	26.5	24.5	23.5	23.75	22	0.69	NS
140	13.5	15	14.5	17.25	20.25	16.5	0.73	NS
Overall	16.25^{c}	19.75^{ab}	18.75^{ab}	20.00^{a}	19.75^{ab}	18.25^{b}	0.45	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly ** ($P<0.01$)

diet as reported earlier and lower levels of glucose was measured in the treatments groups. It indicated that the soluble carbohydrates of treatment groups were more efficiently utilized as compared to NC. The minerals combined in the treatment groups might have promoted the glucose utilization reaction by enhancing the activity of insulin.

4.4.8.5 Insulin

Changes in the levels of insulin due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and sodium selenite have been presented in table 79. Perusal of data revealed significant difference among groups except on 30 days. Lowest value was recorded in negative control group. However, at 60 days the difference was non significant than group VI and at 140 days it was non significant as compared to groups II and III.

Overall insulin concentration was recorded to be highest in group IV and lowest in NC. However, groups II, III, IV and V, and groups II, III, IV and VI did not differ significantly.

Juares-reyes *et al* (2004) and Khan and Ludri (2002) reported higher insulin in early stage and lower in late stage of pregnancy in goats fed berseem hay ad lib and concentrate mixture at the rate of 300 g per day. The results are in accordance to the present investigation.

4.4.8.6 Albumin: globulin ratio

The albumin: globulin ratio in various groups was significantly different on 60 and 90 days. On 60 day value for group V was highest and other groups were non significant to each other. At 90 days lowest value could be recorded in

Table 80: The mean albumin:globulin ratio (mg/dl) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	0.66	0.59	0.73	0.57	0.55	0.8	0.06	NS
30	1.02	0.71	0.86	0.76	1.06	0.8	0.13	NS
60	0.64^{b}	0.9^{b}	0.81^{b}	0.79^{b}	1.37^{a}	0.69^{b}	0.12	*
90	0.66^{c}	0.7^{abc}	0.83^{a}	0.79^{ab}	0.81^{ab}	0.59^{c}	0.04	*
120	0.82	0.76	0.82	0.67	0.73	0.72	0.08	NS
140	0.73	0.96	0.9	0.57	0.76	0.83	0.08	NS
Overall	0.75^{bc}	0.77^{abc}	0.83^{ab}	0.69^{c}	0.88^{a}	0.74^{bc}	0.03	*

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * ($P<0.05$)

Table 81: The mean alkaline phophatase activity (IU/100 ml) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	136.77	140.25	150.50	152.87	165.27	156.36	6.81	NS
30	147.24	166.06	160.51	175.73	170.53	161.50	10.79	NS
60	152.28	162.00	172.27	182.24	180.01	178.03	8.93	NS
90	200.97	202.30	195.47	205.74	194.49	173.51	18.64	NS
120	242.38	250.92	240.01	270.25	264.79	244.25	17.08	NS
140	143.45^{c}	177.78^{bc}	216.40^{ab}	233.79^{a}	232.32^{a}	184.27^{b}	11.78	**
Overall	170.51^{b}	183.22^{ab}	189.19^{ab}	203.44^{a}	201.24^{a}	182.99^{ab}	6.33	*

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * ($P<0.05$),** ($P<0.01$)

group VI, which was non significant to positive control. The difference of value was non significant among groups I, II, III, IV and V and groups I, II, IV and V (Table 80).

As such there were no findings with regards to albumin: globulin ratio however looking to the levels of albumin and globulin in serum it can be predicted that there was no significant difference during the three stages of pregnancy when goats were fed roughage along with concentrate mixture as per the requirement (Amal *et al.,* 2008). These reports could be corroborate with the present findings.

4.4.8.7 Alkaline phosphatase activity

Overall alkaline phasphatase activity was found to be higher in group IV and V and lower in NC. Groups II, III and VI were non significant to each other (Table 81).

Mgassa and Poulsen (1991) and Juma *et al* (2009) reported that alkaline phosphatase activity was higher in early stage and lower in late state of pregnancy in goats. However they have not tested the effect of single feed ingredients on the enzyme activity. In the present investigation the activity of enzyme did not follow a definite trend from early to late pregnancy however it was more due to feeding of soy DOC and UMMB along with roughage.

4.4.9 Mineral study

4.4.9.1 Zinc (Zn)

Serum zinc level in pregnant goat has significant effect due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite (Table 82). During 30 and 60 days of trial significantly lower values were observed in control, groups IV and VI when

compared to groups II, III and V. However, these groups were non significant among themselves. During 120 days lowest value was recorded in group VI and other groups were non significant to each other while on 140 days, lowest value was measured in negative control group, which was non significant to group VI. The non significant values were also recorded for groups II and III, and IV, V and VI.

Highest value of overall serum Zn concentration was recorded in groups II and III and lowest in NC. However, NC, IV and VI, and II, III and V did not differ significantly among themselves (Fig. 20).

No recent data are available on the effect of concentrate mixture or single feed ingredients including UMMB on the levels of serum zinc during early, mid and late stage of pregnancy in sheep or goat. In the present investigation the level of zinc was found when concentrate mixture or maize alone was fed with the roughage. This was reflected by the mineral content of feeding ingredients.

4.4.9.2 Chromium (Cr)

Influence of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite on serum chromium in pregnant goats under various groups has been presented in table 83. Significant difference was recorded during the entire experimental period. At 30 days group II, III, IV and V were non significant to each other, but these groups were significantly higher than VI and negative control. At 60 days, value was observed highest in group II, which was non significant to group II. The other group were also non significant to each other. Significantly lower value was recorded in groups I and VI than other groups. No significant difference was

Table 82: The mean serum zinc (ppm) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	2.49	2.50	2.45	2.53	2.42	2.46	0.10	NS
30	2.43^{b}	3.15^{a}	3.01^{a}	2.33^{b}	3.36^{a}	3.24^{b}	0.15	**
60	2.55^{b}	3.18^{a}	3.49^{a}	3.05^{b}	2.86^{a}	2.88^{b}	0.26	**
90	2.86	3.52	3.11	3.17	3.42	2.72	0.20	NS
120	3.47^{a}	3.55^{a}	3.29^{a}	3.26^{a}	3.27^{a}	2.52^{b}	0.09	**
140	2.3^{c}	3.47^{a}	3.5^{a}	2.86^{b}	2.91^{b}	3.33^{bc}	0.13	*
Overall	2.67^{c}	3.24^{a}	3.14^{a}	2.87^{ab}	3.04^{ab}	2.86^{bc}	0.08	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 83: The mean serum chromium (ppm) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	3.84	3.39	3.47	3.69	3.88	3.41	0.21	NS
30	4.37^{b}	5.34^{a}	5.51^{a}	5.22^{a}	5.41^{a}	4.44^{c}	0.18	**
60	4.49^{b}	5.02^{a}	4.98^{a}	3.56^{b}	3.41^{b}	3.53^{b}	0.30	*
90	3.88^{b}	6.58^{a}	6.29^{a}	6.36^{a}	6.04^{a}	5.08^{b}	0.37	**
120	4.58^{c}	7.41^{ab}	7.33^{ab}	7.68^{a}	6.25^{b}	5.78^{c}	0.26	**
140	4.42	4.83	4.32	4.68	4.61	4.19	0.28	NS
Overall	4.26^{c}	5.43^{a}	5.32^{a}	5.20^{ab}	4.94^{b}	4.41^{c}	0.11	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 84: The mean serum selenium (ppm) in pregnant goats of different groups

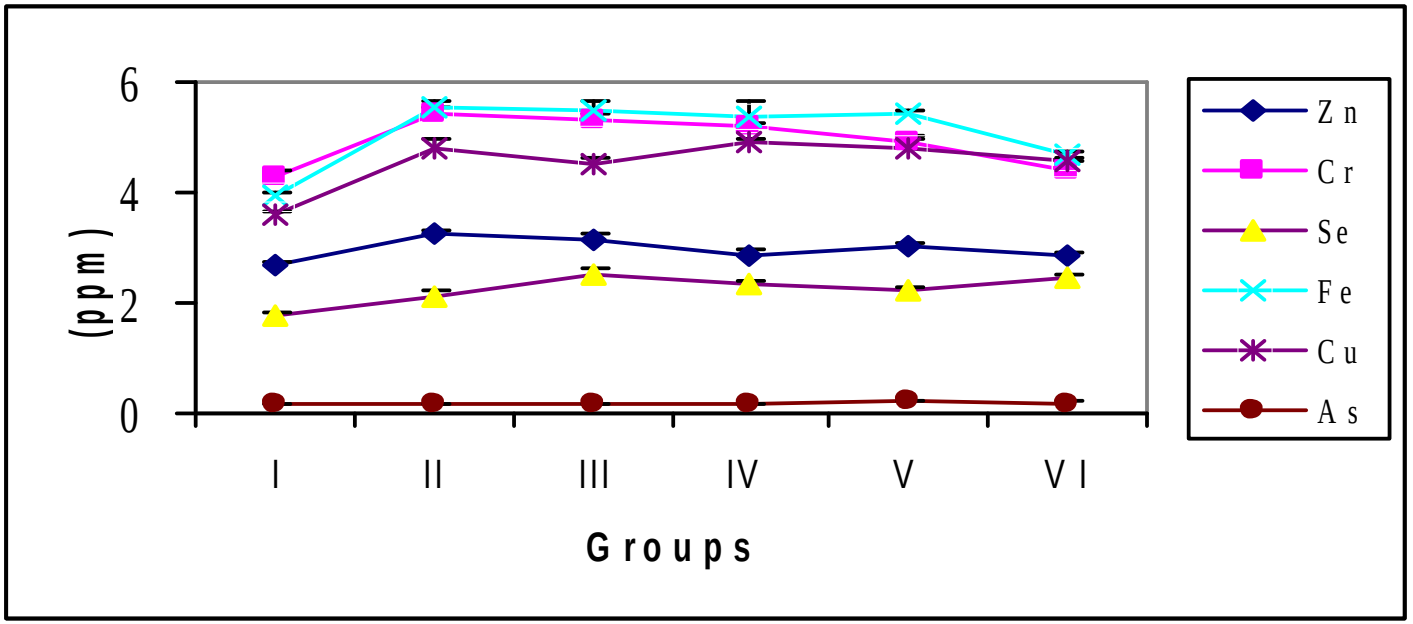
Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	1.5	1.46	1.56	1.36	1.7	1.72	0.27	NS
30	1.64	2.23	2.8	2.56	2.38	2.51	0.13	NS
60	1.63^{b}	1.56^{b}	2.62^{a}	2.46^{a}	2.61^{a}	2.64^{a}	0.12	**
90	2.41	2.55	2.48	2.63	2.58	2.94	0.14	NS
120	1.93	3.01	2.82	2.43	2.55	3.12	0.23	NS
140	1.84^{b}	1.98^{b}	1.96^{b}	1.78^{b}	1.42^{b}	1.7^{a}	0.32	**
Overall	1.79^{d}	2.1^{c}	2.54^{a}	2.32^{abc}	2.21^{bc}	2.44^{ab}	0.10	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly ** (P<0.01)

Fig.20: The overall serum Zn, Cr, Se, Fe, Cu and As concentration (ppm) in pregnant goats of different groups



recorded among groups II, III, IV and V at 120 days while at 140 days groups II, IV and V were significant to groups I, II and VI, respectively.

Overall serum Cr of pregnant goat was recorded to be higher in groups II and III and lower in groups I and VI. Group IV was non significant to groups II, III and V, respectively (Fig. 20).

The levels of Cr in the serum of pregnant goat have not yet been reported by research workers using single feed ingredients as sources of protein or energy. However, the present investigation envisaged a higher level of Cr due to feeding of concentrate mixture or maize as sole ingredient in pregnant goat. Though, no definite trend has been noticed during the entire pregnancy periods.

4.4.9.3 Selenium (Se)

Serum selenium level due to influence of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite was significant at 60 and 140 days of trial and non significant at other periods (Table 84). At 60 days significantly lower values was recorded in negative control and positive control group when compared to other supplemented groups. At 140 days highest value was obtained in group VI. Values of other groups were non significant.

Overall value of serum Se was recorded to be highest in group III and lowest in NC. However, group III was non significant to groups IV and VI. Also groups II, IV and V did not differ significantly with each other.

The literature is scarce in the validated data of serum concentration of Se in pregnant goats maintained on single feed ingredient and roughage diet. The present investigation spelled that feeding maize alone with roughage enhanced the

level of Se in the serum of pregnant goats which was higher during mid pregnancy.

4.4.9.4 Iron (Fe)

Serum Fe due to influence of dietary supplementation has been presented in table 85. Significant difference was obtained during entire period of experiments except at 140 day. At 30 and 60 day, levels in control and VI were significantly lower than all other groups. There was non significant difference between control and group VI and also among II, III, IV and V. Similarly at 90 and 120 day significantly lower value was observed in negative control group, while values of groups II, III and V were non significant to groups IV and VI at 90 days. Values for groups II, IV and V were also non significant to groups III and VI. In regards to overall Fe concentration it was lowest in NC.

Azab and Abdel (1999) reported lower serum Fe in late stage of pregnancy in goat. However no differentiations with respect to dietary treatments were made. In the present investigation the dietary treatment affected the serum Fe concentration and found more during mid pregnancy as compared to NC diet during the same period.

4.4.9.5 Copper (Cu)

Significant effect on serum copper concentration could be noticed in all the groups during entire period due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite (table 86). Significantly lower value was recorded in negative control throughout the period except on 30 days, where group VI has significantly lower value than other groups. No significant difference was noticed among groups II,

Table 85: The mean serum iron (ppm) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	3.19	3.36	3.61	3.53	3.42	3.11	0.39	NS
30	3.41^{b}	4.61^{a}	4.52^{a}	4.92^{a}	4.49^{a}	4.14^{b}	0.30	**
60	3.58^{b}	5.77^{a}	5.53^{a}	5.49^{a}	6.02^{a}	4.96^{b}	0.18	**
90	4.03^{d}	6.3^{b}	6.69^{b}	6.43^{b}	7.58^{a}	5.45^{c}	0.23	**
120	5.32^{c}	7.71^{a}	7.57^{a}	7.08^{ab}	6.31^{bc}	5.55^{c}	0.31	**
140	4.1	4.52	4.82	4.94	4.92	4.78	0.31	NS
Overall	3.94^{c}	5.55^{a}	5.46^{a}	5.40^{a}	5.46^{a}	4.66^{b}	0.13	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly ** (P<0.01)

Table 86: The mean serum copper (ppm) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	2.48	2.83	2.44	2.41	2.86	2.46	0.35	NS
30	2.89^{b}	3.48^{a}	3.02^{a}	3.26^{a}	3.26^{a}	3.51^{a}	0.19	**
60	3.08^{c}	4.59^{b}	4.99^{b}	6.15^{a}	5^{b}	3.59^{c}	0.23	**
90	3.76^{c}	5.99^{ab}	6.15^{ab}	6.34^{a}	6.23^{ab}	5.25^{b}	0.22	**
120	5.52^{c}	7.13^{a}	6.43^{ab}	6.27^{b}	6.63^{ab}	5.91^{c}	0.15	**
140	3.86^{b}	4.9^{ab}	3.88^{b}	5.08^{a}	4.97^{ab}	4.89^{a}	0.40	*
Overall	3.60^{c}	4.82^{ab}	4.49^{b}	4.92^{a}	4.83^{ab}	4.55^{ab}	0.11	**

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05),** (P<0.01)

Table 87: The mean serum arsenic (ppm) in pregnant goats of different groups

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
0	0.19	0.18	0.17	0.19	0.18	0.19	0.03	NS
30	0.16	0.18	0.17	0.21	0.38	0.16	0.03	NS
60	0.16	0.18	0.19	0.19	0.17	0.15	0.01	NS
90	0.16^{b}	0.19^{a}	0.2^{a}	0.18^{ab}	0.17^{ab}	0.19^{b}	0.01	*
120	0.16	0.18	0.19	0.19	0.18	0.14	0.01	NS
140	0.11	0.18	0.17	0.14	0.17	0.15	0.02	NS
Overall	0.16	0.18	0.18	0.19	0.21	0.18	0.01	NS

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * (P<0.05)

III and V, and groups I and VI at 60 days. Similarly on 90 day, groups II, III and V were non significant to groups IV and VI while on 120 day groups III and IV were non significant to groups II and IV. At 140 days groups II, IV and V were similar to groups I, III and VI.

Significant difference was recorded in overall Cu concentration amongst groups, highest being in group IV and lowest in NC. However, groups III and IV were non significant from groups II, V and VI.

The concentration of serum copper has also not been reported by past workers using concentrate or single feed ingredient as source of protein and energy in pregnant goats. The data obtained in the present investigation revealed a higher serum Cu level when goats were fed with sole DOC soy with roughage. This might be due to the fact that protein content of the diet activates Cu for various enzyme functions.

4.4.9.6 Arsenic (As)

No significant effect on serum arsenic was recorded due to dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, Zn methionine, Cr propionate and sodium selenite during the entire period except at 90 day (Table 87). Significantly lower value was observed in group VI than group II and III. However it was non significant than negative control, group IV and V. Values of groups II and III were also non significant when compared with control, IV and V groups. Overall As value in serum of pregnant goat was not significant among each other.

Literature is scarce in the effect of feeding various diets on serum arsenic level in pregnant goats. In the current study the serum arsenic was measured in

pregnant goats and the effect due to feeding of different feed ingredients has been recorded and no significant change in its value could be noted.

4.4.10 Nutritional plane of pregnant goats

In the present investigation the goat in all the treatment groups were fed more than the NRC (1981) requirement due to higher DMI which in turn affected the CP and TDN intake accordingly, however it was below the requirement in the NC group and group VI (Table 88). It suggests better growth performance amongst the treatment groups. However the performance varies depending upon the quality of nutrient available to the pregnant goats.

Table 88: Nutritional plane in different groups of pregnant goats

Periods (Days)	Groups						SEM	Sig.
	I (NC)	II (PC)	III (NC+M)	IV (NC+ SDC)	V (NC+ UMMB)	VI (NC+ Min*)		
Animals	4	4	4	4	4	4	-	-
Initial B.wt (kg)	15.83	15.85	16.08	16.13	16.28	16.25	0.18	NS
Final B. wt (kg)	17.38^{c}	19.00^{a}	17.78^{bc}	17.85^{bc}	18.48^{ab}	17.58^{bc}	0.27	**
Ave. weight gain (kg)	1.55^{bc}	3.15^{a}	1.70^{bc}	1.73^{bc}	2.20^{b}	1.33^{c}	0.23	**
AGL (days)	148.25	149.50	149.75	149.00	149.50	150.75	0.99	NS
Body wt. (M T period)	17.06	17.29	17.75	17.53	17.71	17.54	0.22	NS
$W^{0.75}$ (kg)	8.39	8.48	8.65	8.57	8.63	8.57	0.08	NS
DM intake								
g/day	360.73^{c}	616.29^{b}	764.81^{a}	784.68^{a}	635.12^{b}	334.57^{c}	28.21	**
kg/100kg b wt	2.12^{c}	3.57^{b}	4.32^{a}	4.48^{a}	3.59^{b}	1.91^{c}	0.19	**
g/kg $W^{0.75}$	43.03^{c}	72.72^{b}	88.55^{a}	91.64^{a}	73.65^{b}	39.08^{c}	3.64	**
Crude protein intake								
g/day	50.16^{c}	100.39^{b}	92.19^{b}	184.08^{a}	108.00^{b}	47.25^{c}	4.98	**
kg/100kg b wt	294.38^{c}	580.92^{b}	520.27^{b}	1050.7^{a}	611.28^{b}	269.66^{c}	32.42	**
g/kg $W^{0.75}$	5.98^{c}	11.85^{b}	10.68^{b}	21.50^{a}	12.53^{b}	5.52^{c}	0.64	**
Digestible crude protein intake								
g/day	36.12^{d}	82.58^{b}	56.89^{c}	150.15^{a}	78.86^{b}	36.67^{d}	4.31	**
g/100kg b wt	207.31^{d}	465.73^{b}	313.17^{c}	834.77^{a}	437.24^{b}	204.87^{d}	25.29	**
g/kg $W^{0.75}$	4.24^{d}	9.56^{b}	6.47^{c}	17.19^{a}	9.01^{b}	4.21^{d}	0.51	**
Total digestible nutrient intake								
g/day	165.00^{c}	332.80^{b}	361.45^{b}	439.81^{a}	325.82^{b}	171.30^{c}	14.43	**
kg/100kg b wt	0.97^{c}	1.93^{b}	2.04^{b}	2.51^{a}	1.84^{b}	0.98^{c}	0.1	**
g/kg $W^{0.75}$	19.68^{c}	39.27^{b}	41.85^{b}	51.37^{a}	37.78^{b}	20.01^{c}	1.86	**
Nutrients in the diet (%)								
CP	13.01	16.17	11.41	28.39	26.97	13.01		
DCP	9.35	13.30	7.04	23.17	19.53	10.10		
TDN	45.74	54.00	47.26	56.05	51.30	51.20		
Nutrient Requirement (NRC, 1981)								
DM (g/d)	511.80	518.70	532.50	525.90	531.30	526.20		
CP (g/d)	66.53	67.43	69.23	68.37	69.07	68.41		
TDN (g/d)	284.90	288.74	296.43	292.75	295.76	292.92		
Intake (percent of NRC requirement, 1981)								
DM	70.48	118.81	143.63	149.21	119.54	63.58		
CP	75.39	148.88	133.17	269.25	156.37	69.07		
TDN	57.91	115.26	121.94	150.23	110.16	58.48		

NC: Negative control (roughage), **PC** (positive control), **M**: maize **SDC**: soy deoiled cake, **UMMB**: urea molasses mineral block, **Min**: Zn Methionine (60ppm), Cr propionate (1.5ppm) and sodium selenite (1.5ppm), **SEM**: Standard error mean, **Sig.**: Significance, **NS**: non significance

* The quantity of Zn, Cr, and Se supplemented in group VI was also included in groups II, III, IV and V.

Means^{abcde} having different superscripts in row differ significantly * ($P<0.05$),** ($P<0.0$)

CHAPTER–V
SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH WORK

SUMMARY

The present experiment was conducted to study the effects of supplemental minerals (Cr, Zn and Se), un-medicated UMMB and medicated UMMB on growth performance, nutrient utilization, blood biochemical constituents and hematological and mineral profile in growing, non pregnant and pregnant goats. Three experiments were conducted in goats at growing, adult and during pregnancy.

5.1 Experiment I (Growing kid)

Forty eight kids of 6-9 months age were selected at random on body weight basis and divided into 12 groups of four in each following 3x4 factorial scheme. *Sola* grass and rhea leaf (50:50) were fed *ad lib* to all kids. Concentrate mixture was fed according to NRC (1981). Un-medicated UMMB was fed *ad lib* to group II while medicated UMMB was fed *ad lib* to group III continuously for 10 days followed by un-medicated UMMB. Diet was supplemented with trace elements: Zn, Cr and Se into four sub groups at the rate of 0, 0, 0 (M_0); 20, 0.5, 0.5 (M_1); 40, 1, 1 (M_2) and 60, 1.5, 1.5 (M_3) ppm, respectively.

DMI ($g/Kg^{0.75}$) in kids was significantly higher ($P<0.01$) in MUMMB supplemented group as compared to the other groups. Similar trend was observed for DMI/100 kg body weight of kids. There was no significant difference amongst the groups due to supplementation of different levels of Zn, Cr and Se. Kids in group III attained maximum growth of 54.23 g/day due to feeding of medicated

urea molasses mineral block as compared to UMMB and control. The increase was to the extent of 7.09 % and 21.40 % over UMMB and control respectively. These differences were highly significant ($P<0.01$). There was significant increase in the body weight gain of kid in group M_3 where diet was supplemented with 60, 1.5 and 1.5 ppm Zn, Cr and Se, respectively, as compared to control. Accordingly, the FCR of kid was affected, however, it was found better in UMMB followed by MUMMB and control groups. The mineral supplementation in group M_3 gave better FCR as compared to other two levels of minerals in group M_1 or M_2. The feed utilization was lowest in group M_0 where there was no supplementation. The differences were highly significant.

Digestibility coefficient of dry matter was significantly ($P<0.05$) higher in UMMB (II) and MUMMB (III) as compared to control. In contrary, the digestibility coefficient of CP was significantly higher in control than II and III. The digestibility coefficient of EE was highly significant ($P<0.01$) due to supplementation of UMMB, mineral as well as their interaction. It was highest in group II followed by control and III amongst UMMB supplemented groups and lowest in group M_2 amongst mineral supplemented groups. The UMMB supplementation in the diet also significantly increased the digestibility of HC and CL in groups III and II, respectively.

The interaction effect as well as the various levels of minerals was non significant for N, Ca and P balance while UMMB effect was significant. Balance of N was significantly ($P<0.05$) highest in group III where medicated urea molasses mineral was supplemented. However, II was comparable to both the groups. Calcium and phosphorus (g/day) balance was significantly ($P<0.01$)

higher for both UMMB and MUMMB supplemented groups than control, whereas groups II and III was comparable to each other.

There was no significant difference amongst the groups due to supplementation of UMMB, mineral and their interaction for the PCV. Amongst the UMMB supplemented groups, group II increased the Hb, MCH and MCHC values as compared to MUMMB and control. Similarly amongst the mineral supplemented groups, group M_3 increased the Hb, TEC, MCHC and group II MCH values as compared to the other groups. The interaction effect was significant for TEC and MCH and non significant for MCHC.

There was significant rise in blood glucose due to MUMMB while it was significantly lower in control and UMMB groups although the level was not affected due to insulin. The level of glucose and insulin in the serum was non significant due to minerals or due to the interaction of UMMB x mineral. ALP was significantly ($P<0.01$) lower in control as compared to the UMMB and MUMMB supplemented groups.

No significant change in the serum Zn and Cr was found due to supplementation of medicated or un medicated UMMB and minerals, however, the level of Se was decreased significantly due to UMMB and minerals (M_1) supplementation. Fe and Cu concentrations significantly increased due to dietary supplementation of UMMB and mineral (M_3). The level of arsenic was significantly higher in control (I) than in UMMB or MUMMB supplemented groups. Similarly it was higher in mineral (M_0 and M_3) supplemented groups.

5.2 Expriment II (Non pregnant goat)

Twenty four goats of 12-14 months age were divided into six groups having 4 goats in each. All animals were fed *ad lib* roughage as in experiment I. Group I (negative control –NC: without supplement), II (positive control- PC: concentrate mixture as per NRC (1981), III (maize 350g), IV (soy deoiled cake 300 g), V (UMMB *ad lib*) and VI (MUMMB *ad lib*) were fed respective diets for 30 days. In addition, groups II, III, IV, V and VI were supplemented with Zn, Cr and Se @ 60, 1.5 and 1.5 ppm.

DMI ($g/kg^{0.75}$ and kg/100 kg body weight) was significantly ($P<0.01$) higher in group IV than other groups, however it was lowest in group I (NC). Group VI attained maximum weight gain (25.65 g/day) due to feeding of MUMMB. The digestibility coefficient of CF and CL was increased in group I, EE and NFE in group II, ADF in group III, CP and NDF in group IV and HC in group VI. N balance (%) was significantly ($P<0.01$) higher in group IV and lower in group III. Ca balance (%) increased significantly ($P<0.01$) in II and decreased in III, however, P balance increased in NC (I) and decreased in MUMMB (VI) group.

The level of Hb increased in group VI, TEC in group V , PCV in group II and MCH and MCHC in group I however their levels decreased in group I (NC). Total protein, albumin, globulin and alkaline phosphatase activity in serum were non significant in group II. A significantly higher value of glucose was measured in group I where the level of serum Cr and insulin was lower as compared to UMMB/MUMMB or mineral supplemented groups. The levels of

Zn, Cr, Se, Fe and Cu were found to be significantly decreased in group I. The arsenic level was reduced in group IV.

5.3 Experiment III (Pregnant goat)

Twenty four pregnant goats of 20-24 months age were selected and divided into six groups having four goats in each. All animals were fed *ad lib* roughage. Group I was fed only roughage (*ad lib*). Group II was positive control and fed on concentrate mixture as per NRC (1981) and roughage (*ad lib*). In groups III, IV and V basal diets were supplemented with maize (350g), deoiled soy bean cake (300g) and UMMB (*ad lib*), respectively. Group VI was fed with same diet as in negative control (basal diet) except optimum levels of minerals. Optimum level of Cr (1.5, ppm), Zn (60, ppm) and Se (1.5, ppm) of experiment I was admixed in concentrate mixture (II), maize (III), deoiled soy bean cake (IV), UMMB (V) and NC+Min (VI) groups except negative control group (I).

Dry matter intake ($g/kg^{0.75}$) in pregnant goat was significantly ($P<0.01$) increased in group IV, while it was decreased in NC group (I) as compared to other groups. Group II attained maximum gain (g/d) as compared to other groups, however, the difference was non significant.

DM digestibility was highest in group VI and lowest in group II, while CP digestibility was highest in group II and lowest in group III ($p<0.01$). However, CF digestibility was highest in group VI and lowest in group III. Digestibility coefficient of NFE was decreased significantly in NC. Non significant difference was noticed for digestibility coefficients of EE, NDF, ADF, HC and CL.. Nitrogen balance significantly ($P<0.01$) increased in group IV and decreased in group I (NC). Balance of calcium was also significantly ($P<0.05$) increased in

group IV, while it was decreased in group VI. However, balance of phosphorus was significantly ($P<0.05$) highest in group II and lowest in VI.

Average pregnancy gain (PGADG, g/d) and pregnancy weight (kg) was increased in group II, while it was decreased in group I as compared to other groups. Average gestation length was increased in group II and it was decreased in group I (NC). However, kids' weight was increased in group II and it decreased in group VI. Pregnancy variable such as pregnancy average daily gain (PGADG, g/d)), pregnancy weight (kg) average gestation length (AGL, days) and kid weight (kg) of various groups was non significantly different amongst the groups.

No significant difference amongst groups was observed for MCH and MCHC while significant difference was noticed for Hb, TEC and PCV. Significantly ($P<0.01$) lower Hb and TEC values were observed in NC as compared to other groups. In group III there was significant increase in the PCV value while it was significantly decreased in NC (I). MCH was increased in group II while MCHC was increased in group VI. Difference was non significant amongst the groups. Total serum protein, serum albumin and serum globulin were significantly decreased in NC, while blood glucose was significantly ($P<0.01$) increased in NC. Whereas insulin and alkaline phosphate activity were increased in group IV and decreased in NC. Significantly highest ($P<0.05$) albumin:globulin ratio was observed in group V. Zn, Cr and Fe were significantly increased in group II (PC), Se in group III and Cu in group III while As was non significant in group IV. The lowest values of these minerals were recorded in NC.

CONCLUSIONS

In the current study, the effect of dietary supplementation of concentrate, maize, soy deoiled cake, UMMB, MUMMB, Zn methionine, Cr propionate and Sodium selenite under various groups in growing, adult and pregnant goat were studied and the following conclusions were drawn:

(I) Medicated urea molasses mineral block increased gain in kid (54.23/d) and in adult (25.65) goats however the FCR in kids was lower in UMMB supplemented group as compared to other groups.

(II) Mineral supplementation results in increased gain in body weight, feed conversion ratio and nutrient utilization in kids, non pregnant and pregnant goat over control diet.

(III) The level of blood glucose was increased due to increased levels of insulin and chromium in the mineral supplemented groups which was utilized for better gain in body weights.

(IV) The level of total serum protein and alkaline phosphatase activity were significantly increased in mineral supplemented groups indicating more uptake of Ca for development of skeleton and synthesis of body tissue protein.

(V) Dietary supplementation of Zn methionine and Cr propionate also elevated their levels in serum which is considered as the better index of health status of animals.

(VI) Concentrate mixture could be replaced by single ingredient feeding of soy deoiled cake (300). Also it can be replaced by *ad lib* feeding of UMMB or MUMMB.

(VII) Dietary supplementation of Zn methionine, Cr propionate and Sodium selenite to the level of 60, 1.5 and 1.5 ppm, respectively improved the growth performances in kids and over all performance of adult and pregnant goats.

(VIII) The net profit/kg live weight gain was Rs 3.33 more in UMMB supplemented group (II) than control (I). However Zn methionine, Cr propionate and Sodium selenite (60, 1.5 and 1.5 ppm, respectively) increased the net profit to Rs 5.34 than control (M_0).

SUGGESTIONS FOR FUTURE RESEARCH WORK

1. There is need to explore the possibility of raising adult as well as pregnant goats under semi-intensive grazing system where there is limited feed resources available which are deficient in certain essential minerals.
2. The effect of trace elements especially Zn, Cr and Se individually or in combinations with vitamins A and E need to be studied in different feeding regimes and an area specific mineral mixture to be developed for various physiological stages.
3. To establish an interactive relationship with vitamins, minerals, hormones and enzymes, the study would be required to be carried out at molecular level for better productivity of goats at various physiological stages.
4. The ingredient feeding system should be preferred for raising goat for which a detailed study is required to be conducted under grazing system of rearing.

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INFLUENCE OF CHROMIUM, ZINC AND SELENIUM ON NUTRIENT UTILIZATION AND BLOOD BIOCHEMICAL PARAMETERS IN GOAT FED ON UREA MOLASSES MINERAL BLOCK SUPPLEMENTED DIET

Ph. D THESIS ABSTRACT

The present study was undertaken in growing kid, non pregnant and pregnant goat to study the effects of supplemental mineral (as Cr propionate, Zn methionine and Sodium selenite), concentrate mixture, maize, soy deoiled cake, un-medicated UMMB and medicated UMMB on growth performance, nutrient utilization, blood biochemical constituents, hematological and serum mineral profile. Forty eight kids (6-9 months), 24 non pregnant (12-14 month) and 24 pregnant goats (20-24 months) were selected at random on body weight basis. The kids were divided into 12 groups of four in each following 3x4 factorial scheme. The non pregnant and pregnant goats were divided into six groups having 4 goats in each group following complete randomized design (CRD). Sola grass and rhea leaf (50:50) were fed *ad lib* to all kids for 90 days, non pregnant for 30 days and pregnant goats till kidding. In growing kids concentrate mixture was fed according to NRC (1981), UMMB *ad lid* to group II while medicated UMMB *ad lib* to group III continuously for 10 days followed by UMMB. Diets of kid were also supplemented with trace elements: Zn, Cr and Se into four sub groups at the rate of 0, 0, 0 (M_0); 20, 0.5, 0.5 (M_1); 40, 1, 1 (M_2) and 60, 1.5, 1.5 ppm (M_3), respectively. In non pregnant goats, group I (negative control – NC: without supplement), II (positive control- PC: concentrate mixture), III (maize 350g), IV (soy deoiled cake 300 g), V (UMMB *ad lib*) and VI (MUMMB *ad lib*) were fed

respective diets. In addition, groups II, III, IV, V and VI were supplemented with Zn, Cr and Se @ 60, 1.5 and 1.5 ppm. In pregnant goat, all the groups were fed respective diets as in non pregnant goats except in group VI where NC was supplemented with Cr, Zn and Se at the rate given above.

DMI ($g/kg^{0.75}$ and kg/100 kg body weight) in kids was significantly higher ($P<0.01$) in MUMMB supplemented group. There was no significant difference amongst the groups due to supplementation of different levels of Cr, Zn and Se. DMI ($g/kg^{0.75}$ and kg/100 kg body weight) of non pregnant and pregnant goat was significantly ($P<0.01$) higher in group IV. There was significant increase in the gain of kid in group M_3 among mineral supplemented groups. Accordingly, the FCR was found better in group II among UMMB supplemented groups. Kids in group III attained maximum growth of 54.23 g/day due to feeding of MUMMB as compared to UMMB and control group. Group VI of non pregnant goat attained maximum gain (25.65 g/day) due to feeding of MUMMB, while group II of pregnant goat attained maximum gain as compared to other groups, however the difference was non significant. In kid, the digestibility coefficient of DM was significantly ($P<0.05$) higher in UMMB (II). In contrary, the digestibility coefficient of CP was significantly higher in control. The digestibility coefficient of EE was highest in group II and lowest in group M_2. The UMMB supplementation in the diet also significantly increased the digestibility of HC and CL in groups II and III in kids. The digestibility of CF and CL (I), EE and NFE (II), ADF (III), CP and NDF (IV) and HC (VI) was significantly increased in non pregnant goats. Digestibility of DM and CF (VI), and CP and NFE (II) was also significantly increased in pregnant goat. In kid the balance of N was significantly higher in groups III ($P<0.05$) however in non pregnant and pregnant goat it was

higher in group IV ($P<0.01$). Calcium and phosphorus balances in kid were significantly ($P<0.01$) higher for both UMMB and MUMMB supplemented groups than control. In non pregnant goat the per cent Ca (II) and P balances. (I) were significantly ($P<0.01$) higher as compared to other groups. The Ca (IV) and P (II) balances were significantly ($P<0.05$) increased in pregnant goats.

There was significant increase in Hb, MCH and MCHC (II), Hb, TEC and MCHC (M_3), and MCH (M_1) in kids. In non pregnant goat, the levels of Hb (VI), TEC (V), PCV (II), and MCH and MCHC (I) were found to be significantly increased . Significantly ($P<0.01$) highest values of Hb (II), TEC (V), PCV (III), MCH (I) and MCHC (VI) were recorded in pregnant goats. There was significant rise in blood glucose in MUMMB supplemented group (III) while ALP was significantly ($P<0.01$) lower in control group (I) in kids. In non pregnant and pregnant goats the glucose was higher in group I than other groups. In pregnant goat highest total protein, globulin, insulin and alkaline phosphatase activity (IV), albumin (III) and albumin globulin ratio (V) were recorded. In kids, there was a significant reduction in serum value of Se in group II and M_1 due to supplementation of UMMB and minerals. Serum Fe and Cu concentrations in kids were significantly increased due to dietary supplementation of UMMB (II) and mineral (M_3). However the level of arsenic was significantly higher in I, M_0 and M_3 supplemented groups. In non pregnant goat the levels of Zn (V), Cr (III), Se and Fe (V), and Cu and arsenic (II) was measured higher than other groups. In pregnant goat Zn, Cr and Fe (II), Se (III) and Cu (III) were significantly increased.

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