EFFECT OF DIETARY UREA MOLASSES MULTI-NUTRIENT CAKE (UMMC) ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF RABBIT

A THESIS

By

MD. RUKNUZZAMAN
Registration No. 1505035
Session: 2015-2016
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MASTER OF SCIENCE (MS)

IN

ANIMAL NUTRITION

DEPARTMENT OF GENERAL ANIMAL SCIENCE AND NUTRITION
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY
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[Submitted to the Department of General Animal Science and Nutrition, Faculty of Veterinary and Animal Science, Hajee Mohammad Danesh Science and Technology University, Dinajpur for partial fulfillment of the requirement of the degree]

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Approved as to style and content by

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DEPARTMENT OF GENERAL ANIMAL SCIENCE AND NUTRITION
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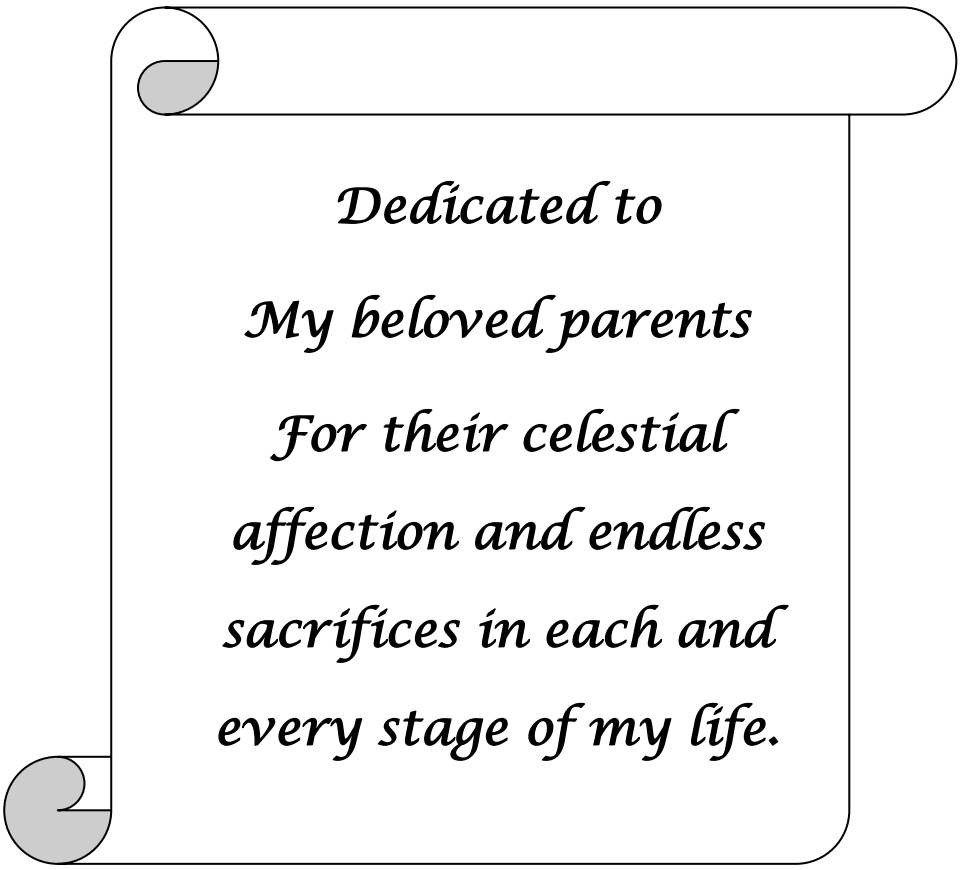
Dedicated to
My beloved parents
For their celestial affection and endless sacrifices in each and every stage of my life.

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The Author

Abstract

The present study was designed to investigate the effect of dietary supplementation of urea molasses multi-nutrient cake (UMMC) on productive and reproductive performances of rabbit. A couple of experiments were conducted using New Zealand rabbits at the Rabbit Research Farm, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. In *Experiment-I*, 20 rabbit does (age 24 weeks) were randomly assigned into four dietary treatment groups (T_0, T_1, T_2 and T_3) to investigate the effect of UMMC on the reproductive performances. In *Experiment-II*, 28 young rabbits (age 5 weeks) were also randomly assigned into another four dietary treatment groups to investigate the effect of UMMC on the productive performance. The rabbits of four dietary treatment groups (T_0, T_1, T_2 and T_3) in both experiments were fed 0, 4, 6 and 8% urea containing UMMC, respectively. The results revealed that the dietary supplementation of UMMC increased ($P<0.05$) live weight of pregnant does, conception rate, litter size, and litter weight and individual kit weight at weaning. On the other hand, dietary supplementation of UMMC reduced ($P<0.05$) the kit mortality, though UMMC supplementation did not affect the gestation period, litter size, litter weight and individual weight of rabbit kits at birth. The present findings also revealed that the dietary supplementation of UMMC improved ($P<0.05$) the productive performances of growing rabbits in terms of live weight gain, feed conversion ratio and performance index by almost same amount of feed intake. On the contrary, blood parameters (Hb, PCV, ESR) were also not affected by the UMMC except for red blood cell and white blood cell counts, but were within their normal range indicating the safe use of UMMC. It was also observed that the UMMC increased ($P<0.05$) the fecal bacterial population, which might be due to the supplementation of urea in the form of UMMC that enhanced bacterial protein synthesis and contributed in raising body protein level, as well as the growth of the rabbit. In both of the conducted experiment, rabbits fed 6% urea containing UMMC showed better performance than that of the rabbits fed 0, 4 and 8% urea containing UMMC. Considering the economic importance in terms of production cost of UMMC, cost was around 15 Tk. less in each kg of feed than that of the commercial pellets used for rabbit. Thus, the results suggested that the dietary UMMC can be an effective alternative than concentrate feed to improve the productive and reproductive performances of rabbits. 6% urea is the optimum level to be incorporated in UMMC preparation for rabbit. Furthermore, considering the economic significance the dietary UMMC may encourage small and large scale farmers to rear rabbit in a more convenient and profitable way.

Key words: Rabbit, Dietary UMMC, productive and reproductive performances, blood parameters, fecal parameters.

Abbreviation and Acronyms

BCS	Body Condition Score
BUN	Blood Urea Nitrogen
cfu	Colony Forming Unit
CP	Crude Protein
CRD	Completely Randomized Design
CSM	Cotton Seed Meal
Dl	Deciliter
DLS	Department of Livestock Services
DM	Dry Matter
EE	Ether Extract
ESR	Erythrocyte sedimentation Rate
FAO	Food and Agricultural Organization
FC	Feed Consumption
FCR	Feed Conversion Ratio
FSH	Follicle-Stimulating Hormone
GDP	Gross Domestic Product
GnRH	Gonadotropin Releasing Hormone
Hb	Hemoglobin
MEI	Metabolizable Energy Intake
ml	Milliliter
MNB	Multi-Nutrient Block
MNUMB	Multi –Nutrient Urea Molasses Block
NDF	Neutral Detergent Fiber
NPN	Non Protein Nitrogen
NRC	National Research Council
PCV	Packed Cell Volume
$PGF_2\alpha$	Prostaglandin
PII	Plasma inorganic iodine
SID	Statistics and Informatics Division

SPSS	Statistical Package for the Social Sciences
TDN	Total Digestible Nutrients
TS	Treated Straw
UMB	Urea Molasses Block
UMMB	Urea molasses Multi-nutrient Block
UMMC	Urea Molasses Multi-nutrient Cake
UNFPA	United Nations Fund for Population Activities
US	Untreated Straw
VFA	Volatile Fatty Acid
WBC	White blood Cell
µg	Microgram
µl	Microliter

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CHAPTER I

INTRODUCTION

Chapter I

Introduction

The world population is increasing day by day. According to the United Nation, current world population is 7.3 billion which will reach to 9.7 billion by 2050 (DESA, 2015). World food productions are consistently lower than human population growth especially in the developing countries (Onwuka *et al.,* 1995). Bangladesh is a small country over burdened with a large number of gradually increased populations. It has 160.41 million people with a ranking of 3rd position among South Asian countries and 8th position in the world (FAO, 2015). It is an established fact that high quality animal protein in the form of milk, meat and eggs is extremely important for the proper physical and mental growth of this population (Fielding, 1993). Meeting the demand of protein of this booming population is a great challenge for Bangladesh.

Around 8% of total protein for human consumption comes from livestock where cattle, sheep, goat and poultry are the main sources of animal protein. As per FAO (2015) estimates, the demand and availability of milk, meat and egg for the country in the year 2015, it is evident that there is a deficit of 57% in milk, 33% in meat and 36% in eggs. Department of Livestock Services (DLS) demonstrated that production of milk, meat and egg are 6.09, 4.52, and 10168 million tons in the fiscal year 2015–2016 against the requirement of 14.02, 6.73, and 15974.4 million ton, respectively (DLS, 2015). That means this sources are unable to fulfill the demands of protein in Bangladesh. Beside this, due to the different constraints and limitations, contribution of these sources to meet up the protein requirement is not increasing as accordance with increasing population. The ever increasing human population coupled with poor performance of the available livestock is some of the major factors limiting the supply of animal protein in the developing countries (Peters *et al.*, 1988).

In order to maximize food production and meet protein requirements in developing countries, variable options need to be explored and evaluated (Owen *et al.,* 2008). So, it is crying need to explore and invent new alternatives of protein sources that will be convenient in both productive and economic aspects and able to contribute strongly to meet up the protein requirement in Bangladesh. From this point of view, the use of fast growing livestock species such as, rabbit may play a vital role in producing animal protein, self-employment and poverty alleviation in Bangladesh. Rabbits are small mammals with fluffy, short tails, whiskers and distinctive long ears (Bradford, 2014). Rabbit is an important micro-livestock

may be considered as a promising and potential alternative source of protein (Vietmeyer, 1985). Rabbit possesses several good attributes which gaining international attention day by day as a means of alleviating poverty threat (FAO, 1996). It has a high reproduction rate (age at maturity 3.5–4.0 months, gestation period 29–33 days, litter-size ranges from 3–12 young) which is potentially more reflective than other livestock on converting forage into meat (Agege, 1994).

Nutritionally rabbit meat is more desired than other livestock species because of its higher protein (20–21%), low fat (10–11%), low calories (1749 Kcal/ kg), low cholesterol content (169 mg/100g on dry matter basis) (Janieri, 1987; Njidda and Isidahomen, 2009). Rabbit meat contains 63% unsaturated fatty acid of total fatty acids, which is good for health (Bielański, 2007). Skin of rabbit may be used in toy, crafts and cottage industry. Moreover, rabbit occupies a vital midway between ruminants and mono-gastric animals. Rabbit can utilize cellulose rich feed effectively with a ration containing less than 20% grain. Short breeding cycle simple biological characteristics, high prolificacy and better feed conversion ratio logically place rabbit just below poultry. Lebas (1983) stated that the conversion efficiency of feed protein to edible meat in rabbit is 20%, whereas it is in broiler chicken 22–23%, in pigs 16–18% and in beef cattle 8–12%.

The rabbit being a non-ruminant herbivore can be fed locally on variable feedstuff of no direct nutritional value to human beings, grass forage, weeds vegetable roots, coarse grasses and house wastes as well as by-products like beans, rice and corn bran (Aduku and Olukosi, 1990). Rabbits can also utilize the available proteins in cellulose–rich plants, whereas it is not economical to feed these to chickens and turkeys, the only animals with higher energy and protein efficiency. The traditional grain and soybean meals fed to these domestic poultry, put them in direct competition with humans for food. For countries with no cereal surpluses, rabbit meat production is thus especially interesting (Samkol and Lukefahr, 2008). Taiwo *et al.* (2004) stated that rabbits are widely raised in developing countries because of its low investment cost, high fecundity, short generation interval and ability to utilize non-human feed (forages-monogastric herbivores). The use of rabbits as a food and income source in developing countries continues to increase, with expanding interest in Eastern Europe, Africa, Asia, and Latin America. Their reputation for fast growth, short gestation period, early maturity, ease of management, remarkable capacity to convert roughages into nutritious meat and their small sizes make them affordable (Chestworth, 2002; Ramesh *et al.,* 2000). Agro-

climatic condition, religious point of view, social practices and technological aspects support the prospects and potentials of raising rabbit (MIDAS, 1992).

Although the rabbit farming has a great potential to be used as a source of protein and to contribute to the economy of Bangladesh, it has a limitation of the high price of concentrate feed as pellet form in case of confined rearing. According to Dairo and Ojekale (2004), rabbit production is limited by the expensive nature of pellet feed whose micro mineral content is unknown and which is out of reach to local livestock farmer. Bhatt *et al.* (2010) said that in spite of having less space requirement, high production and reproduction potential of rabbit, its rearing has not got much tremendous popularity among the poor farmers due to high feeding cost. At present, the high price of most conventional fed ingredients is due to the high competition for their human and industrial usage. Therefore, finding of alternative feed ingredients becomes the main focus of most of the animal nutritionists (Ojebiyi and Farinu, 2008). Cereal-based feeds are generally too expensive for use as supplements (Hulman, 1988). Alternative non-cereal feed supplements have been successfully developed for many livestock species using locally available agro-industrial by-products.

Cheeke and Raharjo (1988) concluded in a review of rabbit production of tropical feed resources that tropical grasses were unsuitable as the only feed for rabbits because of their low digestibility (less than 10%). They considered that adequate supplementation was the principal limiting factor and proposed that the use of multi-nutritional blocks as developed by Leng (Preston and Leng, 1987) could have a potential role in these feeding systems. The value of urea to create a more favorable ruminal environment for tropical forage utilization in ruminants is widely accepted (Preston and Leng, 1987).

Since quite some time the Multi nutrient Block (MNB) is a commonly used feed supplement for ruminants (Sansoucy, 1986; Garcia and Restrepo, 1995). MNB provides fermentable energy (usually from molasses), non-protein nitrogen (usually from urea), essential minerals and occasionally vitamins. Mini-blocks for rabbits have been made in the past (Perez, 1986; Cheeke and Raharjo, 1988). Feeding such blocks to rabbits has several advantages since they can be offered on the ground or the floor of the cage, without the need of a specialized feeder and without wastage (Fillippi *et al.,* 1992). Mini-blocks can be a complete feed for rabbits by including a source of forage in the formulation (Perez, 1990). An experiment carried out in Vietnam by Binh *et al.* (1991) showed that MNB based on molasses could be fed successfully as a substitute for cereal-based concentrates for rabbits during all stages of production.

In a number of countries, various formulations have been tested according to the different ingredients locally available and their prices (Ramchurn *et al.,* 2000). UMMC can be made with locally available cheap, but high quality, nutritive ingredients such as urea, molasses, broken maize bran, wheat bran, rice polish (ash), soybean meal (48), limestone, common salt and cement. The main ingredient of the UMMC is urea, which is a good and cheap source of non-protein nitrogen. In the past, urea has been used successfully as a source of non-protein nitrogenous substance in the ruminant diets that improves the productive and reproductive performances of ruminants (Harris and Mitche, 1941; Wohlt and Clark, 1978; Saadullah *et al.,* 1981). Although rabbit is a monogastric animal, but can utilize urea successfully due to the presence of its large caecum. Rabbits are capable of utilizing urea as a non-protein nitrogenous source because of cecal fermentation due to the presence of urease activity similar to that of ruminants, transfer of blood urea to caecum (Marounek, 1995; Oluokun, 2001; Makkar and Singh, 1987) and cecotrophy (ingestion of cecal contents) (Houpt, 1967). Mandour and Shami (2012) stated that supplying a graded level of urea to the growing New Zealand rabbit significantly increased their live weight after 4 weeks.

Although a little number of researches have been conducted in attempting the preparation of MNB or multi nutrient cake for rabbit by using locally available ingredients and urea, but they were not succeeded to draw a satisfactory conclusion about its uses. Beside this, those researches are not clearly identified the optimum level of urea to be incorporated in the multi nutrient cake. As there is some discrepancy in the effect of supplementing urea in rabbit diet and effect of the multi-nutrient cake on productive and reproductive performances of rabbit. Moreover, sufficient data concerning its effect on blood cellular elements also not available. Therefore, the present study has been undertaken with the following objectives-

- To study the effects of urea molasses multi-nutrient cake (UMMC) on productive and reproductive performances of rabbit does.
- To assess the highest productive and optimum level of urea to be incorporated in the UMMC.
- To investigate the effect of UMMC on blood and fecal parameters of rabbit.
- To determine the economic efficiency of using UMMC.

CHAPTER II

REVIEW OF LITERATURE

Chapter II

Review of Literature

Urea molasses multi-nutrient cake (UMMC) is successfully used as a supplementary feed in the ruminant diet and its effects on both productive and reproductive performances are established since many years ago. A number of researchers have been tried to observe the effect of Urea Molasses Multi-nutrient Block (UMMB) on the performances of rabbit and tried to establish such a feed supplement for the rabbit, which may increase their performances both effectively and economically. This chapter presents the review of relevant literatures which consist of the effects of dietary UMMC supplementation on the productive and reproductive performances of rabbit. Quite a few number of researchers conducted study in this topics worldwide, but in Bangladesh no research has been recorded yet in this topic. As there is a limited number of literatures are available about the effect of using MNB on the productive performances of rabbit and no researches has been conducted on the reproductive effect of UMMC on rabbit, few literatures relevant to the conducted experiment are also reviewed which showed both productive and reproductive effect of UMMB on the ruminants.

2.1 Defining urea-molasses multi-nutrient cake

As the name suggests, these are lick cake containing urea, molasses, vitamins, minerals and other multi-nutrients. The feeding of the cake is a convenient and economically efficient method of providing a range of nutrients required by the animal, which may not present in the diet. The main justification for using the cake depends on their capability to improve productive and reproductive performances of animal, convenience for packaging, storage, transport and ease of feeding. The ingredients are designed to provide a wide range of nutrients to cover all potential deficiencies (FAO, 1986).

2.2 UMMC in rabbit diet

A series of experiments were carried out by Binh *et al.* (1991) to investigate the feasibility of replacing the traditional concentrate supplement in rabbit diets with multi-nutritional blocks based on molasses, cassava byproducts and up to 4% urea. Result of their experiment showed that MNB based on molasses can be successfully fed as a partial substitute for cereal-based concentrates in diets for rabbits during all stages of production. They have not drawn any definite conclusions about the usefulness of including urea in the MNB, but opined that using urea in MNB is not harmful.

Ramchurn and Raggoo (2000) developed multi-nutrient block (MNB) for the domestic rabbit in Mauritius by using molasses, wheat bran, cottonseed meal, cement, mineral mixtures and common salt. They prepared two blocks by using following two formula. They concluded that block prepared by using the formula-1 was too hard while the block prepared by using formula-2 was good in consistency. They also showed that intake of MNB by rabbit is linked to size, shape, composition and hardness of the blocks. Small size block is better and intake declined with increasing block hardness.

2.3 Effects of UMMC on the animal productive performances

Although a definite conclusion was not made by the researchers about the certain usefulness of dietary UMMC in the rabbit diet, however they observed following effects-

2.3.1 Live weight gain

Supplementation of UMMC improves the live weight of the rabbit. Ramchurn *et al.* (2000) reported that rabbits fed MNB containing 15% and 30% cement had a higher ($P<0.05$) dry matter (DM) intake (127±18.8 and 125±9.86 g/head/d, respectively) than the control group (104±11.4 g/head/d). The average weight gains for rabbits fed only pellets was 14.8±5.82 g/head/day, significantly less than for the MNB with15% and MNB with 30% cement treatments (23.4±3.5 and 26.4±6.3 g/head/day, respectively).

Urea can be potentially used as a source of energy for rabbit due to the presence of urease activity in the rabbit cecum (Knutson *et al.,* 1977; Crociani *et al.,* 1984), transportation of urea from blood to the rabbit cecum (Houpt, 1967), high cecal fermentation and ingestion of cecal contents by rabbit which is known as cecotrophy behaviour (Fekete and Bokori, 1985). Several studies with weanling rabbits have not showed any positive effect on growth performance when low protein diets were fed with urea (King, 1971; Cheeke, 1972; Lebas and Colin, 1973). Lang (1981) has suggested that adult animals, with a more developed cecum and lower protein requirements (NRC, 1977) may be more responsive to urea supplementation than weanling rabbits.

Mandour *et al.* (2012) reported that although there were no significant differences in rabbit weights due to feeding ration with different levels of urea after 2 weeks of experiment initiation, marked weight variation ($P<0.05$) was detected after 4 and 6 weeks of starting urea feeding. Rabbits supplied with ration containing 1.5% urea had 166 g weight gain increase after 4 weeks than those fed 1% urea (1995±60 vs. 1829±53 g). The same trend was also

continued at 6 weeks for the same group (1.5%) as its weight was significantly the heaviest 3175±125 g while the 0.5% group was the least (2235±50 g). Control group showed a significant increase in average daily gain at 2–4 weeks period (20.01±1.72 g) compared with those of 0.5% and 1% urea groups (13.62±1.36 and 13.98and 13.98±1.57 g). Similarly, the 0% urea fed group had almost doubled average daily gain at 6–8 weeks compared to the 1 and 1.5% groups (30.5±5.54 vs. 16.12±0.19 and 17.69±3.25).

Binh *et al.* (1991) reported that growing rabbit supplied with UMMB containing 2% urea has slightly lower (18.3±0.31 g/day) and with 4% urea has slightly higher (20.7±0.26 g/day) live weight gain than that of the 0% UMMB group (19.8±0.52 g/day). Amici and Finci (1995) reported that rabbits supplied with molasses block containing 4% and 10% cement showed a significantly higher growth rate (30.4g and 30.5 g/day, respectively) than that of the rabbit supplied solely with alfalfa grass (17.8 g/day). Hasanat *et al.* (2006) worked on Crossbred New Zealand meat type rabbits aged 3.5 to 4.5 months weighing 9.5 to 13.0 kg in a 128 day trial to study the effects of concentrate supplementation on growth and reproductive performance of rabbit under rural condition by supplying conventional diet and conventional diet + concentrate (Same concentrate ingredients used in this experiment except urea). Locally available green grasses were supplied to the animal. Results showed that, average daily live weight gain was significantly ($P<0.01$) higher in conventional diet + concentrate supplemented group (13.02±0.43 g/d) than conventional diet supplemented group (5.30±0.43 g/d).

Yono *et al.* (1986) conducted an experiment on rabbit by dividing it into four treatment groups this were - a 21.5% crude protein (CP) diet control group , a 16% CP diet (LP), LP + 0.3% DL-methionine (LP + met) and LP + 2.1% urea (LP + urea) group. Result of their experiment showed that urea addition in the diet significantly increases the live weight of rabbit. Mubi *et al.* (2012) found that feeding UMMB to Rahaji breed of cattle aged between 18 and 24 months significantly ($P<0.05$) increases the live weight 0.58 kg/day while in control group it was 0.32 kg/day. Supplementation of MNB also increases the live weight of sheep 0.21 kg/day while it was 0.11 kg/day in sheep with no dietary UMMB. Hossain *et al.* (2005) reported that sheep supplied with urea molasses block (UMB) has average daily live weight gain 70 g/day/sheep whereas it was 41 g/day/sheep that was not supplied with urea molasses block.

An experiment conducted on the lambs by using UMB, Anindo *et al.* (1998) reported that after 6 months of age lamb has a higher live weight of 25.7±0.5 versus 21.7±0.5 kg, ($P<0.05$)

and had deposited more body reserves as measured by body condition score (3.2±0.1 versus 2.4±0.1). Tiwari *et al.* (1990) showed that male buffalo calves have a higher growth rate of 275 g/day when supplied with UMMB than 90 g/day when without UMMB. Rafiq *et al.* (1996) showed in an experiment that supplementation UMMB to sheep increases the live weight gain 10.6 g/day to 57.8 g/day. Akbar *et al.* (1991) also reported that Use of UMMB increased live weight gain of buffalo heifers. Hatungimana and Ndolisha (2015) reported that the UMB supplementation has significantly improved ($P<0.05$) the feed intake, live weight gain and feed conversion ratio in sheep. The sheep group fed on grass supplemented with UMB containing 7.2% of urea, showed a higher growth performance than non-supplemented urea group. They also observed that the UMB supplementation did not negatively affect the health status of sheep. Animals supplied with MNB in their feeding regimen can have better nutrient utilization capacity and high rumen DM degradation at a price that can be afforded by smallholder farmers (Dzidiya *et al.,* 2015).

An experiment was conducted under the framework of an RCA project in Muktagacha and Fulbaria of Bangladesh using UMMB supplement. Results of the experiments in both areas showed similar trends in terms of milk yield, live weight gain and condition score. Although a small increase was observed in the UMMB fed animals compared to the non-fed groups, there was no significant difference in body condition score (BCS) of the cows between the UMMB supplemented groups and the non-supplemented groups. Body condition scores recorded on day 45 of the experiment showed that BCS tended to increase during the experiment in the UMMB groups whereas BCS remained static in of the non-supplemented groups. However, live-weight gain was significantly ($P<0.05$) higher in the supplemented group than the control (non-supplemented group) in Fulbaria. This was not the case in Muktagacha, where there was no significant effect of UMMB feeding on live-weight (LW) gain. Live-weight of animals of the non-supplemented group in both areas decreased compared to the UMMB fed group. In both areas, supplementation with UMMB significantly ($P<0.05$) increased milk production in the cows compared to the non-supplemented control cows.

Mulholland and Coombe (1979) reported that significant differences in mean live weight occurred between un-supplemented sheep and those offered a mineral/urea block, or a molasses lick. Akter *et al.* (2004) observed that supplementation of UMB increased milk production of cow from 2.86 to 4.43 L/day and live weight of calves 20.29 to 25.57 kg. A feeding experiment was conducted by Sudana and Leng (2016) in which lambs were given a

basal diet of wheat straw plus 0.5% mineral mixture, supplemented with either 2.5% urea, 150 g cottonseed meal (CSM)/day, 2.5% urea + 150 g/day CSM, UMB (*ad libitum*) alone or with 150 g CSM. Supplementation of the basal diet with the urea-molasses block significantly (P<0.001) increased the live weight of lambs' 53 g/day loss on the basal diet to a live weight gain of 10 g/day.

Rafiq *et al.* (2007) investigated the effect of strategic supplementation with multi-nutrient urea molasses blocks (MNUMB) on BW and body condition score (BCS) in Lohi ewes (treated, $n = 514$) during late gestation and lactation and compared with those (control, $n = 391$) grazing on only post-harvest crop residues and road side in the irrigated district of Okara in central Punjab (Pakistan). Result of this study showed that, there was highly significant (P<0.01) differences in live weight (BW) and body condition score (BCS) of ewes of various ages with different reproductive status and seasons under both flocks. Mean BW and BCS in ewes of control flock was 33.5 and 2.08 kg, and lower (P<0.05) than 35.0 and 2.31 in ewes in the treated flock, respectively. Ewes aging 12, 24 and 36 months fed with strategic supplementation of MNUMBs were not only heavier (P<0.01), but also had highest BCS of 2.34. Based on this improvement they concluded that supplementation with appropriate sources of energy and nitrogen shows favorable effects on the traits of economic importance in sheep.

2.3.2 Feed intake

Ramchurn *et al.* (2000) reported that in the growth trial, rabbits in treatments MNB with15% urea and MNB with 30% urea had higher (P<0.05) DM intake (127±18.8 and 125±9.86 g/head/day, respectively) than those on the control treatment (104±11.4 g/head/day). Several studies have shown that intake of low quality roughages is increased when supplements of non-protein nitrogen (NPN) are given (King, 1971; Raharjo *et al.,* 1986; Singh *et al.,* 1988 and Oluokun, 2001). Mohammed and Jamala (2013) were conducted an experiment to evaluate the effect of varying levels of urea treated and untreated cowpea husk on the performance of weaned rabbit. Two diets were formulated in which cowpea husk was included at 40% (untreated control), 40, 50 and 60% urea treated cowpea husk at 4% designed as diet 1, 2, 3 and 4, respectively. The result of daily feed intake showed that there was significant difference (P<0.05) between the treatment with highest feed intake in treatment 4 (60.0%) and lowest in treatment 2 (44.14).

In an experiment with swamp buffaloes fed rice straw or rice straw and natural grasses with and without UMMC supplementation, Thu *et al.* (1997) reported that there was a significant increase of feed intake for the diet supplemented with urea molasses cake. Kunju (1986) also showed an increased straw intake from 4.4 to 5.7 kg per day, when replacing 1 kg concentrates with 560g urea molasses lick block. Huq *et al.* (1996) reported that supplying UMB to the Black Bengal Goat diet significantly increases the DM intake and TDN intake. Anindo *et al.* (1998) also conducted an experiment in the Menz ram lambs with UMMB and concluded UMMB supplementation increases DM intake 568±11g versus 532±11 g DM per head per day. Using twenty male buffalo calves of about 9–13 months of age Tiwari *et al.* (1990) conducted an experiment with the supplementation of only chopped straw to control group and treatment group with chopped straw and UMMB , showed that the average daily DM intake was higher ($P<0.01$) in UMMB supplemented group. Garg and Gupta (1992) conducting an experiment on twelve male crossbred calves of 18 months of age were feeding *ad libitum* wheat straw with and without supplementation concluded that UMMB supplemented group has a significantly higher feed intake than that of the control group.

Badrudeen *et al.* (1994) conducting two separate experiments with crossbred bulls (Sahiwal indigenous) fed with untreated (US) or urea treated (TS) rice straw with or without lick block supplementation reported that with both experiments urea treatment did not affect DMI, but lick block supplementation significantly ($P<0.05$) increased DMI. The DMD values obtained in both experiments for TS were significantly ($P<0.05$) higher than for US, but lick block supplementation did not affect the DMD of either US or TS fed animals. Both urea supplement (6.97 vs 6.93) and lick block supplementation (6.98 vs 6.92) significantly ($P<0.001$) reduced the rumen p^H.

Mulholland and Coombe (1979) reported that supplementation of UMMB to the sheep significantly increases the total DM intake. Supplementation of the basal diet with the urea-molasses block increased straw dry-matter intake by lambs significantly ($P<0.001$) from 333 to 420 g day^{-1} (Sudana and Leng, 2016). Conducting an experiment on sheep with UMMB supplementation Sing *et al.* (1999) reported that DM intake (kg/100 kg B. Wt. and g/w0.75 kg) was significantly ($P<0.01$) higher in UMMB supplemented group (1.95±0.06; 75.55±1.79) as compared to control group (1.27±0.08; 48.77±2.43). In order to investigate the effect of plane of nutrition on intake and nutrient utilization from urea molasses mineral block (UMMB) Hosamani *et al.* (1998) conducted an experiment on 20 intact and 12 rumen fistulated male Murrah buffaloes aged about 3 years and weighing 320.3±13.11 kg. Singh *et*

al. (2010) reported that use of UMMB in the buffalo diet significantly (46.66%) increases the fodder intake. Hatungimana and Ndolisha (2015) also showed in an experiment that feed consumption was higher in UMB supplemented group of sheep than in the non UMB supplemented group.

2.3.3 Feed conversion ratio

Ramchurn *et al.* (2000) conducted an experiment on 18 rabbits using MNB as a treatment group and commercial pellet as the control one and concluded that feed conversion was slightly higher, but not statistically significant between the treatment (5.1±0.73 and 4.8±1.13in MNB15 and MNB30, respectively) and control group (7.8±3.67). Mohammed and Jamala (2013) also reported that rabbit fed with urea treated cowpea husk has significantly higher feed conversion ratio than the rabbit fed with untreated cowpea husk.

Rahman *et al.* (2011) using four dietary treatments-control, bentonite-supplemented (with 2.5% sodium bentonite), urea-supplemented (with 1% urea) and urea-bentonite co-supplemented (1% urea+ 2.5% sodium bentonite) conducted an experiment on rabbit and stated that FCR is significantly better in urea supplemented groups than the non-supplemented group. Rafiq *et al.* (1996) conducting an experiment in the sheep by using UMMB found that ,UMMB supplementation significantly decreases the amount of feed needed to be converted into 1 kg of sheep meat (1:3 and 1:2 FCR in the control and UMMB fed group, respectively). Hossain *et al.* (2005) reported that sheep supplied with UMB required 5.30 kg dry matter for 1 kg live weight gain, but sheep that is only supplied with the natural grasses with no UMB required 8.1 kg dry matter.

2.3.4 Cost effectiveness

Ramchurn *et al.* (2000) reported that total cost to produce the blocks was estimated to be Rupees (Rs.) 5.40/ kg (1 US$ = 25 Rs. 1999 exchange rate) compared with Rs. 7.20/ kg for the commercial pelleted feed. From an economic standpoint, there is distinct advantage from feeding the MNBs. Feed costs per unit gain in live weight were lower by 25% and 36% for treatments MNB15 and MNB30, respectively. Rahman *et al.* (2011) using urea and with bentonite combination in rabbit diet reported that, prices for adding 1% urea and 2.5% bentonite are 0.05 and 0.02 L.E./ kg rabbit diet, respectively totaling approximately 0.07 L.E./ kg rabbit diet. The price of 7.6% soybean meal that was removed and replaced by this treatment is 0.2 L.E./ kg rabbit diet. This implies that using this treatment could save about 0.13 L.E/ kg rabbit diet. Therefore the total feeding cost decreased by addition of urea alone

or in combination with bentonite in comparison with control diet. However, the relative profit was increased by 55.5% in case of urea-bentonite combination. It is obvious that this was related to increased average meat yield/rabbit suggesting an improvement of feed conversion ratio in case of urea addition. It also demonstrated that block technology is a cost effective approach to maximize the utilization of locally available feed resources for better animal performance in the wet season (Mubi *et al.,* 2012).

2.3.5 Digestibility

Ramchurn *et al.* (2000) in their experiment found that the MNB had higher calcium and phosphorus contents compared to the pellets. Although MNB had a low crude protein, DM, organic matter and gross energy content than the pellet, it had a higher NDF content of 18.9 % in DM compared to 10.8 % DM in the pellets. The lignin content in the MNB was low implying that the fiber in the blocks would be highly digestible. Digestibility of DM and organic matter increased with amounts of MNB offered. The difference between MNB30 and the control was significant. This tendency was even more marked for NDF the digestibility of which increased progressively ($P<0.05$) as the level of MNB was increased. However, Anindo *et al.* (1998) reported that there were no differences between the treatments in the digestibility of the protein and ether extract or in total energy. Digestibility of herbage with UMB Supplementation is greatest in the wet season). Tiwari *et al.* (1990) also reported that the digestibility coefficient of DM, OM and nitrogen, EE, ADF and NDF is significantly higher in groups supplemented with UMMB than the control groups. Garg and Gupta (1992) observed that feeding UMMB to calves significantly increases the digestibility coefficient of DM, OM and CP compared to group not supplemented with UMMB. However, digestibility coefficients of EE, CF and NFE were non-significantly different between the two groups. UMMB treated group exhibited significantly ($P<0.01$) higher and positive N, Ca and P balances as compared to control group which exhibited negative balances. Total-N, ammonia-N and urea-N in the blood plasma of animals were significantly ($P<0.01$) higher as compared to the non UMMB supplemented group.

In order to investigate the effect of the plane of nutrition on intake and nutrient utilization from UMMB, Toppo *et al.* (1997) conducted an experiment by using sixteen adult crossbred cattle which were divided into four equal groups and fed individually for 60 days *ad libitum* with either wheat straw alone (Group I) or with wheat straw with UMMB (Group II) or with wheat straw and UMMB with 50% of energy requirements provided by crushed barley fortified with mineral mixture and common salt (Group III) or with wheat straw and UMMB

with 100% of energy requirements provided by fortified crushed barley (Group IV). At the end of the feeding trial they conducted a metabolism trial of six days duration. Findings of the experiment showed that feed intake (except for ether extract) and digestibility of all the nutrients significantly increased (P<0.01) in the groups fed UMMB which was further increased by energy (barley) supplementation except for neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibility, which decreased owing to concentrate supplementation. Digestible protein contents and total digestible nutrients of UMMB were 42.5% and 56.6, respectively. It was also found that, concentrations of total nitrogen and its fractions significantly increased (P<0.01), except TCA-perceptible-N due to block feeding.

Sing *et al.* (1999) conducted an experiment on twelve male crossbred calves of 18 months of age were divided into two groups. Animals in both the groups were fed wheat straw ad lib. However, animals in group II had free access to urea molasses mineral block (UMMB) lick and concluded that straw DM digestibility coefficient was not significantly different in groups I and II. However, in group II DOMI (kg/100 kg B. Wt.) was significantly (P<0.01) higher (0.986 0.05) than the group I (0.615 0.03). Digestibility coefficient of DM, OM and CP were significantly higher in group II as compared to group I. However, digestibility coefficients of EE, CF and NFE were non-significantly different between the two groups. Significantly (P<0.01) higher and positive N, Ca and P balances was observed in animals in group II than the group I which showed negative balances. Total-N, ammonia-N and urea-N in the blood plasma of animals in group II were significantly (P<0.01) higher as compared to group I.

2.3.6 Blood parameters

Inoculation of urea to the UMMC at the safe level has no significant changes in the blood parameters of the rabbit. Mandour *et al.* (2012) reported that no significant trend was detected for the hemogram parameters, except for the RBC count of 0.5% urea group ($6.48\pm0.21\times10^6$ and control group ($5.96\pm0.16\times10^6$) (P<0.05) and monocyte% for the1% group ($8.56\pm0.82\times10^3$) and 1.5% group ($4.99\pm1.38\times10^3$) (P<0.05). The values for the RBC count ranged from $9.65\pm0.16\times10^6$ for control group to $6.48\pm0.21x10^6$ for the 0.5% urea group, while the WBC count ranged from $7.25\pm0.8\times10^3$ for the control to $9.41\pm0.62\times10^3$ for the 1% urea group.

Moreover, monocyte% was 5.5±1% for the control group to 8.56±0.82% for the 1% urea fed group; neutrophil% was 43.25±3.33% for the 1% urea group to 50.23±6.7% for the control

group; Lymphocyte% was 48.05±7.06% for control and 58.46±4.91% for the 1.5% urea group; The Packed Cell Volume (PCV) ranged from 37.97±1.21% for the control group to 40.22±1.52% for the 0.5% urea group; The hemoglobin content (Hb) was 11.06±0.28 g/dl for control group and 11.63±0.27 g/dl for the 0.5% urea fed group. They concluded in this experiment that total protein, albumin were significantly differed ($P<0.05$) among treatment groups 1.5% (5.75±0.57 g/dl) and 1% (4.13±0.57 g/dl). Level of AST in the serum were significantly decreased in all experimental and control group (25.96±2088 µ/l) except the 1.5% urea fed rabbits which showed 4 times more than the other groups (94.45±36.67 µ/l). The blood urea also increased with urea level increase in diet. Serum calcium was significantly lower at 0.5% urea level (10.13±0.05 mg/dl) while it was highest at the control group (16.33±0.32 mg/dl). Inclusion of up to 1.5% urea in to the diets of growing rabbits has no adverse on hematological parameters of rabbit.

Badrudeen *et al.* (1994) reported that Phosphorus content in blood plasma is significantly ($P<0.01$) increased due to UMMB lick block supplementation, whereas the Fe content in blood is significantly increased ($P<0.01$) by urea treatment. Hemoglobin content in blood ranged from 11.3 to 11.7 g/dl, and is not influenced by UMMB lick block supplementation. Lick block significantly reduced the number of red blood cells, but increased the mean corpuscular volume of blood.

Rahman *et al.* (2011) conducting an experiment by using urea and urea bentonite combination found that serum urea and creatinine concentration not affected by addition of urea-bentonite combination. Serum urea concentration is a good indicator of protein and energy status of the animal as well as functioning of the liver and kidney. In case of glucose or energy deficit, a large portion of blood urea originates from amino acids deamination (Abdelgadier *et al.,* 1996). Urea supplementation did not increased the creatinine level markedly indicates that damage to the kidney didn't occur (Silanikove *et al.,* 1996). Addition of urea-bentonite combination was associated with increased serum glucose concentration indicating that addition of bentonite and urea probably improved hepatic gluconeogenesis activity. Moreover, addition of urea with bentonite was associated with increased cecal butyrate concentration. Butyrate is the basic metabolic fuel in the large intestine tissues of the rabbit and it also serves as an activator of hepatic gluconeogenesis (Remesy *et al.,* 1995). Thus, increased cecal butyrate concentration could increase the absorption of glucose precursors and/or enhance hepatic gluconeogenesis. Serum total protein concentrations were increased in his experiment by addition of urea-bentonite combination with reference to

control. Plasma proteins are mainly synthesized in the liver and their values in rabbits supplemented with urea-bentonite combination indicate that these animals were in a good nutritional status and their livers had no pathological lesions. Amino acids are sources of metabolic energy as well as being the building units of proteins and their use by the animal for protein synthesis take place only in the energy needs are met. Serum levels of AST were decreased in his all experimental groups in comparison with control group. Serum levels of ALT and AST are conventionally used for diagnosing domestic animals hepatic damage (Silanikove and Timokin, 1992). Changes in these enzymes were found when feed-related hepatotoxicity occurred (Silanikove *et al.,* 1996). His recorded values of the two enzymes suggest that no damage to the liver had occurred by addition of urea.

To assess the effect of supplementary feeding of urea-molasses multi-nutrient block (UMMB) enriched with area specific mineral mixture on productive and reproductive traits of buffaloes, a study was undertaken by Singh *et al.* (2010) in the intermediate zone of Rajouri district in Jammu region. Buffaloes (12; age group 3–8 years) were selected and allowed to lick a UMMB @ 400–600 g daily for 30 days. Blood samples were analyzed for hemato-biochemical parameters, macro and trace elements and hormonal status (T3, T4 and progesterone) at the beginning and after completion of trial. They concluded that in the UMMB supplemented group plasma protein and albumin level were significantly increased, but no significant effect was observed on PCV, BUN, Hb, glucose, magnesium, copper, calcium, zinc, phosphorous, plasma inorganic iodine (PII), manganese and iron level in blood.

2.3.7 Effect of urea in the fermentation pattern and microbial population of rabbit caecum

Supplementation of urea in the rabbit diet increases the concentrations of cecal VFAs and causes greater cecal microbial activity (Rahman *et al.,* 2011). Increased NH3-N concentration by addition of urea alone could be attributed to production of surplus amount of NH3-N via highly active ureolytic cecal microbes (Marounek *et al.,* 1995). The cecal pH value increases by addition of urea. The pH value of rabbit cecal chyme shows a falling tendency when VFAs concentrations grows and ammonia concentration falls (Garcia *et al.,* 2002), and hence, increased cecal pH associated with addition of urea is mostly due to excessive ammonia production. This change in fecal pH did not hampered cecal physicochemical conditions, but it increases the production of VFA from the breakdown of urea resulting increased cecal bacterial mass. This increased bacterial mass by addition of urea points to a synchronous

supply of energy and NH3-N in the cecum for continuous growth of cecal microbes (Rahman *et al.,* 2011). Carabaño *et al.* (2011) also reported that hydrolysis of urea in the rabbit caecum produces ammonia that is used for microbial growth and leads to the more microbial population.

2.3.8 Biochemical changes after UMMB supplementation

High circulatory urea concentration, which may occur after consuming protein-rich diet, has been linked to an altered uterine environment and reduced fertility in dairy cattle (Beam and Butler, 1998). UMMB is a urea based nutritional supplement and apprehensions about its possible ill effects on animal health are not totally unfounded. Laboratory studies were undertaken by Garg *et al.* (2007) to assess biochemical changes, if any, following long term UMMB consumption in buffaloes. But they found the blood urea-nitrogen remained within physiological limits (<20 mg/dl). Blood glucose did not differ between the groups of buffaloes studied under field conditions. Total plasma proteins, insulin and creatinine, estimated at weekly intervals in various studies remained within normal physiological limits. Blood concentration of free fatty acids, an indicator of fat mobilization in lactating animals, was relatively lower in UMMB supplemented than in un-supplemented buffaloes (42 vs 49 mg/dl). This suggested a superior nutritional status in the supplemented animals (Kang, 2002; Randhawa *et al.*, 2003)

2.4 Effect of UMMC in the animal reproductive performances

2.4.1 Pre-partum UMMC supplementation effects

Hasanat *et al.* (2006) conducted an experiment by using the same concentrate ingredients except urea used in this study and they found that concentrate supplementation significantly ($P<0.05$) increases litter weight at birth (180.38±16.37g) than control group (137.19±16.37g). Litter size at weaning differed ($P<0.05$) and the mean values were 1.37±0.30 for treatment group and 2.37±0.27 for control group. They also observed superior ($P<0.01$) kit weight at weaning was in treatment group (408.12±3.85g) than control group (310.62±3.56g). Yono *et al.* (1986) conducted an experiment on New Zealand rabbits by using four dietary treatments, 21.5% crude protein (CP) diet control, a 16% CP diet (LP), LP + 3% DL-methionine (LP + met) and LP + 2.1% urea (LP + urea) and they found that urea supplementation did not significantly increased the gestation period and conception rate of does, but litter weight, individual kit weight and weight gain was higher in the urea fed group.

UMMB supplementation to the dam increases birth weight of newborn calf 13.6kg to 17.8kg. (Shikui *et al.* (2003) Supplementation of UMB decreases the mortality rate of new born young by increasing the survival rate from 90.2 to 96.4% (Shikui *et al.,* 2003). Wang *et al.* (1997) reported that the survival rate of calves can be increased by 20% after UMB supplementation. Salman (2000) reported that the effect of using supplementary UMMB on the reproductive performance of Awassi ewes grazing cereal stubble has been investigated in one on-station experiment. Using during stubble grazing MNB increases the conception rate of the ewes about 11% than the control group. By conducting a study on anestrous buffalo using UMMB supplementation Singh *et al.* (2010) showed that after 30–45 days of completion of trial 72.72% (9/11) of the buffaloes came in heat and conceived to first impregnation. The reproductive performances of rabbit can be improved through UMMB supplementation. Zhang (1998) reported that the pregnancy rate of the Tianzhu white yak cows can be increased by 17.4% and that of the Gannan black yak cows by 23.4% when the yak cows were supplemented with UMMB. Shikui *et al.* (2003) conducted an experiment on yak cow by supplying UMMB to one group with natural grass and another group with only natural grasses and showed that UMMB supplementation increases the pregnancy rate from 63.7 to 72.5%.

2.4.2 Post-partum UMMC supplementation effects

Good quality nutrition is a necessity for proper puerperal and postpartum production and reproductive events, which, however, remain constrained by limitations in concentrates and green fodder availability. Garg *et al.* (2007) reported that UMMB supplementation to 14 freshly calved buffaloes belonging to small-scale rural farmers proved beneficial. The average percent live weight loss was greater (0.53 to 3.9 percent) in un-supplemented than in supplemented (0.02 to 3.00 percent) buffaloes. Further, the supplemented buffaloes started gaining live weight earlier (5th week postpartum) than did the un-supplemented controls (7th week postpartum). A higher proportion (71 percent) of the supplemented buffaloes displayed estrus within 50 days postpartum, compared with only 14 percent in the controls (Randhawa, 2002).

2.4.3 Effects of UMMB supplementation in true anestrus

Brar and Nanda (2002) conducted a study on fifty-four rural buffaloes suffering from true deep anestrus, as confirmed from history, per rectal examination of genitalia and circulatory progesterone concentrations, were supplemented with UMMB. Of these, 90 percent came

into heat and conceived within one month of supplementary feeding, compared with only 28 percent in the control group In another, similar, trial during May–June – a period with minimal breeding activity in buffaloes (Nanda, Brar and Prabhakar, 2003) UMMB supplementation for 30 days induced behavioural estrus in 40 percent of the buffaloes, compared with only 10 percent in the control group. Extended UMMB supplementation for another 30 days (total 60 days) induced behavioural estrus in 85 percent of buffaloes, with a 100 percent first-service conception rate (Kang *et al.*, 2002). These studies suggested that malnutrition is a major cause of anestrus, and that it could be ameliorated through UMMB supplementation.

2.4.4 Other beneficial reproductive effects of using UMMB

UMB supplementation has a significant effect in the postpartum ovarian activity in animals. According to Ghosh *et al.* (1993) UMMB supplementation initiated ovarian cyclicity in Zebu cows between days 14 and 44 (25.50±3.39) postpartum. Behavioural estrus was within 35–84 days (67.63±5.52). In the control group (non UMMB supplemented group) ovarian cyclicity between days 60–125 postpartum and behavioural oestrus within 145–196 days. Significant differences ($P<0.001$) were observed between the two groups of cows in the interval of resumption of ovarian cyclicity of cows and for calving to first postpartum estrus.

Salman (2000) showed in a study that using MNBs enriched with cotton seed meal (a source of by-pass protein) and vitamin A, D and E resulted in considerable improvement of lambing percentage (26%), twinning percentage (15%) and cycling activity compared to the control non-supplemented group. Supplementation with MNB also considerably improved the reproductive performance of goats (Hendratno *et al.,* 1991). Vu *et al.* (1999) conducted an experiment on sixty Holstein–Friesian crossbred cows on 11 smallholder farms were divided equally into control, UMMB and UTRS supplementation groups and showed that the intervals from calving to onset of ovarian activity (91–94 days), to conception (121–122 days) to estrus (110–114 days) and the calving interval (13.4–13.6 months) in the trial groups were significantly shorter as compared to the control group (112, 135, 152 days and 14.4 months, respectively). Khan *et al.* (2007) conducted a study using 0; 350; 500; and 650 g/head/day UMB to four group crossbred cows and showed that the intervals from calving to initiation of luteal activity(96, 87, 82, 62 days, respectively), estrus(162, 132, 123, 142 days, respectively) and service per conception (2.67, 2, 1.8, 1.73, respectively) were shorter in UMMB-fed lactating cows .The postpartum reproductive intervals of cow can be reduced by feeding UMMB (Hendratno, 1999) which is of economic significance.

CHAPTER III

MATERIALS AND METHODS

Chapter III

Materials and methods

3.1 Experimental site and animals

The present study was conducted with two experiments for a total duration of about 11 months from January to November, 2016 at Rabbit Research Farm of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh. In *Expt. I*, 20 New Zealand rabbit does with the average age of 24 weeks were selected to investigate the reproductive performances. In *Expt. II*, a total of 28 post weaned New Zealand young rabbits with average age of 5 weeks were selected to study the productive performance. All of the experimental rabbits were healthy, disease free and physiologically sound.

Photo 1. Experimental site and animals used in the experiment

3.2 Experimental design and dietary treatments

3.2.1 Experiment I

The study was conducted with 20 New Zealand adult rabbit does which were randomly assigned into four dietary treatment groups under a completely randomized design (CRD), so that there were 5 rabbits in each group. The control group was fed UMMC without urea and other dietary groups were fed UMMC containing three different levels of urea (4, 6 and 8%). All the does were supplied UMMC @ 30 g twice daily, at 9.00 am and 3.00 pm. The experimental layout was as follows:

T_0 = UMMC containing 0% urea + Napier grass.
T_1 = UMMC containing 4% urea + Napier grass.
T_2 = UMMC containing 6% urea + Napier grass.
T_3 = UMMC containing 8% urea + Napier grass.

3.2.2 Experiment II

A total of 28 weaned rabbits from *Expt. I* were randomly assigned into 4 dietary treatment groups in a completely randomized design (CRD) having 7 rabbits in each group and feed was supplied as following layout.

T_0 = UMMC containing 0% urea + Napier grass.
T_1 = UMMC containing 4% urea + Napier grass.
T_2 = UMMC containing 6% urea + Napier grass.
T_3 = UMMC containing 8% urea + Napier grass.

In case of all groups, 15 g size cake provided twice daily during 1st month of experiment, 20 g size cake provided during 2nd month of the experiment and then up to 5 month of experimental period, and 30 g size cake was supplied twice daily, at 9.00 am and another at 3.00 pm.

3.3 Preparation of UMMC

The required feed ingredients were purchased from local market and UMMC were prepared as followed by the steps according to the Table 1.

i) At first according to the Table 1, all ingredients were weighed and kept in separate containers.

ii) Solid urea was grinded and added with limestone, cement and ½ of the common salt in a container and mixed thoroughly to prepare the Mixture-1.

iii) Mustard oil cake also grinded and added with the broken maize, soybean meal (48), wheat bran and ½ of the common salt and mixed thoroughly to prepare Mixture-2.

iv) Then Mixture-1 and mixture-2 were mixed in another separate container.

v) Gradually molasses was added and mixed thoroughly to prepare a homogenous final mixture of the ingredients.

vi) Then the final mixture was entered into a metal tube of 60 cm length and 5 cm diameter (special device made by my Co-supervisor). Hammer and rod valve were used to apply pressure in the mixture within the tube so that the mixture can be compact to form a better consistency of the cake.

vii) After entering the mixture into the metal tube the screws (beside the tube) were tightened and sundried for 2–3 days.

viii) After that the tubes were opened by loosening the screws and the hardened mass was cut into several pieces by a knife to prepare required size cake (20, 40, 50 and 60 g).

ix) Finally the prepared UMMC was kept in the container to be used for the experiment.

Table 1. Ingredient and nutrient composition of UMMC

Feed Ingredients	**Experimental Group**			
	T_0 (%)	**T_1 (%)**	**T_2 (%)**	**T_3 (%)**
Urea	0.0	4.0	6.0	8.0
Molasses	40.0	40.0	40.0	40.0
Broken maize	4.0	11.6	12.8	12.8
Wheat bran	10.0	4.0	0.0	0.0
Rice polish	22.0	16.0	16.0	16.0
Soybean meal (48)	0.0	6.0	7.2	7.2
Mustard oil cake	14.0	8.4	8.0	8.0
Lime stone	3.0	3.0	3.0	2.0
Common salt	3.0	3.0	3.0	3.0
Cement	4.0	4.0	4.0	3.0
Total	100	100	100	100

Table 1. Ingredient and nutrient composition of UMMC (Continued)

Nutrient Composition (Calculated)	Experimental Group			
	T_0 (%)	T_1 (%)	T_2 (%)	T_3 (%)
ME (kcal/ kg)	2171.00	2170.24	2171.12	2171.15
CP (%)	10.70	10.67	10.58	10.59
CP (%; Provided by urea)	0.00	11.52	17.28	23.04
CF (%)	2.52	2.59	2.33	2.44
EE (%)	3.39	3.34	3.22	3.28
Ca (%)	1.43	1.39	1.39	1.41
P (%)	0.42	0.39	0.39	0.39
Lysine (%)	0.45	0.47	0.47	0.47
Methionine (%)	0.17	0.16	0.16	0.16
Linoleic acid (%)	0.18	0.33	0.33	0.33
Tryptophan (%)	0.09	0.10	0.11	0.11

N.B. 1 g urea is equivalent to 2.88 g CP. (FAO's Animal Feed Resources Information System. 1991-2002)

Photo 2. Ingredients used for the preparation of UMMC

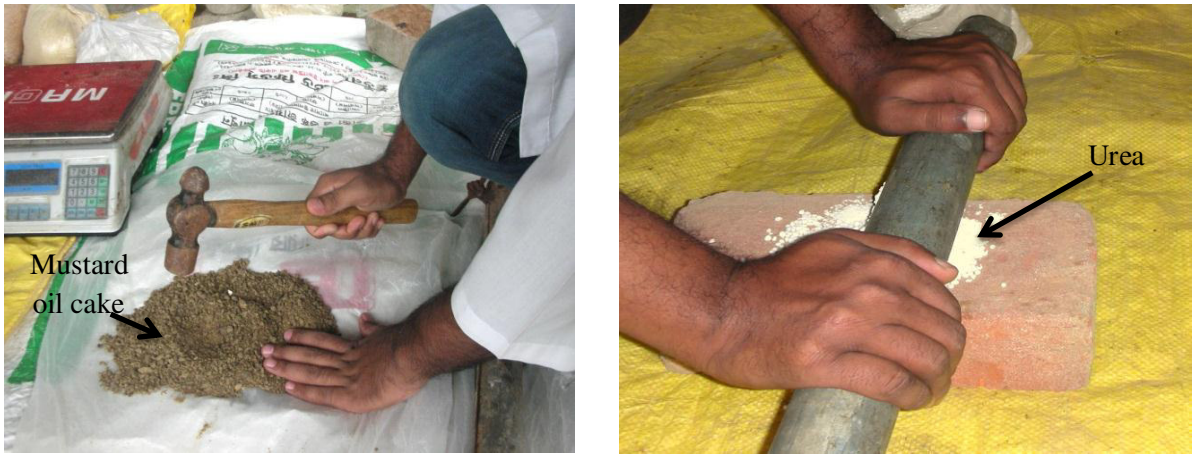


Photo 3. Grinding of til oil cake and urea

Photo 4. Weighing of ingredients

Photo 5. Mixing of ingredients before adding molasses

Photo 6. Mixing of ingredients after adding molasses

Photo 7. Final mixture of UMMC

Photo 8. Putting the mixture into the UMMC tube

Photo 9. Hammering and tightening the UMMC tube screw to make a hard and compact UMMC

Photo 10. Sun drying and opening of the UMMC tube

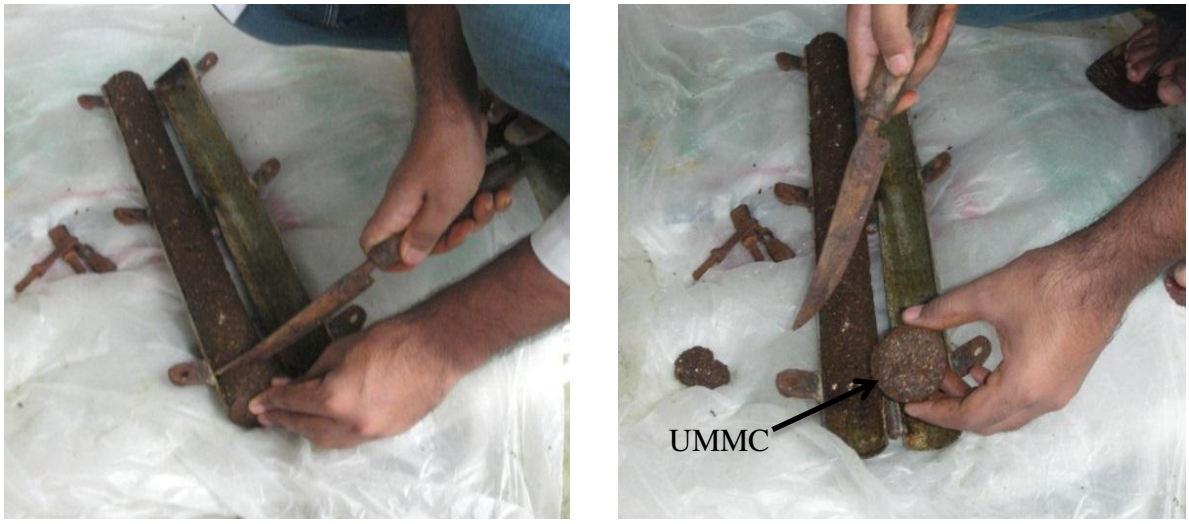


Photo 11. Cutting of UMMC into desirable size

Photo 12. Weighing and keeping UMMC in the jar for feeding of rabbit

3.4 General management

Each rabbit was kept in a separate steel-iron made cage (2×2 feet) equipped with feeder and waterer and a one square feet flattened area at the corner of the floor of the cage to facilitate the coprophagy behavior of the rabbit. Each experimental rabbits were earmarked with the permanent marker as well as with particular tags in front of their cages. The rabbits of the different groups were supplied with the same amount of Napier grass. All adult does of the *Expt. I* was supplied with 300 g Napier grass/doe/day and weaned rabbits under the *Expt. II* were supplied with 200 g during the 1st month of experiment and later months with 300 g Napier grass/rabbit/day. The supplied Napier grass was given half in the morning (at 9:00 am) and rest half in the afternoon (at 3.00 pm). Fresh and clean drinking water supplied *ad libitum* to the experimental rabbits twice daily at 9:00 am and 3.00 pm. All rabbits were kept under same management practices with providing 16h: 8 h light and dark cycle. Good hygienic and sanitary condition was maintained during the study period. Foot bath was placed

in front of the farm and no visitors were allowed to enter into the farm. Waterer and feeder were cleaned with detergents once weekly. Feces, urine and feed residues in the tray of the cage were cleaned daily. The live weight of the does was recorded weekly. Finally at the 28 days of mating, live weight was taken to determine the total live weight gain of does during gestation. After birth of kits, litter size and litter weight were recorded in each week at morning. In case of does with a litter size more than 5, fostering was done to help the kits in the getting of milk of the doe. All newborn kits were intensively and carefully handled with wearing hand gloves. Physical condition of the does and their kits were observed regularly and dead kits were recorded. The dead kits were buried after a post mortem examination carried out to diagnose the causes of death.

Photo 13. Rabbit cages

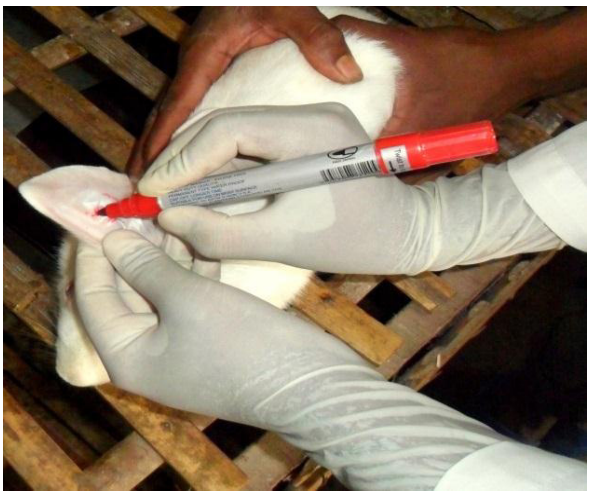


Photo 14. Ear marking of rabbits

Photo 15. Collection of grasses from field

Photo 16. Weighing of grasses

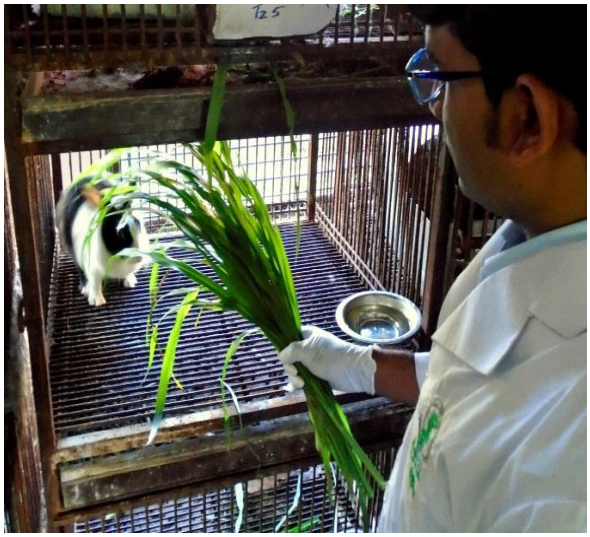


Photo 17. Supplying grasses to the rabbit

Photo 18. Supplying UMMC to the rabbit

Photo 19. Supplying water to the rabbit

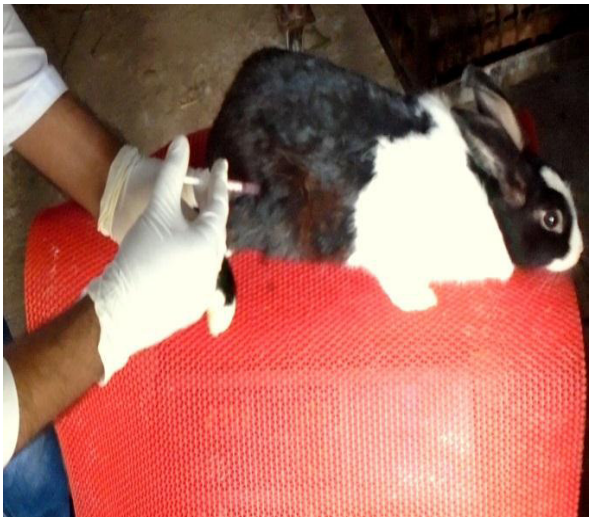


Photo 20. Injecting hormone to the does.

Photo 21. Carrying does to the buck cage for natural breeding

Photo 22. Breeding of rabbits

Photo 23. Supplying maternity box to the preganant does

Photo 24. Doe with newborn kits

Photo 25. Weighing of newborn kits

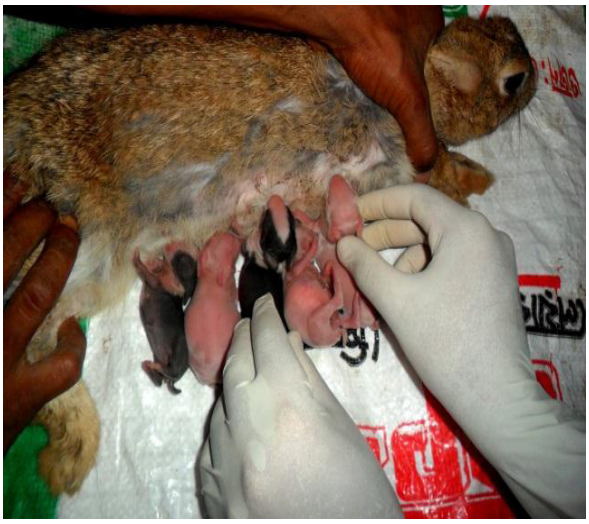


Photo 26. Fostering of newborn kits

3.5 Waste Management

Waste grass, UMMC and feces were collected once in a week. After weighing UMMC waste was sun dried for few days and then supplied to the rabbits out of experiment of the farm. Feces and grass residue were weighed and kept in a soil pit for decomposing. Rabbit urine and feces contains higher amount of nitrogen that produces farm manure which was used as an alternative of inorganic fertilizer in the field of Napier grass.

3.6 Record keeping

A standard record book was maintained throughout the experimental period. Following parameters were recorded in the record book:

- Daily supplied amount of grass and UMMC

- Amount of residual grass and UMMC
- Weight of the rabbits (in each week)
- Feed conversion ratio (FCR)
- Length of gestation period (day)
- Conception rate
- Date and Amount of injecting hormone
- Tag no. of the does and bucks mated
- Palpation date
- Weight of the does after mating once in a week
- Nesting date
- Kindling Date
- Litter size at birth
- Litter size at 7, 14, 21 and 28th day of kindling
- No. of dead kit at birth
- No. of dead kit at 7, 14, 21 and 28th day of kindling
- Vaccination and medication record
- Any disease or abnormal condition of the both doe and kits

Photo 27. Maintaining different records of the experiments

3.7 Measurements and methods of interpreting results-

Different parameters of the rabbit were calculated by the following way-

3.7.1 Live weight (LW)

Rabbits were individually weighed to the nearest gram in the early morning before providing any food and water at the initial weight and weekly during the experimental period.

3.7.2 Live weight gain of rabbit

It was calculated by using following formula-

$LWGR_X = LWR_X – LWD_0$

Where:

LWD_0 = Initial weight of the rabbit at the time of start of experiment.

LWD_x = Final weight of the rabbit at the x time period.

(x = Specific weeks when live weight is calculated)

3.7.3 Growth rate of the rabbit

It was calculated by following formula -

$$\text{Growth rate} = \frac{\text{Total weight gain in a certain time period}}{\text{Total days of the experiment}}$$

3.7.4 Feed consumption (FC)

Feed consumption per doe was calculated for each doe by sum of the daily consumption for 28 days of age from 1st day of mating.

3.7.5 Feed conversion ratio (FCR)

It was calculated using the following formula (according to Ensmingar, 1980):

$$\text{FCR} = \frac{\text{Total weight gain (g)/doe during a certain period}}{\text{Feed Consumption (g)/doe during the same period}}$$

3.7.6 Performance index (PI)

The PI of the growing period was weekly calculated according to the equation described by North (1981) as follows:

Performance Index, PI = (LW, kg/FCR) ×100

Where,

LW= Live weight

FCR = Feed conversion ratio

3.7.7 The parameters of doe

3.7.7.1 Live weight gain of does (LWGD)

It was calculated at 28 days after mating by using the following formula:

$$LWGD_{28} = LWD_{28} - LWD_0$$

Where:

LWD_0 = Initial weight of does at the time of start of experiment
LWD_{28} = Final weight of does at 28 days after breeding

3.7.7.2 Gestation period

The duration of pregnancy is also called the gestation period. The gestation period was recorded for each doe during the experimental period from October to December 2015.

3.7.7.3 Conception rate

The conception rate was calculated for each treatment by the following equation:

$$\text{Conception rate (\%)} = \frac{\text{Number of pregnant does}}{\text{Number of mated does}} \times 100$$

3.7.8 The parameters of offspring

3.7.8.1 Litter size

The litter size (total, alive and dead) was recorded at birth and at each week up to weaning.

3.7.8.2 Litter weight and individual kit weight

The litter weight and individual kit weight were recorded with the help of digital balance at birth, 7, 14, 21 and 28 days of age.

3.7.8.3 Kit mortality

Kit mortality was recorded from birth to weaning. Following formula was used to identify the mortality rate of offspring:

$$\text{Kit mortality (\%)} = \frac{\text{(Total litter size at birth - alive kits number at weaning)}}{\text{Total litter size at birth}} \times 100$$

3.8 Hematological parameters

3.8.1 Determination of Hemoglobin Concentration (Hb) %

Hemoglobin Concentration was determined by following Helligehemo meter method described by Lamberg and Rothstein (1977). Briefly, at first 0.1 N hydrochloric acid (HCl) was taken up to 2 marks of a graduated tube with a dropper. Then the homogenized blood sample was taken up to 20 cm mark of the Sahli pipette. Tip of the pipette was wiped clearly by using sterile cotton and the pipette blood was immediately transferred into the graduated tube that contains HCl. Then the blood and acid were mixed thoroughly by stirring with a glass stirrer. Acid hematinic mixture was formed in the tube by hemolysing red blood cells by the action HCl. The tube containing acid-hematin mixture was kept standing for 5 minutes in the comparator. Then distilled water was added drop by drop to the tube. The solution was well mixed with a glass stirrer until the mixture color was resembled to the standard comparator color. Final result was read in daylight by observing the height of the liquid in the tube considering the lower meniscus of the liquid column.

3.8.2 Determination of packed cell volume (PCV)

Citrated well mixed blood sample was taken into special loading pipette (Wintrobe pipette). Then the tip of the pipette was inserted up to the bottom of a dry and clean Wintrobe hematocrit tube. Wintrobe tube was then filled from the bottom by pressing the rubber bulb of the pipette. When blood came out, the pipette was slowly withdrawn, but pressure was still continued on the rubber bulb of the pipette for excluding the air bubbles. Tip of the pipette

was kept under the rising column of blood to avoid foaming and the tube was exactly filled to the 10 cm mark. Then Wintrobe hematocrit tube containing blood sample was centrifuged for 30 minutes at 1008×*g*. Finally, the hematocrit or PCV was recorded by reading the graduation mark. Then the volume percent occupied by the hematocrit was calculated by using the following formula as described by Lamberg and Rothstein (1977).

$$\text{PCV\%} = \frac{\text{Height of total blood in cm}}{\text{Height of the red cell volume in cm}} \times 100$$

3.8.3 Determination of Erythrocyte Sedimentation Rate (ESR)

At first, the fresh anticoagulant mixed blood was taken into the Wintrobe hematocrit tube by the help of special loading pipette exactly up to 0 marks. Then, excess blood above the mark was wiped away by using sterile cotton. Filled tube was placed vertically undisturbed on the wooden rack for 1 hour. After 1 hour ESR was recorded from the top of the pipette. Result was expressed in mm in 1st hour.

3.8.4 Red blood cells (RBC's) count

The RBCs count was determined by using hemocytometer according to Perkins (2009). Briefly, the number of red cells is very high in the blood, so diluted 200 times with an appropriate dilution fluid before the cells are counted in a counting chamber. Their number in undiluted blood then can be calculated.

Materials Used to count RBC

- Compound microscope
- Counting chamber
- Coverslip or cover glass
- Red cell diluting pipette with rubber tube
- Filter Paper
- Absorbent cotton
- Hayems solution (Diluting fluid)
- Blood sample

Procedures followed

i. At first tip of the dry and clean red pipette on the blood sample was placed
ii. Gently the blood was sucked up until it reached the exactly 0.5 marks
iii. Then the tip of the pipette was carefully wiped with the absorbent cotton
iv. Tip of the pipette immediately placed in the diluting fluid and filled the pipette exactly up to 101 marks
v. Then stretched the rubber tube around the tip of the pipette and hold with thumb and finger at each end
vi. Pipette contents were shaken thoroughly with 8 knot or twisting motion for 1–2 minutes
vii. Counting chamber was placed with the cover glass under the microscope and made visible the finely rolled area with low power objective
viii. After discarding or 3 drops, a small drop from the pipette was placed to the end of the polished surface of the counting chamber containing the ruling and allowed the space to fill the area under the cover glass
ix. Allowed the chamber to stand for 2 minutes to settle the erythrocyte
x. Then the cell counting was started with the high power objectives (45×)
xi. RBC was counted on the four corner squares and one center square
xii. All the cells touching the top and left ruled the boundary lines were included
xiii. RBC number was calculated as follows:
Number of RBC = No. of cell counted ×10,000
xiv. Finally the result was expressed million/cubic mm ($\times 10^6/mm^3$)

3.8.5 White blood cells (WBC) count

White blood cells (WBC) count was done by following the method described by Lamberg and Rothstein (1977). At first, well-mixed blood sample was taken exactly up to 0.5 marks of the pipette with the help of red blood cell diluting pipette. Outside of the pipette tip was wiped by using cotton. Then the pipette was immediately filled up to 101 marks with the red cell diluting fluid (Hayem's solution). Free end of the pipette was wrapped around with the rubber tube stretching to both the ends and held with the middle finger and thumb. The content of the pipette was mixed thoroughly by shaking with 8-knot motion for 3–5 minutes. Then the counting chamber with special cover glass was placed under microscope by using low power (10×) objectives.

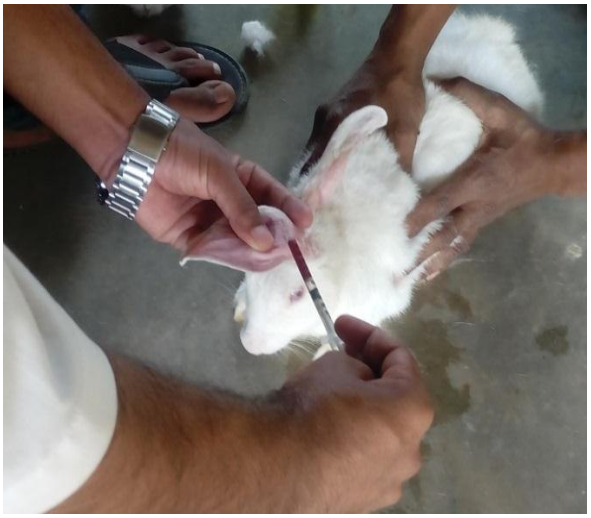


Photo 28. Collection of blood from ear vein

Photo 29. Hb. determination by the hemocytometer

Photo 30. Centrifugation of blood

Photo 31. Microscopic observation for blood cell count

Photo 32. Sucking blood into the loading pipette

Photo 33. ESR determination

Then 2 or 3 drops of fluid from the pipette was discarded and a small drop was placed to the edge of the cover glass on the counting chamber as to fill the entire area under the cover glass by the fluid. One-minute was spared to allow the cells to settle on the chamber under the cover glass. Then the cells were counted from all the 80 small squares (16×5) under high power objectives (45×) by taking 5 larger squares (4 in the 4 corners and the central one) of the central large square. At last, after the completion of counting, the total number of WBC was calculated as number of cells counted ×10, 000 and the result was expressed in million/ µl of blood.

3.9 Fecal parameter

Fecal bacterial count

Materials used

- **Diluent:** Phosphate buffer solution (PBS)
- **Sample-** 50g feces sample from 5 rabbit of each group
- **Media:** Plate count agar media.
- **Others:**
    - Glass wire
    - Pipettes
    - Petridish
    - Test tube
    - Glass spreader
    - Wooden rack
    - Incubator
    - Beaker
    - Cotton

Procedures followed

i. At first 50g feces sample from 5 rabbit of each group was collected
ii. Feces sample was homogenized in 450 ml of diluent and a suspension was made in a beaker
iii. From the original sample, 1ml was transferred in the test tube no.1 and was mixed thoroughly
iv. Then 1ml from 1st tube is transferred to 2nd tube, and this way dilution was made up to last tube, and finally 1ml discarded from the last tube

v. For each tube, 3 petridishes were taken containing PCA media

vi. 0.5ml of mixture was transferred from each of the test tube to the corresponding petridish separately

vii. One pipette was used for each test tube

viii. Tip of the pipette was touched gently to the media

ix. Dilution sample was spread over the surface of the media using glass spreader

x. After drying the media, the Petri dishes were marked (sample no.) and kept in the incubator in inverted position at 32–35^{0}C temperature for 2 days

xi. The plate containing 30–300 colonies were counted and others are discarded.

xii. The colonies found in all 3 petridishes were made an average

xiii. Average count was multiplied with the multiplying factor, which results the number of organism

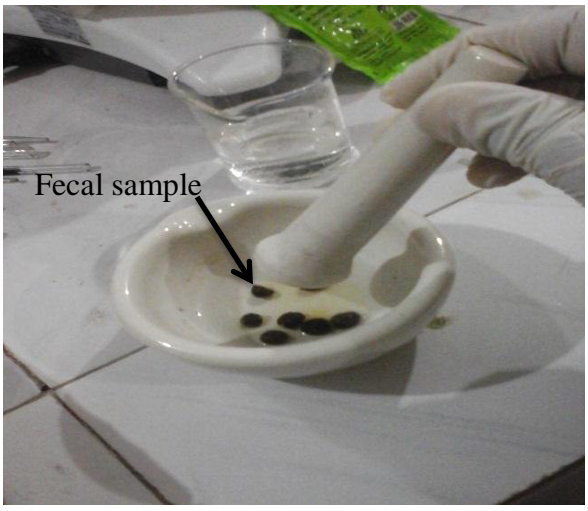


Photo 34. Grinding of rabbit fecal sample

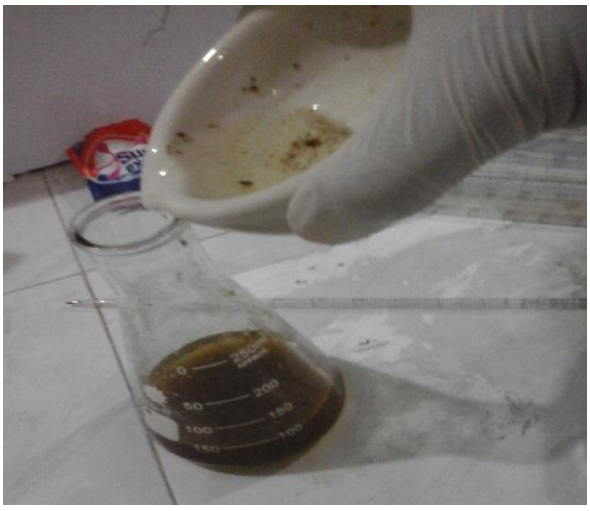


Photo 35. Pouring of liquid fecal sample

Photo 36. Preparation of liquid fecal sample

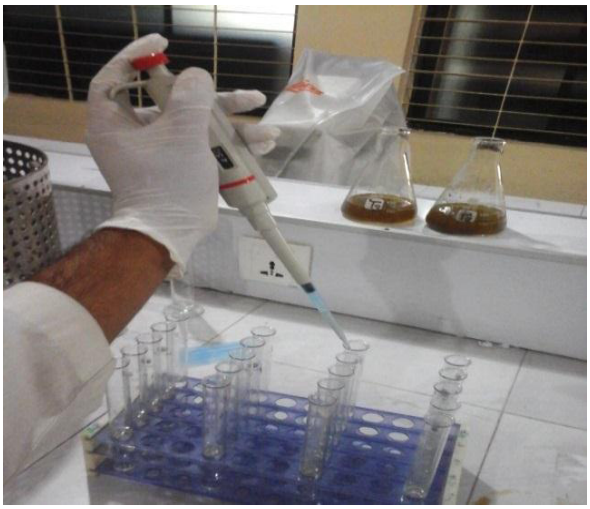


Photo 37. Dilution of fecal sample

Photo 38. Pouring diluted fecal sample to the petridishes

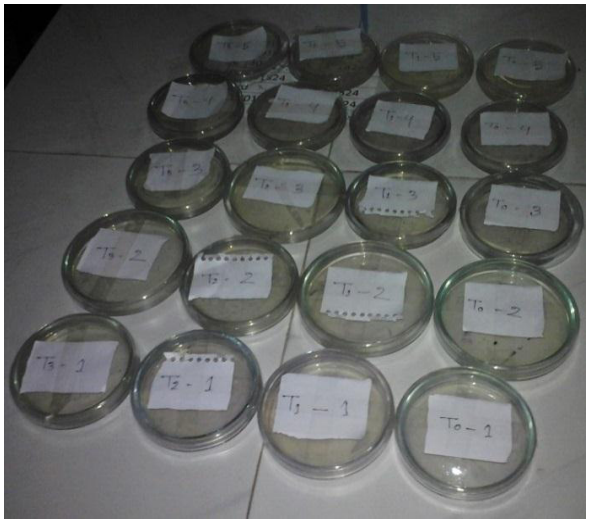
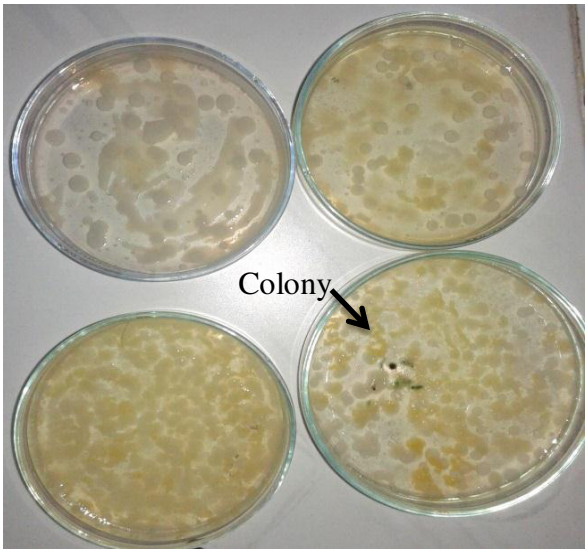


Photo 39. Pouring agar into the petridishes

Photo 40. Marking of petridishes

Photo 41. Incubation of petridishes

Photo 42. Checking of petridishes after 2 days



Phot 43. Coloni formation on the petridishes

Photo 44. Counting of fecal bacterial colony

3.10 Vaccination and medication

Prior to the starting of all experiments, animals were treated with @ 0.1ml A-Mectin® (each ml containing 10 mg Ivermectin BP, The ACME Laboratories Ltd., Bangladesh) for prevention of ecto and endo-parasites (Rai, 1988).

3.11 Statistical analysis

Both the experiments were designed by using Completely Randomized Design (CRD). The collected data under this study were analyzed and presented using simple statistical techniques. The raw data were entered and sorted into MS Excel spread sheet, then analyzed using analytical software Statistical Package for the Social Sciences (SPSS, version 16) for descriptive analysis.

$$\mathbf{Y_{ijk} = \mu + BW_i + LS_j + (BW \times LS)_{ij} + e_{ijk}}$$

Where,

Y_{ijk} = data of individual animals

μ = overall mean

BW_i = effect of birth weight

LS_j = effect of litter size

$(BW \times LS)_{ij}$ = interaction of birth weight and litter size and

e_{ijk} = random error term

All data were expressed as mean±SEM. Differences were considered significant at 5% level of significance.

CHAPTER IV

RESULTS

Chapter IV

Results

4.1 Gestation period

Dietary effect of UMMC containing different levels of urea on gestation period of rabbit does are presented in Figure 1. It shows that, average gestation periods were 31.00 days in rabbit does fed 0% urea containing UMMC (control group, T_0) while it was 32.50, 31.40, 32.00 days in rabbit does fed 4 (T_1), 6 (T_2) and 8% (T_3) urea containing UMMC, respectively. Although highest gestation period was observed in the does fed 4% urea containing UMMC (T_1), still the average values were not differed significantly (P>0.05) among the does of different groups.

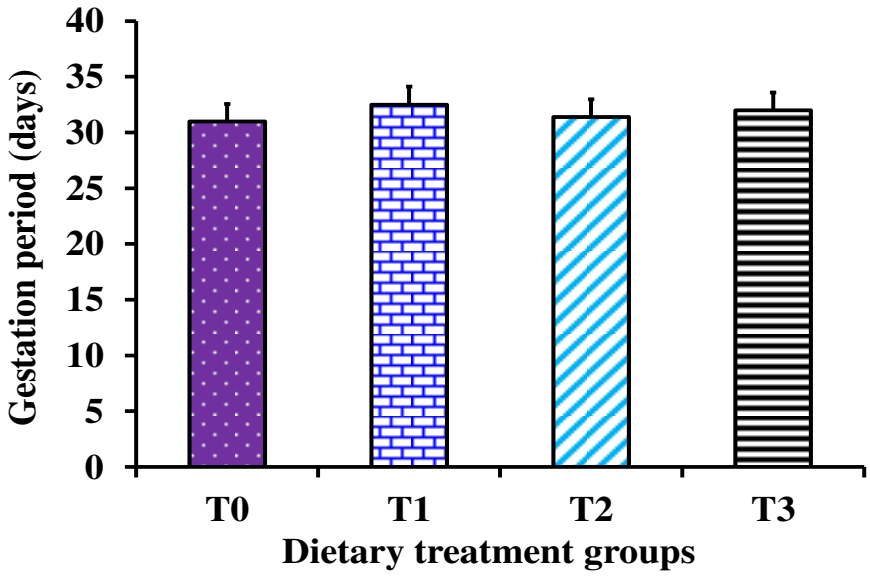


Figure 1. Effect of UMMC containing different levels of urea on gestation period of rabbit does (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were not significant at 5% level of significance (P>0.05).

4.2 Live weight gain of does during gestation period

Effect of UMMC containing different levels of urea on live weight gain of rabbit does (g/doe/day) during gestation period are shown in Figure 2. It shows that significant differences (P>0.05) in live weight gain of the does during gestation period were observed between the rabbit groups fed 0% (Control group,7.74 g/day) and 6% urea containing UMMC (10.26 g/day). Although, live weight gain was slightly higher in the rabbit does fed 4

and 8% urea containing UMMC (8.79 and 8.89 g/day, respectively), but were not significantly differed (P>0.05) with the control group (7.74 g/day).

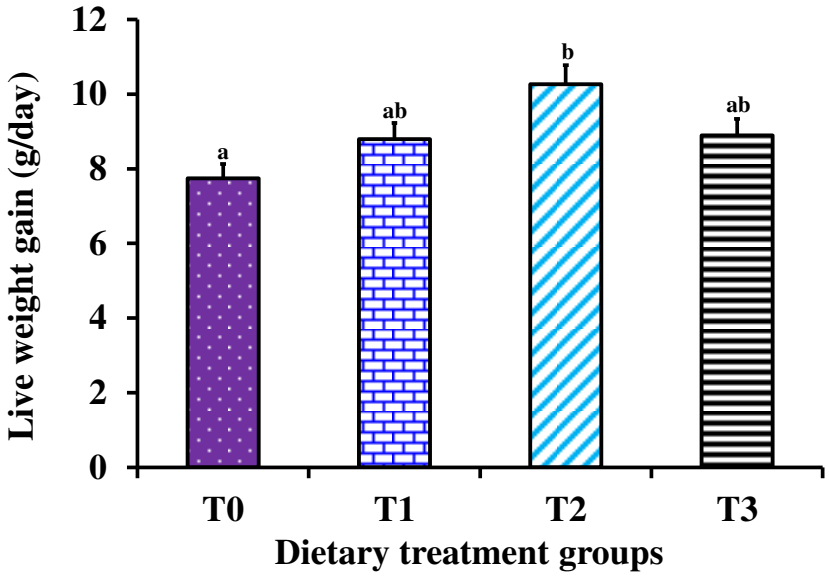


Figure 2. Effect of UMMC containing different levels of urea on live weight gain of rabbit does (g/doe/day) during gestation period (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05).

4.3 Conception rate

Dietary effect of UMMC on conception rate of the does observed in the *Expt. I* is presented in Figure 3. It was observed that, average conception rate was significantly (P<0.05) differed between the does fed UMMC without urea (80%) and the does fed 6% urea containing UMMC (100%). However, there was no significant differences (P<0.05) among the recorded conception rates (80% in each group) in the rabbits fed 0, 4 and 8% urea containing UMMC.

4.4 Litter size at birth and weaning

Effect of UMMC on litter size at birth and weaning observed in *Expt. I* is shown in Figure 4. It was observed that litter size at birth was not significantly differed (P>0.05) among the groups. Rabbit does fed 0, 4, 6 and 8% urea containing UMMC had 4.00, 4.25, 4.00 and 3.75 litter size, respectively and highest litter size was observed in does fed 6% urea containing UMMC. Litter size at weaning was significantly (P<0.05) differed between the control group (2.75) and the dietary group (6% urea containing UMMC, 3.40). Although rabbit does fed 4 and 8% urea containing UMMC (T_1) showed a little higher litter size (3.25 and 3.25, respectively) but not significantly differed (P>0.05) with the control group (2.75).

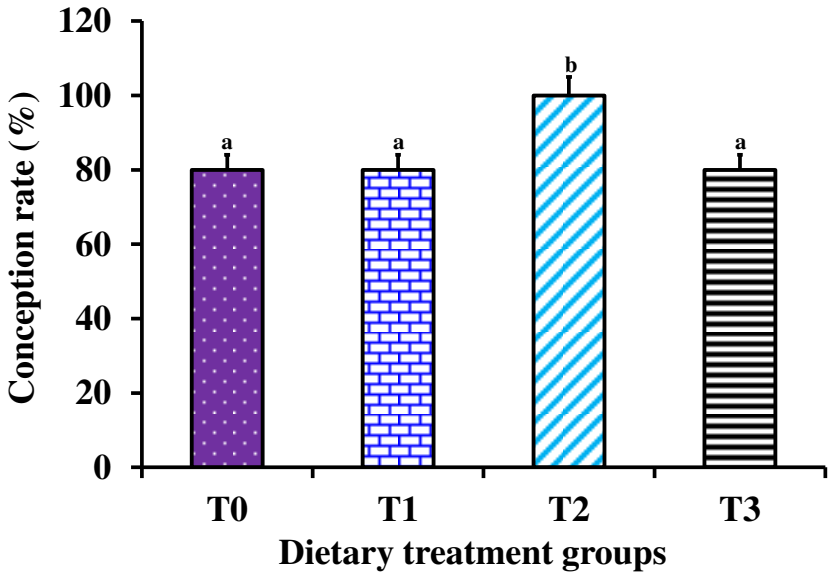


Figure 3. Effect of UMMC containing different levels of urea on conception rate of rabbit does (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance ($P<0.05$).

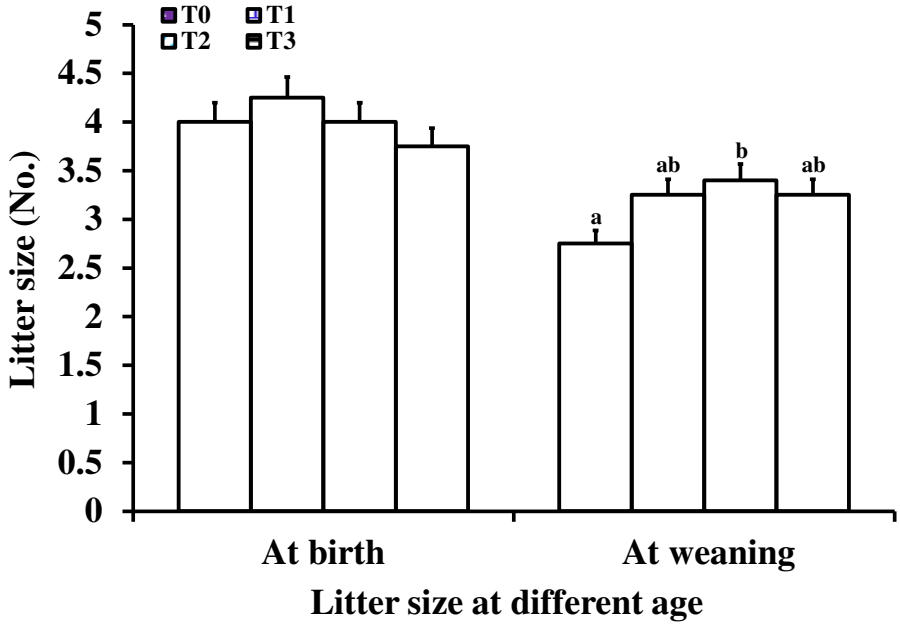


Figure 4. Effect of UMMC containing different levels of urea on litter size at birth and weaning of rabbit does (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance ($P<0.05$).

4.5 Litter weight from birth to weaning

Effect of UMMC containing different levels of urea on litter weight from birth to weaning of rabbit does observed in *Expt. I* is shown in Table 2. At birth and 7th days, litter weight was not significantly differed (P>0.05) among the rabbit does. However, at 14th, 21st and 28th day of kindling litter weight was significantly differed (P<0.05) between the does of control group and the dietary group (6% urea containing UMMC), but the rabbits fed 4 and 8% urea containing UMMC showed no significant (P>0.05) variation with the control group.

Table 2. Effect of UMMC containing different levels of urea on litter weight from birth to weaning of rabbit does

Experimental Period	Dietary treatment groups*				Level of Significance
	T_0	T_1	T_2	T_3	
Litter wt. at birth	191.4±6.7	221.4±13.6	230.4±2.4	202.8±32.0	NS
Litter wt. at 7 d	383.8±27.4	454.1±45.9	406.6±52.9	385.8±64.8	NS
Litter wt. at 14 d	535.8±18.5^{a}	593.45±20.6^{ab}	635.4±9.2^{b}	615.5±11^{ab}	*
Litter wt. at 21 d	631.2±12.5^{a}	738.7±29.5^{ab}	787.7±17.2^{b}	757.9±10.6^{ab}	*
Litter wt. at 28 d	643.7±47.8^{a}	907.4±94.7^{ab}	994.8±87.4^{b}	944.7±82.6^{ab}	*

$^{a, b, ab}$ Mean values with different superscripts within the same row differed significantly; NS = Non significant (P>0.05), * = Significant (P<0.05). Here, T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea.

4.6 Individual kit weight

Effect of dietary UMMC supplementation on individual kit weight from weaning to kindling observed in *Expt. I* is shown in Table 3. It was observed that individual kit weight from birth to 21st days had no significant differences (P>0.05) among the groups, but significant differences (P<0.05) in individual kit weight were observed at the 28 days of birth between the does of control group (210 g) and the group fed 6% urea containing UMMC (293 g). Although rabbit does fed 4 and 8% urea containing UMMC showed a little higher individual kit weight (279 g and 291 g, respectively) but not significantly differed (P>0.05) with the control group (234 g).

Table 3. Effect of UMMC containing different levels of urea on individual kit weight from birth to weaning of rabbit does

Individual kit wt. at different feeding period	Dietary treatment groups*				Level of Significance
	T_0	T_1	T_2	T_3	
At birth	47.85±3.4	52.1±3.3	57.6±4.1	54.1±3.2	NS
At 7th day	118.1±9.1	121.1±17.2	119.6±4.1	118.7±6.9	NS
At 14th day	178.6±7.2	182.6±8.6	186.9±6.7	189.4±8.4	NS
At 21st day	210.4±4.8	227.3±10.3	231.7±11.1	233.2±4.3	NS
At 28th day	234.1±17[a]	279.2±14.3[ab]	292.6±11.3[b]	290.7±11[ab]	*

[a, b, ab] Mean values with different superscripts within the same row differ significantly ; NS = Non significant (P>0.05), * = Significant (P<0.05). Here, T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea.

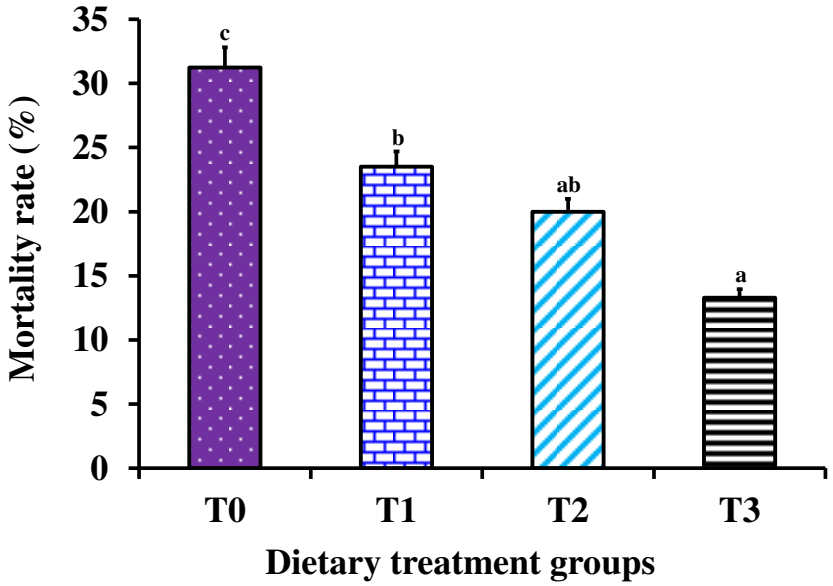


Figure 5. Effect of UMMC containing different levels of urea on mortality rate of kits of the does (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were significant at 1% level of significance (P<0.01).

4.7 Mortality rate of kits

The mortality rates of kits observed in *Expt. I* is shown in Figure 5. It was observed that mortality rate was significantly ($P<0.01$) differed among the rabbit groups fed 0, 4 and 8% urea containing UMMC (31.25, 23.52 and 13.30%, respectively). Does fed 6% urea containing UMMC showed significant differences ($P<0.05$) in mortality rate (20.00%) with the control group, but was not significant ($P>0.05$) with other groups. Highest (31.25%) and lowest (20.00%) mortality rates were observed in the rabbit group fed 0 and 8% urea containing UMMC, respectively.

4.8 Live weight of growing rabbits

Effect of UMMC on live weight of growing rabbits of *Expt. II* during the 20 weeks of experimental period is shown in Table 4. Result of the experiment showed that average live weight of young rabbits was not differed significantly ($P>0.05$) among the groups up to 6 weeks of the experimental period. From 7^{th} week to the 20^{th} week of the experiment significant ($P<0.05$, $P<0.01$) differences in the live weight were observed among the rabbit groups. It was also observed that from 7^{th} week of the experiment consistently higher live weight was observed in the rabbit group fed 6% urea containing UMMC (T_2) than the rabbit group fed 0 (T_0), 4 (T_1) and 8 % urea containing UMMC (T_3). At the end (20 weeks) of the experiment live weight of the growing rabbit was significantly differed ($P<0.001$) among the rabbit groups and it was 1490. 86, 1633.71, 1861.86 and 1770.86 g in rabbit group fed 0 (T_0), 4 (T_1), 6 (T_2) and 8 % urea (T_3) containing UMMC, respectively.

4.9 Average weight gain of growing rabbit

Effect of dietary UMMC supplementation on average weight gain of growing rabbits of *Expt. II* during the 20 weeks of experimental period is shown in Table 5. Result of this experiment revealed that average weight gain of young rabbits did not differed significantly ($P>0.05$) among the rabbit groups up to 3 weeks of the experimental period. But from 4^{th} week to 20^{th} week of the experiment significant ($P<0.05$) differences were observed among the rabbit groups. This study also showed that from the 4^{th} week of the experiment consistently higher growth rate was observed in the rabbit group fed 6% urea containing UMMC (T_2) than the rabbit group fed 0 (T_0), 4 (T_1) and 8 % (T_3) urea containing UMMC. At the end of the experiment highly significant ($P<0.001$) weight gain was observed among the rabbit groups and it was 8.10, 9.11, 10.73 and 10.10 g/rabbit/day in the rabbit groups fed 0 (T_0), 4 (T_1), 6 (T_2) and 8% urea (T_3) containing UMMC, respectively.

Table 4. Effect of UMMC containing different levels of urea on live weight of growing rabbits

Live weight at different feeding period	Dietary treatment groups*				Level of Significance
	T_0	T_1	T_2	T_3	
Initial Weight	356.8±7.1	357.1±6.5	358.57±9.7	356.71±9.3	NS
At 1st wk.	408.4±7.4	407.4±4.9	411.43±7.8	407.11±6.3	NS
At 2nd wk.	446.0± 6.9	447.7±6.9	450.2±6.4	451.1±6.3	NS
At 3rd wk.	492.8±8.3	504.8±7.1	512.5±6.2	498.7±6.6	NS
At 4th wk.	523.1±9.9	536.0±11.1	555.0±10.4	530.4±9.9	NS
At 5th wk.	603.2±12.2	618.5±10.5	646.1±8.8	615.2±10.2	NS
At 6th wk.	613.1±13.7	637.3±11.7	672.1±12.0	635.3±12.7	NS
At 7th wk.	$650.0±13.4^{a}$	$679.7±11.3^{a}$	$731.8±9.6^{b}$	$691.1±10.7^{ab}$	*
At 8th wk.	$677.8±13.1^{a}$	$706.4±9.7^{ab}$	$767.7±10.2^{b}$	$727.8±10.5^{ab}$	**
At 9th wk.	$738.0±12.0^{a}$	$770.8±8.4^{ab}$	$849.4± 8.0^{c}$	$803.7 ±9.3^{b}$	**
At 10th wk.	$792.4±13.1^{a}$	$820.1±6.1^{ab}$	$892.2±9.3^{c}$	$861.5±7.3^{bc}$	**
At 11th wk.	$937.1±10.7^{a}$	$990.4±7.8^{ab}$	$1081.1±9.8^{a}$	$1037.2±8.7^{bc}$	**
At 12th wk.	$947.0±11.9^{a}$	$1003.4±7.5^{ab}$	$1105.4±9.8^{c}$	$1049.1±9.5^{bc}$	**
At 13th wk.	$978.0±12.6^{a}$	$1050.2±10.2^{b}$	$1166.0±11.1^{c}$	$1098.4±11.5^{b}$	**
At 14th wk.	$1041.2±14.1^{a}$	$1107.5±12.2^{ab}$	$1253±13.5^{c}$	$1165.1±12.1^{b}$	**
At 15th wk.	$1094.4±16.8^{a}$	$1167.3±15.7^{ab}$	$1323.4±14.2^{c}$	$1229.8±29.7^{b}$	**
At 16th wk.	$1131.1±19.4^{a}$	$1207.1±17.0^{ab}$	$1369.7±16.4^{c}$	$1288.7±20.5^{bc}$	**
At 17th wk.	$1150.1±19.5^{a}$	$1230±16.8^{ab}$	$1395.6±18.8^{c}$	$1307.4±22.4^{b}$	**
At 18th wk.	$1277.7±32.3^{a}$	$1389.8±29.1^{b}$	$1517.1±22.3^{c}$	$1484.8±27^{bc}$	**
At 19th wk.	$1394.8±31.3^{a}$	$1520.7±23.2^{b}$	$1767.8±17.1^{d}$	$1659 ±18.2^{c}$	**
At 20th wk.	$1490.8±30.2^{a}$	$1633.7±24.8^{b}$	$1861.8±18.2^{d}$	$1770.8±25.7^{c}$	**

a, b, c, ab, bc Mean values with different superscripts within the same row differ significantly ($P<0.05$); NS = Non significant ($P>0.05$), * = Significant ($P<0.05$) , **= Significant ($P<0.01$)

Here, T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea.

Table 5. Effect of UMMC containing different levels of urea on live weight gain (g/d) of growing rabbits

Live weight gain at different feeding period	Dietary treatment groups*				Level of Significance
	T_0	T_1	T_2	T_3	
At 1st wk.	7.37±0.37	7.18±0.37	7.55±0.36	7.31±0.35	NS
At 2nd wk.	6.37±0.18	6.47±0.31	6.55±0.29	6.75±0.29	NS
At 3rd wk.	6.47±0.18	7.03±0.30	7.33±0.22	6.76±0.26	NS
At 4th wk.	5.94 ±0.19^{a}	6.39±.27^{ab}	7.02 ±0.19^{b}	6.20 ±0.25^{a}	*
At 5th wk.	7.04±0.21^{a}	7.47±0.5^{ab}	8.2 ±0.22^{a}	7.39 ±0.24^{ab}	**
At 6th wk.	6.09 ±0.19^{a}	6.74±0.14^{b}	7.45 ±0.19^{c}	6.65 ±0.25^{ab}	**
At 7th wk.	5.98±0.17^{a}	6.58±0.16^{ab}	7.62±0.21^{c}	6.92±0.26^{b}	**
At 8th wk.	5.73 ±0.15^{a}	6.24 ±0.1^{b}	7.31 ±0.19^{c}	6.60±0.19^{b}	**
At 9th wk.	6.05±0. 1^{a}	6.57±0.10^{ab}	7.79± 0.10^{c}	7.09±0.2^{b}	**
At 10th wk.	6.22 ±0.14^{a}	6.61 ±0.10^{a}	7.63 ±0.14^{b}	7.21± 0.19^{b}	**
At 11th wk.	7.53 ±0.11^{a}	8.22 ±0.10^{b}	9.38± 0.15^{c}	8.83±0. 21^{bc}	**
At 12th wk.	7.03±0.11^{a}	7.69±0.13^{b}	8.89±0.15^{c}	8.24±0.20^{b}	**
At 13th wk.	6.83±0.11^{a}	7.62±0.15^{b}	8.87 ±0.14^{c}	8.15± 0.47^{b}	**
At 14th wk.	6.98 ±0.12^{a}	7.65±0.15^{b}	9.13±0.15^{c}	8.25±0.19^{b}	**
At 15th wk.	7.02 ±0.13^{a}	7.71±0.17^{b}	9.19 ±0.18^{c}	8.31±0.18^{b}	**
At 16th wk.	6.91 ±0.14^{a}	7.59±0.17^{b}	9.03 ±0.19^{d}	8.32±0.24^{c}	**
At 17th wk.	6.67 ±0.14^{a}	7.34±0.16^{b}	8.71 ±0.19^{d}	7.99±0.22^{c}	**
At 18th wk.	7.30±0.23^{a}	8.19±0.24^{b}	12.51±0.39^{c}	8.95±0.29^{b}	**
At 19th wk.	7.80±0.22^{a}	8.75±0.18^{b}	10.54±0.17^{d}	9.79± 0.22^{c}	**
At 20th wk.	8.10 ±0.21^{a}	9.11±0.18^{b}	10.73±0.13^{d}	10.10±0.22^{c}	**

$^{a, b, c, ab, bc}$ Mean values with different superscripts within the same row differ significantly; NS = Non significant (P>0.05), * = Significant (P<0.05).Here, T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3 ,UMMC containing 8% urea.

4.10 Grass intake of growing rabbits

Average daily grass intake of growing rabbits of *Expt. II* during the experimental period is shown in Figure 5. Grass intake of growing rabbit was not significantly (P>0.05) differed among the rabbit groups. Grass intake was 133.10, 134.30, 135.40 and 133.60 g/day/rabbit in the rabbit groups fed 0 (T_0), 4 (T_1), 6 (T_2) and 8 % urea (T_3) containing UMMC, respectively.

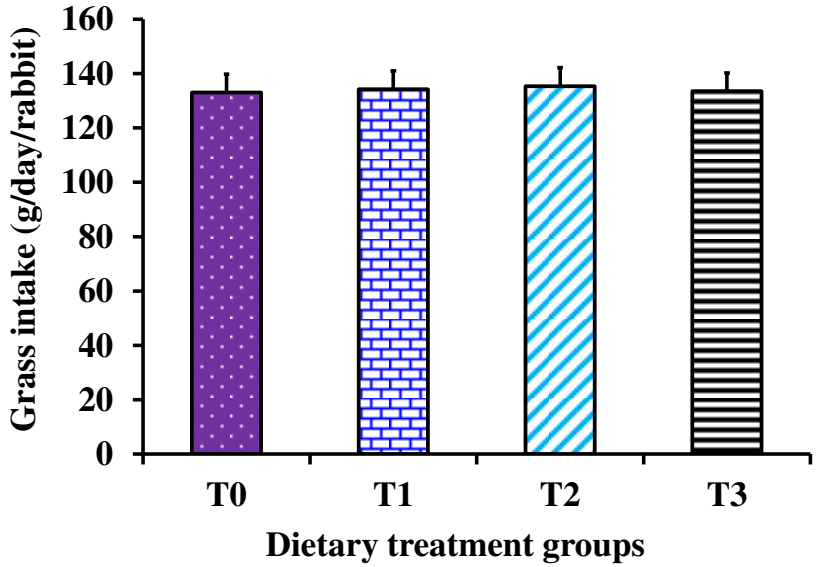


Figure 6. Effect of UMMC containing different levels of urea on grass intake of growing rabbits (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3,UMMC containing 8% urea).Each bar with error bar represents Mean ± SEM value. Differences were not significant at 5% level of significance (P>0.05).

4.11 UMMC intake of growing rabbit

Average daily UMMC intake of growing rabbits of *Expt. II* during the experimental period is shown in Figure 6. Average daily UMMC intake of growing rabbit was not significantly (P>0.05) differed among the rabbit groups. UMMC intake was 49.1, 49.6, 50.0 and 49.0 g/day/rabbit in rabbit group fed 0 (T_0), 4 (T_1), 6 (T_2) and 8 % urea (T_3) containing UMMC, respectively.

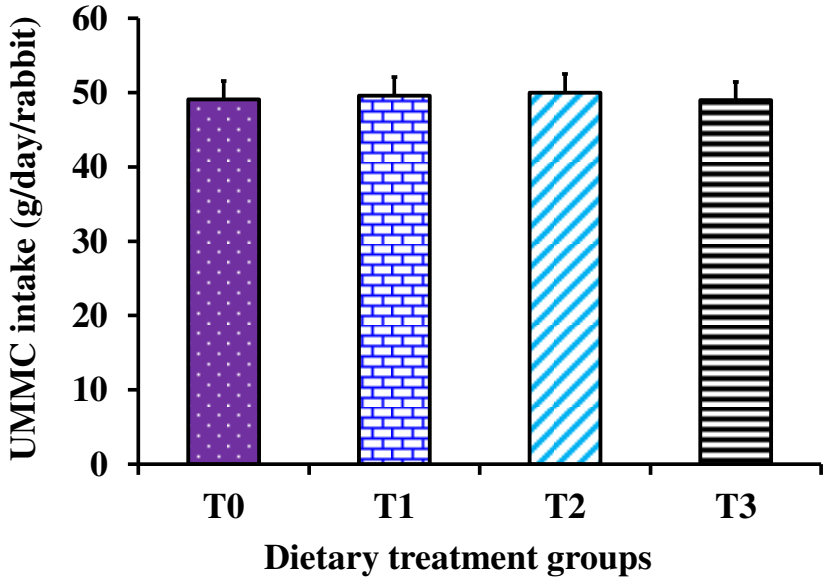


Figure 7. UMMC intake of growing rabbits (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3, UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were not significant at 5% level of significance (P>0.05).

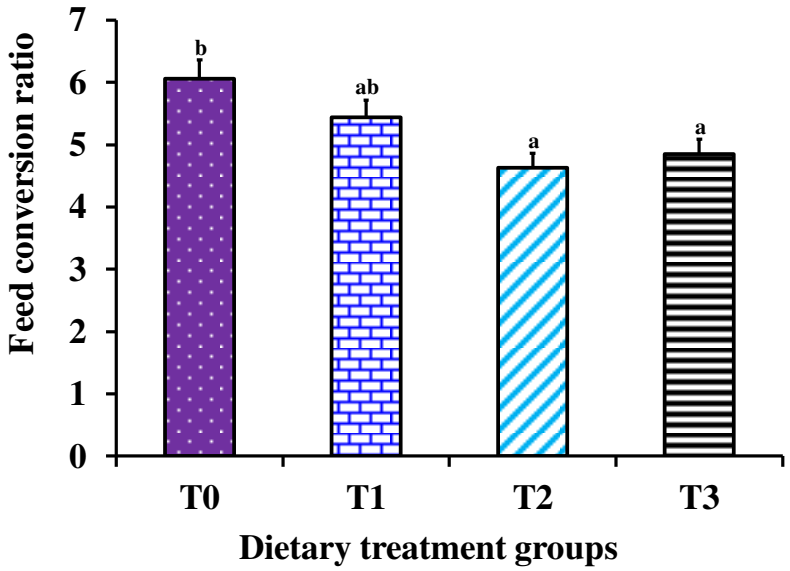


Figure 8. Effect of UMMC containing different levels of urea on feed conversion ratio of growing rabbits (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3, UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance

4.12 Feed conversion ratio (FCR) of growing rabbit

Effect of UMMC containing different levels of urea on feed conversion ratio of growing rabbits under *Expt. II* is shown in Figure 7. Results showed that FCR was significantly differed ($P<0.05$) between the rabbits of control group (6.06) and rabbit fed 6% (4.63) and 8% (4.85) urea containing UMMC. Although rabbit fed 4% urea containing UMMC had showed slightly lower FCR (5.44) but was not significantly differed ($P>0.05$) with the control group (6.06).

4.13 Performance index (PI) of growing rabbits

Performance index (PI) of growing rabbit in *Expt. II* is shown in Figure 8. UMMC had a significant ($P<0.05$) effect in terms of performance index between the rabbits of control group (246.01) and the group fed 6% urea containing UMMC (415.59. Rabbit fed 4% (300.86) and 8% (365.42) urea containing UMMC had a slightly higher PI, but non-significant with the control group (246.01).

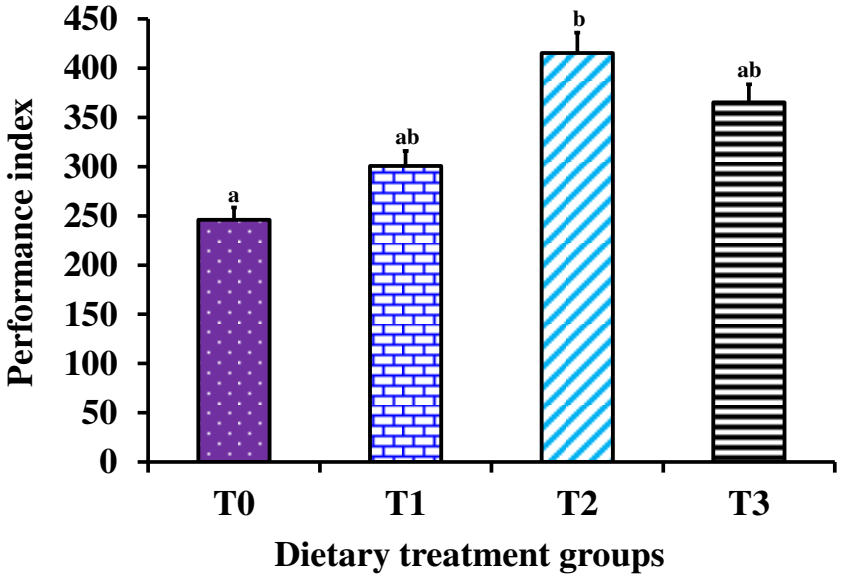


Figure 9. Effect of UMMC containing different levels of urea on performance index of growing rabbits (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3, UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM. Differences were significant at 5% level of significance ($P<0.05$).

Table 6. Effect of UMMC containing different levels of urea on hematological (blood cellular elements) parameters of rabbits (Means ± SE)

Blood Parameters	Dietary treatment groups*				Level of Significance
	T_0	T_1	T_2	T_3	
Hemoglobin (g/dl)	11.41±0.23	11.65±0.20	11.92±0.18	11.75±0.20	NS
PCV (%)	35.24±1.02	36.41±0.83	38.05±1.13	35.78±1.47	NS
ESR (mm/h)	2.07 ±0.21	2.35±0.23	2.51 ±0.11	2.56±0.44	NS
RBC ($\times 10^6$/mm^3)	6.05±0.09^a	6.45±0.12^b	6.27±0.10^{ab}	6.59±0.15^b	*
WBC ($\times 10^3$/µl)	7.13±0.37^a	7.81±0.46^{ab}	8.69±0.29^b	7.58±0.15^{ab}	*

$^{a, b, ab}$ Mean values with different superscripts within the same row differ significantly ($P<0.05$); NS = Non significant ($P>0.05$), * = Significant ($P<0.05$). Here, T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3, UMMC containing 8% urea.

4.14 Hemoglobin (g/dl) of growing rabbit blood

Results of the hemoglobin content (g/dl) of growing rabbit blood of the *Expt. II* are shown in Table 6. No significant (P>0.05) trend was detected for the hemoglobin of blood among the experimental rabbit groups. However, a rise in hemoglobin content were observed in the rabbit groups fed urea containing UMMC (11.65, 11.92 and 11.75 g/dl of blood in 4, 6 and 8% urea containing UMMC fed rabbit group, respectively) compare to the control group (11.41 g/dl).

4.15 Packed cell volume (PCV)

Packed cell volume (PCV) of growing rabbit blood of *Expt. II* is presented in Table-5. It was observed that no significant (P>0.05) differences were observed in the blood PCV values among the groups. Highest PCV was observed in the rabbit group fed 6% urea containing UMMC (38.05%) while it was 35.24, 36.41 and 35.78 % in rabbit group fed 0 (T_0), 4 (T_1) and 8 % urea (T_3) containing UMMC, respectively

4.16 Erythrocyte Sedimentation Rate (mm/h)

Erythrocyte sedimentation rate (ESR) of growing rabbit blood of *Expt. II* is presented in Table-5. The values of ESR were not significantly (P>0.05) differed among the groups. However, it was also observed that rabbit group fed different level of urea containing UMMC had a somewhat higher ESR value than the control rabbit group. The highest ESR was recorded in rabbit group fed 8% urea containing UMMC group (T_3) (2.56mm/h) and lowest in control group (2.07 mm/h). Rabbit group fed 4 (T_1) and 6% urea (T_2) urea containing UMMC also showed a higher ESR value (2.35 and 2.51 mm/h, respectively) than the control group (T_0).

4.17 Red blood cell count ($\times 10^6$/µl)

Red Blood Cell (RBC) Count of growing rabbit blood of *Expt. II* is depicted in Table-5. RBC count was significantly differed (P<0.05) between rabbits of the control group (6.05×10^6/µl blood) the rabbit fed 4% (6.45×10^6/µl blood) and 8% (6.49×10^6/µl blood) urea containing UMMC. Rabbit fed 6 % urea containing UMMC showed a higher RBC count (6.27×10^6/µl blood) but was not significantly differed with the control group. Highest RBC was counted in rabbit group fed 8% urea containing UMMC (6.49×10^6/µl blood) and lowest value was in control group (6.05×10^6/µl blood).

4.18 White blood cells count (×10^3/µl)

White blood cells count (WBC) of growing rabbit blood of *Expt. II* is shown in Table-5. It was observed that WBC count of experimental rabbit blood was significantly (P<0.05) differed between the rabbits of the control group (7.13 ×10^3/µl blood) and the rabbit fed 6% urea containing UMMC (8.69×10^6/µl blood). Though rabbit fed 4 % (7.81 ×10^3/µl blood) and 8% (7.58 ×10^3/µl blood) urea containing UMMC showed a higher WBC count, but was not significantly differed (P>0.05) with the control group. Highest WBC count was recorded in rabbit group fed 6% urea containing UMMC (8.69×10^3/µl blood) and lowest value was in control group (7.13 ×10^3/µl blood).

4.19 Fecal bacterial count (×10^3 cfu/ g)

Effect of dietary UMMC supplementation on the fecal bacterial count of growing rabbit of *Expt. II* is presented in Figure 10. Number of fecal bacteria was significantly (P<0.05) differed between the rabbits of control group (1.77×10^3 cfu/ g of feces) and the rabbits group fed 6% urea containing UMMC (2.51×10^3 cfu/ g of feces). However, rabbits fed 4% (2.12×10^3 cfu/ g of feces) and 8% (2.38 ×10^3 cfu/ g of feces) urea containing UMMC showed a higher fecal bacterial count but not significantly differed (P<0.05) with the control group.

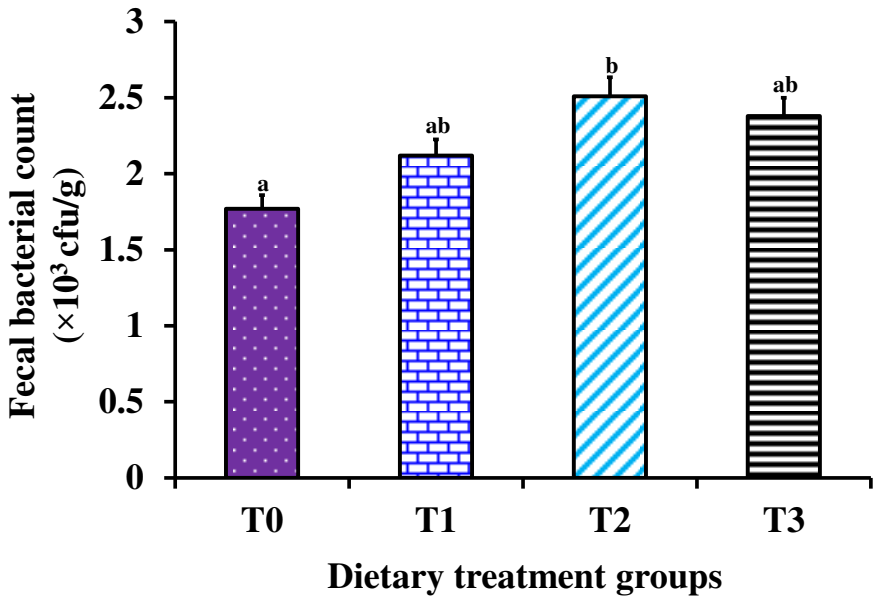


Figure 10. Effect of UMMC containing different levels of urea on fecal bacterial count of rabbit (T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3, UMMC containing 8% urea). Each bar with error bar represents Mean ± SEM value. Differences were significant at 5% level of significance (P<0.05).

4.20 Preparation cost of UMMC

Cost of UMMC preparation is presented in Table 6. It was found that cost of 1 Kg. UMMC preparation is significantly lower (P<0.05) then the price of available commercial pellet. For the preparation of 1 kg UMMC containing 0 (T_0), 4 (T_1), 6 (T_2) and 8% (T_3) urea required 27.5, 26.8, 26.5 and 26.6 Tk., respectively while 1kg local commercial pellet price is 42.0 Tk.

Table 7. Preparation cost of UMMC in different dietary treatment groups and their comparison with the available pellet price.

Feed Ingredients	Tk./ kg.	Dietary treatment groups*				Commercial pellet Price	Level of significance
		T_0	T_1	T_2	T_3		
Urea	15.0±0.4	0.0±0.0	0.6±0.1	0.9±0.1	1.2±0.1		
Molasses	17.0±0.8	6.8±0.1	6.8±0.1	6.8±0.2	6.8±0.5		
Broken maize	24.0±1.1	0.9±0.1	2.7±0.2	3.1±0.1	3.1±0.1		
Wheat bran	32.0±1.2	3.2±0.1	1.2±0.1	0.0±0.0	0.0±0.0		
Rice polish	26.0±0.9	5.7±0.2	4.1±0.2	4.2±0.2	4.2±0.1		
Soybean meal	50.0±1.8	0.0±0.0	3.0±0.2	3.6±0.5	3.6±0.3		
Mustard oil cake	48.0±1.1	6.7±0.1	4.0±0.3	3.8±0.3	3.8±0.2		
Lime stone	15.0±0.7	0.4±0.2	0.4±0.1	0.4±0.2	0.3±0.1		
Common salt	14.0±0.8	0.4±0.1	0.4±0.3	0.4±0.2	0.4±0.2		
Cement	7.6±0.2	0.3±0.1	0.3±0.2	0.3±0.1	0.2±0.2		
Other costs		3.0±0.0	3.0±0.0	3.0±0.0	3.0±0.0		
Total (Tk./ kg)		27.5±1.2[a]	26.8±1.4[a]	26.5±1.7[a]	26.6±1.3[a]	42.0±1.9[b]	*

[a, b] Mean values with different superscripts within the same row differ significantly (P<0.05); NS = Non significant (P>0.05), * = Significant (P<0.05). Here, T_0, UMMC containing 0% urea; T_1, UMMC containing 4% urea; T_2, UMMC containing 6% urea and T_3, UMMC containing 8% urea.

CHAPTER V

DISCUSSION

Chapter V

Discussion

Dietary effect of UMMC on gestation period of rabbit does observed in the *Expt. I* was not differed among the groups which were ranged from 31.40 to 32.00. The result indicates that UMMC has no effect in the gestation period of rabbit does. Gestation period of rabbit does observed in this experiment is more or less similar to the findings of Salma *et al.* (2002), they found a gestation period 31.60–32.30 days in rabbit does supplied with different levels of protein. Rashwan *et al.* (2003) reported that rabbit does normally kindled in 31.00–33.00 days after natural mating or artificial insemination. The average gestation lengths for Chinchilla, Dutch belted and New Zealand rabbit were 30.50, 30.54 and 30.51 days, respectively (Addass *et al.,* 2010). Gestation period in different breeds of rabbit ranged between 28.00–36.00 days (Morimoto, 2009). Tahir (2001) found that pure New Zealand rabbit had longest gestation length (33.00 days). Dorra *et al.* (1997) also reported that gestation period of rabbit does is approximately 31.00 days.

In the present study, UMMC increased live weight gain of does during gestation period between the rabbit groups fed 0% urea containing UMMC (Control group, 7.74 g/day) and 6% urea containing UMMC (10.26 g/day) but rabbit fed 4 and 8% urea containing UMMC (8.79 and 8.89 g/day, respectively) showed no significant differences with the control group. This differences in live weight gain of does during gestation period was observed most probably due to the higher level of non-protein nitrogen in the rabbit diet supplied by the addition of urea into the UMMC, which increased the protein level of rabbit and caused higher live weight gain. The protein requirements for reproductive does were studied by several researchers (Partridge and Allan, 1982; Adams, 1983; Partridge *et al.*, 1986; Parigi *et al.*, 1990; Sanchez *et al.*, 1985, 1991, 1992; Xiccato *et al.*, 1992; Salma *et al.*, 2002) and they determined that rabbit needs higher protein (around 20%) to optimize reproductive performances than those needed for growth. UMMC contains urea, the most important source of non-protein nitrogen. This non-protein nitrogen improved the body protein level and helps to meet up the protein requirement of does during gestation period resulted higher live weight gain of the does. According to Rahman *et al.* (2011), urea improves ammonia utilization by cecal microbes that directly increase protein level and indirectly increases energy level in rabbit by saving the energy losses during extra urea genesis in the rabbit body because supplemented urea compensate this process. However, the present results regarding live weight gain of does during gestation period was somewhat lower than the results of Alikwe *et*

al. (2011). They found that live weight gain of does were 300–360 g while in the present study were 208–287 g.

Effect of UMMC on conception rate was differed between the does of control group (80%) and the group fed 6% urea containing UMMC (100%). But no differences in conception rate were observed among other groups (T_0, T_1 and T_3). This variation in conception rate may be due to the differences in the levels of urea supplementation to the does. Reproductive events, like follicular development, ovulation and fertilization are depend on dietary nutrition especially on dietary protein. To support these events of conception, optimum protein is required which might be supplied in the rabbits fed 6% urea containing UMMC, as a result it showed better conception rate (100%) than the other rabbit groups. In spite of higher level of urea (8%) containing UMMC fed by the rabbits, comparatively lower conception rate (80%) was observed than the rabbit fed 6% urea containing UMMC (100%) and it was occurred might be due to the alteration of uterine and vaginal pH by high blood urea nitrogen contributed by the higher levels of urea (8%) containing UMMC. Optimal vaginal and uterine pH to maintain sperm viability and motility for conception ranges from 7.0 to 8.5 (Kelly, 1990 and Brannigan *et al.*, 2008). Reduction in sperm motility was seen at a vaginal pH of less than 6.0 which may reduce the conception rate (Brannigan *et al.*, 2008; Makler *et al.,* 1981; Peek *et al.,* 1986 and Javos *et al.*, 1980). When blood urea nitrogen is increased vaginal and uterine pH is decreased (Butler, 2005). Conception rate of the present study was almost similar to the previous findings, where Yono *et al.* (1994) found a variation in conception rate ranged between 82–96% by feeding the does with or without urea supplementation. Hassanein (2000) also found that the percentage of conception rate was 100% in the natural mating of does. Salma *et al.* (2002) found 40–100% conception rate in rabbit does supplied different levels of protein supplementation.

The present study revealed that UMMC have effect on litter size at weaning though have no effect at birth. This differences in litter size of the rabbit does fed urea containing UMMC were due to the increased protein level by the addition of urea which caused a more protein balance in the rabbit milk and also caused more milk production, as a result kits of the does supplied with UMMC had a higher survivability and caused higher litter size. However, this result was little higher than that of Hasanat *et al.* (2006), they found a litter size 2.50–3.25 at birth and 1.37–2.37 at weaning in rabbits supplied with the same concentrate supplement used in this study except addition of urea. El-Hady (2001) also reported that litter size at birth was not influenced by increasing dietary protein levels up to 19%. Salma *et al.* (2002) could not found any effect of different levels of protein supplementation on litter size either at birth

(2.00–4.40) or at weaning (2.00–4.00), which is nearly similar to the present findings. But, Alma *et al.* (2002) observed that litter size at birth were higher in 18% CP containing diet than 15% CP diet. Ayyat *et al.* (1996) also reported that supplementing different levels of protein to the New Zealand rabbit diet had no effect on litter size at birth (5.70–6.24) and at weaning (3.70–4.89). But Yono *et al.* (1986) found larger litter size at birth (7.56–7.94) and at weaning (6.22–7.32) by supplying moderately low crude protein diet with or without methionine.

Litter weight from birth to weaning was not differed among the groups up to 7 day of kindling but it was differed at 14, 21 and 28 days between the does of control group and the group fed 6% urea containing UMMC. Urea increases the protein level of does and higher protein level causes higher milk production (McNitt and Moody, 1988; Fraga *et al.*, 1989) and higher intake by the kits of the rabbits fed UMMC, as a result litter weight was higher at 14, 21 and 28 days after kindling. Present study supports the result of Hasanat *et al.* (2006), they also found a higher litter weight from birth to weaning (180.3 g vs. 137.1 g in concentrate supplemented and non-supplemented group of rabbits, respectively). Ayyat *et al.* (1996) also reported that does fed 18.4% crude protein based diet had higher litter weight at weaning than those fed diet containing 16.3% crude protein. Alma *et al.* (2002) also observed that litter weight at birth and weaning were higher in 18% CP containing diet than 15% CP containing diet. However, Yono *et al.* (1986) and Sanchez *et al.* (1985) had not found any differences in litter weight of kits at weaning. Salma *et al.* (2002) reported that different levels of protein supplementation had no effect on the litter weight of rabbit from birth to weaning (120.0, 200.0 and 212.0 g; 690.0, 1191.0 and 1164.0 g at birth and weaning for 13.17, 16.64 and 21.00% CP diet, respectively) .

Individual kit weight was not differed among the does up to 21 days, but it was differed at 28 days between the does of control group (210.4 g) and the group fed 6% urea containing UMMC (292.6 g). This difference in individual live weight gain of kits were also due to the higher amount of protein enriched milk consumption from the does supplied with urea containing UMMC. Yono *et al.* (1986) observed that providing urea along with low crude protein diet increased the individual kit weight at birth (58.6 g vs. 63.8 g) but Salma *et al.* (2002) observed no effect of the different protein levels on the individual kit weight from birth to weaning (60.0, 46.7 and 49.0 g; 355.0, 267.0 and 285.0 g at birth and weaning in 13.17, 16.64 and 21.00% CP supplemented diet).

In the present study, it was found that UMMC had an effect on the mortality rate of kits and it was 13.30–31.25%. It was also observed that mortality rates were lowest in the rabbits fed 8% urea containing UMMC (13.30%) and highest in the rabbits fed UMMC without urea (control group, 31.25%). Until 18–19 days of age, kits are entirely depends on the milk of their mother (Maertens and Groote, 1990; Lamothe and Gidenne, 2000). Therefore, early livability performances of litter are closely related to the quantity and quality of the milk ingested (Lebas, 1969 and 1976; McNitt and Moody, 1988; Fraga *et al.*, 1989; Szendrö and Maertens, 2001). UMMC increased the protein level of does, higher protein level in the rabbit diet increased milk production (Pontes *et al.,* 1995) which in turn caused more milk ingestion by the kits resulting increased survivability and decreased mortality in the rabbit groups fed UMMC. Present findings are the agreement to the findings of Salma *et al.* (2002) and Yono *et al.* (1986). Salma *et al.,* (2002) found that the mortality rate of kit was 0–18% in the rabbit groups and it was affected by the level of protein in the diet. Yono *et al.* (1986) reported that the mortality rates of kits were affected by the protein supplementation in the rabbit diet and they found the mortality rate 7.04–18.42% and lowest mortality rate was observed in urea supplemented groups. Rahman *et al.* (2011) also found the differences in mortality rate (5.26–21.05%) by using 1% urea and urea-bentonite mixture.

Live weight of growing rabbit was not differed from the 1st to 6th weeks of the experiment, but it was differed from the 7th to 20th week of the experimental period among the rabbit groups. Higher weight was observed in 4 and 8% urea containing UMMC than the rabbits fed 0% urea containing UMMC and live weight was highest in the rabbits group fed 6% urea containing UMMC. This significant difference in live weight gain of growing rabbits supplied with urea containing UMMC was due to the high blood protein level of rabbit contributed by the non-protein nitrogen (urea). This higher level of protein helped in the body formation of growing rabbits which caused more live weight gain in the rabbits fed UMMC then the rabbits fed UMMC without urea. Using MNBs as a feed supplement, Ramchurn *et al.* (2000) also found a higher live weight in the treatment group. Present results also supports the results of Yono *et al.* (1986) and Isikwenu (2011), they also found differences in live weight between urea fed group and control group. This difference in live weight of rabbit was due to the utilization of urea as non-protein nitrogenous sources and to improve the body protein balance as well as weight gain. Urea is utilized by the cecal microbes and produces volatile fatty acid (VFA). Depending on rabbit's age and physiological status as well as feed ingredients, concentrations of VFAs could reach to a value up to 99.8 mmol/l (Garcia *et al.*, 2002). When absorbed, VFAs produced in the cecum can cover about 40% of rabbit

maintenance requirement (Marty and Vernay, 1984). So, higher VFAs production could be beneficial with regard to better energy supply and better live weight as a consequence. Additionally, VFA provide the main metabolic fuel for the mucosa of the large intestine (Roediger, 1986). Addition of urea also increases the butyrate at the expense of acetate and propionate (Vernay and Marty, 1984) that enhance body protein level of rabbit resulting higher live weight of rabbits.

Average daily weight gain of growing rabbits differed among the groups from 4th week to 20th week of the experiment. At the end of the experiment, higher growth rate was found in the rabbit groups fed UMMC and the weight gain was 9.11, 10.73 and 10.10 g/day in the rabbit group fed 4, 6 and 8% urea containing UMMC, respectively whereas it was 8.10 g/d in control group. This difference in weight gain in growing rabbits supplied with urea containing UMMC was due to the high protein level contributed by the urea which helps in the body building of growing rabbits. This result of the present study is an agreement to the result of Hasanat *et al.* (2006), they also found that average daily weight gain was higher in concentrate supplemented groups (13.02±0.43 g/d) than in control (5.30±0.43 g/d) group. Ramchurn *et al.* (2000) has also found that MNB supplementation has an effect in weight gain of rabbits (14.8±5.82 g/head/day) in control group was less than the rabbits supplied with MNB containing 15 and 30% cement (23.4±3.50 and 26.4±6.30 g/head/day, respectively). Mandour *et al.* (2012) reported that urea had a positive effect in the live weight gain of rabbits and they observed that rabbits supplied with ration containing 1.5% urea had higher live weight after 4 weeks than those fed 1% urea (1995±60 vs. 1829±53 g). Rahman *et al.* (2011) also found differences in average daily gain 12.92, 18.81 and 20.88 g by using 1% urea, 2.5% bentonite and 1% urea+2.5% bentonite against the control group (15.70 g). Amici and Finzi (1995) reported that supplementation of molasses block increased the daily gain (30.5 g vs. 17.5 g in molasses supplemented and no-supplemented group, respectively). Yono *et al.* (1986) also reported that urea supplementation increased the weight gain of rabbit (40 g/day/rabbit). Mohammed and Jamala (2013) reported that daily weight gain is increased in the rabbit fed with urea treated cowpea husk (16.97, 16.67 and 17.84 g/day in 40, 50 and 60% urea treated cowpea husk, respectively) than the control group (16.61 g/day). Momoha *et al.* (2015) found a daily weight gain of about 13.5 and 9.6 g/day in two crossbred rabbit supplied with 17 and 12% CP, respectively. Ayyat *et al.* (1996) found that different levels of protein supplementation increased the daily weight gain of growing rabbits (20.2 g/day/rabbit in 14.6% protein group vs. 24.6 g/day/rabbit in 16.3% protein group). Elamin *et al.* (2011) also observed daily weight gain of weaned rabbit similar to the present findings (9.93, 9.73 and

9.00 g/day, respectively in Berseem, sweet potato and *C. ternatea* fed rabbit). However, Dinh *et al.* (1991) has not found any effect of the UMB supplementation to the weight gain of rabbits (Daily gain, g/d; 19.8±0.52, 18.3±0.31, 20.7±0.26 in 0, 2 and 4% urea fed rabbit group, respectively). Oluokun (2001) reported that rabbit has the ability to utilize urea like ruminants through cecal fermentation. Marounek *et al.* (1995) also found that rabbits are efficiently capable of utilizing urea as a nitrogen source because of the high urease activity in the caecum. However, many researchers observed that weanling rabbits did not showed any remarkable response in their growth performance by feeding urea supplements with low protein diets (Lebas and Colin, 1973; Lang, 1981).

In the present study, UMMC supplementation has no effect on the grass intake of growing rabbits. It refers that addition of urea in the UMMC has no linkage with the quantity of grass intake. This result is the agreement to the result of Dinh *et al.* (1991), they also had not found any effect of the UMB supplementation on the grass intake of rabbits. Ramchurn and Raggoo (2000) and Mandour *et al.* (2012) also had not found any effect of using urea on the grass intake of rabbits.

Total UMMC intake of growing rabbit did not differed among the experimental rabbit groups that means UMMC had no impact in terms of feed ingestion. This finding is the agreement to the findings of the other authors; they also have not found any differences in the MNB intake of the rabbit (Dinh *et al.,* 1991; Ramchurn and Raggoo, 2000; Mandour *et al.,* 2012; Yono *et al.*, 1986 and Ramchurn *et al.*, 2000). However, Mohammed and Jamala (2013) found a difference in the feed intake between the urea treated cowpea husk and control group with highest feed intake in 60.0% urea treated cowpea husk and lowest in control group. Aduku and Olukoisi (1990) also found a higher feed intake in urea fed rabbit group.

Feed conversion ratio (FCR) in growing rabbit was differed between the rabbits of control group (6.06) and rabbit fed 6 (4.63) and 8% (4.85) urea containing UMMC. Highest FCR was observed in the control group (6.06) and lowest as well as best FCR was observed in the rabbit group fed 6% urea containing UMMC (4.63). It was occurred most probably due to the increasing live weight gain of urea containing UMMC treated rabbit groups. Present result supports the result of Rahman *et al.* (2011), they also found differences in feed conversion ratio (16.23, 19.28, 25.65) by using 1% urea, 2.5% bentonite and 1% urea+ 2.5% bentonite against the control group (19.28). Mohammed and Jamala (2013) reported that feed conversion ratio was differed between the rabbit fed with urea treated cowpea husk (2.97, 3.24 and 3.62 in 40, 50 and 60% urea treated cowpea husk, respectively) than in untreated

cowpea husk (4.33). However, Ayyat *et al.* (1996) did not found any differences among the treatment groups in the FCR of rabbit (5.19 and 3.93 in14.6% and 16.3% protein supplemented rabbit groups, respectively). Yono *et al.* (1986) has also found that urea has not effect in the FCR of rabbit, but they found little better FCR then present findings (3.58, 3.55 and 3.53 in 21 and 16% CP and 2.1% urea supplemented diet, respectively). Momoha *et al.* (2015) found a feed conversion ratio of about 3.70 and 4.50 in two crossbred rabbit supplied with 17% and 12% CP, respectively. Ramchurn *et al.* (2000) reported that that MNB supplementation to the rabbit has no effect to the FCR and it was 5.1 and 4.8 in control group and MNB fed group, respectively.

In *Expt. II*, Performance index (PI) in growing rabbit was differed among the groups. Best PI was observed in the rabbit group fed 6% urea containing UMMC (415.59) and lowest PI was observed in the control group (246.01). Better performance of the growing rabbit supplied with UMMC was may be due to the efficient utilization of urea by the cecal microbes and converting it into the body protein. Abdel *et al.* (2010) found a difference in performance index (186.23, 219.72 and 215.12) of growing rabbits by supplying organic Se, inorganic Se and mixed organic and inorganic Se, respectively.

In the present study, blood hemoglobin (Hb) did not varied due to the use of UMMC and the Hb levels in the rabbit groups. These values were within the normal range (10.67 to 12.60 g/dl) recorded by Njidda *et al.* (2011) and Njidda and Isidahomen (2006) which indicates that up to 8% urea in the UMMC is safe for rabbit and had no negative impact on its health status. However, slightly higher Hb level in the rabbits fed UMMC indicates that the experimental UMMC helped in maintaining good nutritional status of rabbit because hematological parameters especially PCV and Hb are positively correlated with the nutritional status of the animal (Adejumo, 2004). Present findings are agreement with the findings of the Mandour *et al.* (2012), they also did not found any differences in the Hb level of rabbit blood due to the feeding of urea.

Packed cell volume (PCV) of experimental rabbit blood did not differed among the groups (35.24 to 38.5%). This result reveals the healthy status of experimental rabbits after using UMMC that means urea addition has not caused any negative effect to the blood constituents of the rabbits. Mandour *et al.* (2012) also did not found any effect of different levels of urea on PCV of rabbit blood and found a nearly similar range of PCV value (37.97 to 40.22%). Present results of PCV were also close to the range of 31.00 to 38.00% reported by Shah *et al.* (2007) and Njidda and Isidahomen (2011). PCV is a blood toxicity reduction index and its

abnormal level point to the presence of a toxic factor which has a drastic effect on blood formation (Oyawoye and Ogunkunle, 1998). This suggests that detoxification of urea processing was good enough as demonstrated in the normal PCV range of values observed for rabbits on diets containing urea.

Erythrocyte sedimentation rate (ESR) was not differed among the rabbit groups. Highest ESR was observed in the rabbits fed 8% urea containing UMMC group (2.56 mm/h) and lowest was observed at the control group (2.07 mm/h). Slightly increased ESR in the treatment group may be due to the increased blood urea as well as protein level which causes a slightly heavier weight of the RBC to sediment in a less time than the RBC of control group of rabbits. This also indicates that use of UMMC do not causes basic alteration in the normal physiological value of blood parameters as well as normal physiological condition of rabbit. Present findings was within the normal range 1.18–3.16 mm/h reported by Chineke *et al.* (2006).

On the other hand, red blood cell (RBC) counts differed between the rabbits of the control group and the rabbit fed 4 and 8% urea containing UMMC. The values were within the normal range 3.8 to 7.9×10^6/mm^3 reported by Anon (2004). Rabbit groups fed urea containing UMMC had a higher protein levels which is needed for the RBC formation as a result higher RBC count in the rabbits fed urea treated UMMC. Present result supports the results of the Mandour *et al.* (2012), they also found a differences in the RBC count of rabbit blood due to the feeding of different levels of urea. The values of the white blood cells count (WBC) did not increased with the increased level of urea supplement in the rabbit diet with 6% level having the highest value of 8.69×10^3/ µl and control having the lowest WBC value of 7.13×10^3/ µl. Present WBC count results were close to the range of 5 to 13×10^3/ µl reported by Njidda and Isidahomen (2011) and Hillyer (1996). Normal WBC values are the indication of non-allergic conditions, free parasitism or absence of foreign body in circulating system (Lehninger *et al.*, 1993). As the WBC values in the present study were within the normal range that indicates that the experimental rabbits were healthy during the experimental period. Mandour *et al.* (2012) also found a differences in the WBC value of rabbit blood with 1% urea supplemented rabbit group had the highest value of 9.41×10^3/ µl and control having a lower value of 7.25×10^3/ µl.

In the present study, fecal bacterial count was differed between the rabbits of control group and the rabbits fed 6% urea containing UMMC. Highest fecal bacterial count was observed at rabbits fed 6% urea containing UMMC (2.51×10^3 cfu/ ml) and lowest bacterial count was

observed at the control group (1.77×10^3 cfu/ ml). Adding urea to rabbit feed provide adequate levels of ammonia in the cecum for continuous growth of cecal microbes (Rahman *et al.,* 2011). Rabbits fed urea containing UMMC supplied more urea to the rabbit which is absorbed and presented to the caecum. The caecum is the main reservoir for microorganisms in the intestinal tract (1010–1012 bacteria/ g of cecal content; Penney *et al.*, 1986). More urea in the caecum is utilized by the cecal microbes and produces more ammonia nitrogen which is the potential substrates that allows the growth of microorganisms. As a consequence, increased microbes in the caecum caused increased bacterial count in the fecal contents. Haffar *et al.* (1978) also observed an increase in the microbial population (particularly *Clostridium)* in animals fed diets containing high protein concentration. Emaldi *et al.* (1979) observed that the main activity of ceca microbiota is-ammonia-user, ureolytic, proteolytic and cellulolytic. Present finding also support the findings of the Carabaño *et al.* (2011), they also found that an increase of the nitrogen flow into the caecum could favour the changes in microbial growth as a result more microbial population in the caecum as well as feces. Present result supports the result of the Gallois *et al.* (2010), they observed that rabbit after 45 days of age had a bacterial count less than 1×10^4 / g of feces. Sorlini *et al.* (1988) found a total viable count of 10^2-10^3 of methanogenic and anaerobic bacteria in each gram of rabbit feces.

UMMC not only improved the productive and reproductive performances of rabbits, but also cheaper than the available commercial pellet used as rabbit concentrates and its cost was 15 Tk. less than the commercial pellet in each kg, which showed more economic efficiency of using UMMC over other concentrate supplements.

CHAPTER VI

SUMMARY AND CONCLUSION

Chapter V

Summary and Conclusion

To meet up the increasing protein demand of the large-scale population of Bangladesh, it is the optimum time to investigate and evaluate the alternative animal protein sources. In this context, an easily reared, highly prolific and lean meat producer animal like rabbit as a micro-livestock can play a major role in accomplishing the protein demand as well as in poverty alleviation. As rabbit is an unfamiliar animal species to be reared for commercial purpose in Bangladesh, it has some limitations, including unavailability of their commercial concentrates supplement, high price of the substitute used pellet and low performance of the rabbit in the poor diet. To overcome these limitations, the present study was conducted with the aims to investigate and establish a suitable concentrate supplement by using locally available cheap, but nutritionally enriched ingredients including urea, as a non-protein nitrogenous source to improve both productive and reproductive performances of rabbits. Therefore, two experiments were carried out in Rabbit Research Unit of Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

In *Experiment-I,* a total of 20 rabbits does of 24 weeks old were randomly divided into four dietary treatment groups (T_0, T_1, T_2 and T_3). All groups of rabbits were supplied Napier grass *ad libitum* and UMMC (60 g/h/d) containing 0 (T_0), 4 (T_1), 6 (T_2) and 8% urea (T_3), respectively for 9 weeks. Then the adult rabbit does of the experimental groups were mated with the bucks. It was observed that the gestation period of rabbit does were not significantly differed ($P>0.05$) among the rabbit groups. Live weight gain of the does during gestation period was higher ($P<0.05$) in the T_2 group of rabbits (10.26 g/d) fed 6% urea containing UMMC than that of the rabbits of control group (7.74 g/d), but rabbits fed 4 and 8% urea containing UMMC (8.79 and 8.89 g/d respectively) did not showed any significant differences ($P>0.05$) with the control group. Conception rate was significantly ($P<0.05$) higher in the rabbits fed 6% urea containing UMMC than the other groups (T_0, T_1 and T_3). There were no significant differences ($P>0.05$) in the litter size at birth among the rabbit groups, but at weaning it differed significantly ($P<0.05$) between the T_2 and T_0 groups of rabbits. UMMC did not significantly ($P>0.05$) affect the individual kit weight at birth, but at weaning it significantly increased the individual weight of rabbits fed 6% urea containing UMMC compared to the control group. Kit mortality rate was significantly differed ($P<0.01$) among the rabbits fed 0, 4 and 8% urea containing UMMC, but not significantly differed with the rabbits fed 6% urea containing UMMC.

In *Experiment-II*, a total 28 young rabbits of 5 weeks age obtained from *Experiment-I* was randomly assigned into 4 dietary treatment groups having 7 rabbits in each. All groups of rabbits fed *ad libitum* green grass (Napier grass) and 0 (T_0), 4 (T_1), 6 (T_2) and 8% (T_3) urea containing UMMC for 20 weeks under the same management explained for *Expt. I*. It was observed that the growth performance and feed conversion ratio were higher ($P<0.05$) in the young rabbits (T_2 and T_3) fed 6 and 8% urea containing UMMC compared to the rabbits fed 0 and 4% urea containing UMMC (T_0 and T_2, respectively). Among the dietary treatment groups, the rabbits of T_2 group showed highest ($P<0.05$) growth performance as well as feed conversion ratio. However, the total feed intake did not differ ($P>0.05$) among the treatment groups in both experiments. UMMC did not alter the blood parameters including ESR, Hb and PCV% of the experimental rabbits. RBC and WBC counts were significantly higher ($P<0.05$) in the T_1 and T_2 group of rabbits, respectively compared to the control group, but it was within the normal range. Non-harmful effect of UMMC on their blood parameters of rabbit indicated that experimental rabbits were physically sound and healthy during the experimental periods. The fecal bacterial count was significantly higher ($P<0.05$) in the rabbit fed 6% urea containing UMMC (2.51×10^3 cfu/ g) than the control group (1.77×10^3 cfu/ g) revealed more bacterial growth supported by supplied NPN (urea) of UMMC. In present two experiments, it was also observed that supplying 6% urea containing UMMC to the rabbit is safe and may be best in improving their productive and reproductive performances. Moreover, preparation cost of UMMC was significantly lower ($P<0.05$) than the price of available commercial pellets indicates their effective and economic use instead of commercial pellet.

Finally, it may be concluded that UMMC has significant effects in improving both productive and reproductive performances of rabbit, and the addition of 6% urea in preparing UMMC is the best level for rabbit production without any adverse effect. Limitation of unavailability of commercial concentrate supplement of rabbit and their high price may also be overcome by using UMMC. These findings may suggest and encourage the farmers for rabbit production by using UMMC with locally available green grass, which may contribute to meet up the national protein demand as well as develop the economy of Bangladesh.

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APPENDICES

Appendices

Appendix-I

UMMC intake record of rabbit

Date: …..……

Treatment Group	Animal No.	Amount of UMMC provided (g)	Amount of UMMC wastage (g)	Net amount of UMMC intake (g)
T0				
T1				
T2				
T3				

Appendix-II

Grass intake record of rabbit

Date: …..……

Treatment Group	Animal No.	Amount of grass provided (g)	Amount of grass wastage (g)	Net amount of grass intake (g)
T_0				
T_1				
T_2				
T_3				

Appendix-III

Live weight record of rabbit

Treatment Group	Animal No.	Initial Live weight at…….	Live weight at…… week	Live weight at…… week	Live weight at…… week	Live weight at…… week	Live weight at…… week	Live weight at…… week
T_0								
T_1								
T_2								
T_3								

Appendix-IV

Rabbit breeding record

Rabbit No. (Doe): ---------- Breed: ---------- Dam: ---------- Sire: ----------DOB: ----------

Type:---------- Experimental group:----------Previous no. of breeding:----------

Note: ----------

Sl. No.	$PGF_2\alpha$ Inj. Date	GnRH. Inj. Date	WBB	Breeding Date	Buck No.	PD	Wt. at 1st Wk. of Gestation	Wt. at 2nd Wk. of Gestation	Wt. at 3rd. Wk. of Gestation	WBN	Nesting Date	Wt. at 4th. Wk. of Gestation	Kindling Date	WAK	Litter size at birth	
															Live	Dead

+

LS at 1st wk. of K.		LS at 2nd wk. of K.		LS at 3rd wk. of K.		LS at 4th wk. of K.		LWB	IKWB	LW 7D	IKW 7D	LW 14D	IKW 14D	LW 21D	IKW 21D	LW 28D	IKW 28D	LSW	Remarks
Live	Dead	Live	Dead	Live	Dead	Live	Dead												

Where, WBB- Weight before breeding, PD- Pregnancy diagnosis, WBN- Weight before giving nest, WAK- Weight after kindling, LSB- Litter size at birth, SB- Still birth, LWB- Litter weight at birth, IKWB- Individual kit weight at birth, LW 7D- Litter weight at 7 day, IKW 7D- Individual kit weight at 7 day, LW 14D- Litter weight at 14 day, IKW 14D- Individual kit weight at 14 day, LW 21D- Litter weight at 21 day, IKW 21D- Individual kit weight at 21 day, LW 28D- Litter weight at 28 day, IKW 28D- Individual kit weight at 28 day and LSW- Litter size at weaning