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EFFECT OF PARTIAL SUBSTITUTION OF SOYABEAN MEAL PROTEIN BY UREA IN RABBIT NUTRITION

(With 7 Tables)

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تأثير إحلال جزء من بروتين كسب فول الصويا باليوريا في تغذية الأرانب

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أجريت هذه الدراسة في تجربتين لدراسة إمكانية الإحلال الجزئي لبروتين كسب فول الصويا باليوريا فى علائق الأرانب التجربة الاولى:- تمت على عـــدد ٣٠ مـــن ذكـــور الأرانـــب النيوزيلندي والكاليفورنيا البالغة والتي تزن ٣كجم تقريبا لقياس تأثير إحلال اليوريـــا محـــل جزء من بروتين كسب فول الصويا على معاملات هضم العناصر الغذائية. تم تقسيم الأرانب إلى ٥ مجموعات بطريقة عشوائية ثم غذيت علي ٥ علائق الأولى منها كنترول وخالية من اليوريا بينما الأربع علائق الأخرى تم فيها استبدال كسب فـــول الصـــويا باليوريـــا بنســـبة ٥و١٠و١٥و٢٠ فى المائة من بروتين العليقة على التوالى. استغرقت التجربة ١٤ يوم منهـــا ٨ أيام فترة تمهيدية و٦ أيام فترة رئيسية. وقد خلصت التجربة إلى أن إحلال اليوريا محـــل بروتين كسب فول الصويا بالنسب السابقة ليس له تأثير معنوي على معاملات هضم كل من المادة الجافة والمادة العضوية والبروتين الخام والدهون والمـــواد الكربوهيدراتيـــة الذائبـــة والألياف والرماد. التجربة الثانية:- اجريت علـــى عـــدد ٥٠ مـــن الأرانـــب النيوزيلنـــدي والكاليفورنيا النامية خليطه الجنس عند عمر ٦ أسابيع ومتوسط أوزانها ٩٠٢ جرام. قســـمت الأرانب عشوائيا إلى ٥ مجموعات غذيت على نفس علائق التجربـــة الســـابقة. اســـتغرقت التجربة ١٠ أسابيع وخلصت نتائجها إلى أن إحلال اليوريا محل بروتين كسب فول الصـــويا بنسبة ٥-١٠ فى المائة من بروتين العليقة يؤدى إلى زيادة معنوية في وزن الجسم وكفـــاءة التحويل الغذائي في حين أن الإحلال بنسبة ١٥-٢٠ في المائة يؤدى إلى انخفاض القياسات السابقة.كما لوحظ زيادة فى مستويات البروتين الكلى واليوريا مع انخفـــاض معنـــوي فـــي مستوى الجلكوز وعدم تأثر مستوى الكوليسترول في دم المجموعات التـــي غـــذيت علـــى مستويات عالية من اليوريا (١٥-٢٠) فى المائة. وقد خلصت الدراسة إلى أنه يمكن إحلال اليوريا محل بروتين كسب فول الصويا بنسبة تصل إلى ١٠ في المائة في علائق الأرانـــب النامية وبنسبة تصل إلى ٢٠ فى المائة فى علائق الأرانب البالغة.

SUMMARY

Two experiments were conducted to investigate the feasibility of partial replacing of soybean meal protein with urea in rabbit diets .The first experiment was carried out with 30 New-Zealand White (NZW) and California adult male rabbits (av. 3Kg in weight), to measure the effect of soybean meal substitution with urea on the digestibility of nutrients. The rabbits were divided randomly into five groups (6 per each). They were fed five diets, the first was urea free and considered as control while in the other four diets, urea substituted soybean meal protein by 5, 10, 15, and 20 % respectively. The experiment lasted for 14 days with 8 days as preliminary (transition) period and 6 days principle (collection) period. The results revealed that urea had no significant effect on the digestion coefficients of either dry matter, organic matter, crude protein, ether extract, crude fiber, nitrogen free extract or ash. The second experiment was designed to study the utilization of urea for growth by young rabbits, five groups (10/ each) of NZW and California growing rabbits of mixed sex (av. 6 weeks in age and 902 gm in weight) were experimented on. They were given the same diets of the first experiment with the similar levels of urea substitution. The experiment lasted 10 weeks. The results indicated that replacing soybean meal by urea up to 10 % of total dietary protein showed a significant increase in body weight, body gain, and feed efficiency, however the higher levels of substitution (15-20%) reduced the previous parameters. Total protein and urea levels in the blood increased significantly ($p < 0.05$) as the level of urea increased in the diet, however, serum glucose decreased. The serum cholesterol was not significantly affected by any level of dietary urea. It could be concluded that, urea can be successfully and economically fed as partial substitution for soybean meal protein up to 10 % in the diets of growing rabbits and up to 20 % in the diets of adult ones.

Key words: *Urea, soybean, substitution, rabbits, diets.*

INTRODUCTION

Rabbits have a symbiotic microbe population live in the hindgut, responsible for fiber fermentation. As a consequence, the microbial activity of the caecum is of great importance for the processes of digestion and nutrient utilization. Because of the bacterial protein synthesis in the hindgut, it has often been assumed that protein quality is not important in rabbit nutrition. Many workers tended to add different cheap nitrogen supplements to poor protein rations to improve their quality (Price and Greenhalge, 1978). In this respect, the most suitable supplement in animal nutrition is urea as a source of non-protein nitrogen (Martin *et al.*, 1981; and Gihad *et al.*, 1989).

In ruminants, microbial protein satisfies major amino acid requirements for *animal*, however, this is not true for rabbits. Even though amino acids produced by bacteria may be available via coprophagy (especially lysine, sulfur amino acids and threonine). Carabano and Piquer, (1998), showed that microbial protein plays only a minor role in meeting rabbit's protein and amino acid needs (McNitt *et al.*, 1996). The majority of microbial protein utilized by animal is digested in the colon (Stevens and Hume, 1995).

In non-ruminants, some researchers have suggested that urea is unable to be utilized and it has no nutritional value for rabbits (Kobayashi *et al.*, 1981). Others suggested that, urea may replace some non-essential amino acids in diet of non-ruminants (Sucio *et al.*, 1990). However, significant increase in mass gain has been observed when low levels of urea were used with broiler chicks (Pervaz *et al.*, 1996). It was reported that, gut microorganisms were responsible for the growth-promoting effect of urea in chicks. Urea is recycled by the rabbit large intestine in a manner similar to that occurring in the rumen (Stevens and Hume, 1995). However, when dietary urea is fed to rabbits, it is not well utilized by microbes. Prolonged feeding of 0.5% urea in the diet of rabbits will result in liver or kidney lesions (Cheeke, 1994).

Urea is converted to ammonia in rabbit gut, and when absorbed, it results in toxicity. Microbes in rabbit gut produce VFA, as do microbes in the rumen of the cow. In rabbit fed a traditional alfalfa/corn diet, acetate is the primary volatile fatty acid produced by microbes, with more butyrate than propionate being formed. Butyrate is the preferred energy source for the hindgut (Steven and Hume, 1995; Gidenne *et al.*, 1998; Jenkins, 1999).

Microbes in rabbits produce more VFA on starch-based diets than on forage diets (Cheeke, 1994). Steven and Hume (1995) indicated that, VFA provide a major energy source in rabbit colon. In the presence of molasses, non-protein nitrogen (usually from urea), microbes in hindgut are able to make fermentation (Leng, 1984; Sansoucy, 1986; Garcia and Restrepo, 1995).

Okumura *et al* (1976) concluded that the microorganisms are responsible for the growth promoting effect of urea, presumably through release of ammonia by bacterial urease and its consequent incorporation into amino acids. When urea replaced protein diet, special care in mineral supplementation must be exercised, since most sources of protein provide substantial amounts of sulfur and phosphorus which are absent in non-protein nitrogen Synthesis of bacterial protein in the cecum and subsequent consumption of the cecal contents by coprophagy (cecotrophy) would suggest an ability of rabbit to utilize non-protein nitrogen sources such as urea. The advantages of such use would be primarily economic because urea is a cheaper source of nitrogen than other protein supplements. Urea-hydrolyzing (ureolytic) bacteria are present in the rabbit (Crociani *et al.*, 1984), as are organisms that can utilize ammonia for amino acid synthesis. Care should be taken when feeding high levels of dietary protein, because excess protein may increase cecal ammonia levels, causing an increase in cecal pH (Cheeke, 1994).This rise in pH may allow pathogens to flourish and may increase the potential for enteritis. If it is assumed as recorded by some authors that urea has no nutritional value for rabbits under practical dietary conditions, it is still important to ascertain whether urea may have any deleterious effects when fed to adult or growing rabbits. In the literature there are few, but contradictory data on the utilization of urea by rabbits so these experiments were accordingly conducted to investigate this possibility.

MATERIALS and METHODS

Two experiments were conducted to investigate the feasibility of replacing part of SBM protein by urea in the diet of rabbits. The experiments were carried out at The Poultry Farm of Faculty of Agriculture, Assiut University.

The first experiment was designed to test the nutritive value of urea for mature rabbits, while the second experiment was carried out to study the utilization of urea for growth by young rabbits. In experiment 1 (digestibility trial) thirty male New Zeland White and California adult rabbits (averaged, 3.0 Kg) were divided randomly into five groups, six per each. All rabbits were housed individually in metabolic cages. The digestibility trial lasted 14 days with 8 transitional days followed by 6 days for principle period. The first group fed the basal diet (control) while, in the other four groups (T1, T2, T3 and T4) urea substitute soybean meal protein by 5, 10, 15 and 20%, respectively. All experimental diets were isonitrogenous, isoenergetic and were formulated using Feed Formulation System (1995) .The ingredients of the experimental diets were sampled, ground, mixed thoroughly and analyzed for the determination of its different nutrients (DM, OM, CP, EE, CF, NFE and Ash) according to the methods of the AOAC (1984). Along the experiment, each rabbit was offered a weighed amount of the respective diet. Fresh water was automatically available all the time by stainless steel nipple for each cage. During the principle period, the daily fecal matter was collected from each rabbit weighed, dried, sampled, ground, mixed and stored to be analyzed for different nutrients.

In the second experiment, utilization of urea by young rabbits was evaluated with 50 New Zeland White and California rabbits of mixed sex, aged 6 weeks, averaged (902 gm).The rabbits were equally distributed in five groups fed the same five diets as in experiment 1 The performance of the rabbits of these groups was measured as body weight gain, feed efficiency, in addition to some biochemical parameters. The experimental rabbits were kept under the same managerial, hygienic and environmental conditions as experiment 1.

Variables studied

1-Digestion coefficients:

From the analysis of feed and fecal matter (experiment 1), The digestibility of any nutrient was calculated using the following equation (Maynard, 1979):

$$\frac{\text{Amount of nutrient intake} - \text{amount of nutrient in fecal matter}}{\text{Amount of nutrient intake}} \times 100$$

2- Body weight and body weight gain:

Rabbits of the second experiment were individually weighed at 6 weeks of age (initial weight) and then every two weeks during the experiment. Live weight gain was calculated by subtracting initial weight from the weight at end of each period, final body weight gain was calculated by subtracting intial weight from the weight at 16 week of age.

3- Feed efficiency:

Feed consumption was estimated on individual basis during the experimental period. Adjusted feed efficiency (gm gain / gm feed) was calculated as: live weight gain + gain of dead rabbits at the date of death divided by feed consumed by live rabbit + feed consumed by dead rabbit until the date of death for each treatment.

4-Blood samples:

Blood samples were collected at the end of the second experiment from the ear vein of rabbits. The samples were taken in the morning before feeding and sera were separated and kept at -20°C till analysis. Total serum protein, cholesterol, glucose and urea were determined using standard kits supplied by Bio-Merieux (Baines/France).

5-Statistical Analysis:

Analysis of variance (ANOVA) was performed on the collected data with equal subclasses number using the general liner model (GLM) of Statistical Analysis System (SAS, 1995). The analysis was carried out according to the following model:

Yij = + Ti + Eij Ti = treatments Eij =random error

When a significant main effect was proved, differences between treatment means were tested for significance by Duncan, 1995.

REULTS and DISSCUTION

Digestion Coefficient

Data presented in Table (3) cleared that the digestion coefficient of DM was not significantly decreased when urea levels in the diets were increased, however, the values of digestion coefficients for CF and CP were not significantly increased. These results may be attributed to the overgrowth of the natural bacterial flora that lives in hindgut of rabbits when using the nitrogen produced from urea and consequently synthesis of microbial protein. A slight decrease in the digestion coefficients of organic matte, ether extract and nitrogen free extract was observed by the increased urea level.

Robinson *et al.* (1986) found that, the digestibility of protein was significantly increased when urea substituted soybean protein by 15% in rabbit diets while the DM digestibility decreased from 58.2 to 55.5. Matter *et al.* (1995) stated that replacing up to 25 % from the crude protein of concentrate feed mixture by NPN sources in dairy cows ration had a positive effect on crude protein and crude fiber digestibility. However, Mary *et al*, (1979) reported that, urea and soybean meal were equally effective in stimulating dry matter digestibility relative to the control ($P < 0.05$). Ferrell *et al.*, (1999) stated that, apparent nitrogen digestibility was least for control and greatest for urea treatments in sheep, while DM and OM digestibility were increased.

Abdel-Hafeez and Tony (1975) in their study with sheep stated that, urea improved the digestibility specially that of protein and NFE, while the digestibility of EE was highly decreased. Thornton, 1970 and Orskov, *et al.* (1972) reported that, digestibility of DM, OM and CP were significantly increased when urea was added to the basal ration of sheep. On the other hand, Allam *et al.*, (1982) noticed no significant differences between groups of animals fed either urea molasses mixture or urea free ration.

Murphy (1990) reported that, increasing the nitrogen supply in cattle had lead to increases in the numbers of cellulolytic bacteria and fiber digestion protozoa which may also be responsible for an efficient fiber digestion (Wejdenar., 1996) by themselves or by a higher growth rate of cellulolytic bacteria in presence of protozoa which increases ammonia level in the rumen liquid (Jouany and Ushida., 1999).

Feed intake

There were no significant differences between the experimental groups in the amount of feed intake at the period of 6-8 and 8-10 weeks of age as shown in table (7) except T2 at the age of 6-8 week. At the age of 10-12 weeks there were no significant differences between T2, T3 and T4 compared with control and T1. However, the feed intake was decreased significantly at the age of 12-16 weeks by increasing urea levels.These results are in agreement with that reported by Dinh *et al* (1991) who found that increasing urea concentration in the molasses-urea blocks for rabbit diets significantly decreased DM intake. The reduced feed intake at the high level of urea in the diet was probably due to poor palatability and possibly to elevated blood ammonia concentration as recorded by Poos *et al* (1979). Other workers (Van Horn *et al*, 1967, 1975) have reported depression in feed intake when urea comprised more than 2% of concentrates in the ration of dairy cattle.In contrast, Greathouse *et al* (1974) and Plegge *et al* (1983) found no differences in the dry matter intake by cattle fed finishing diets containing either supplemental urea or other natural protein sources. Urea provides NH3 to the rumen that can be used for microbial protein synthesis. Increasing microbial protein yield in the rumen should increase digestibility and feed intake (Arelovich *et al*, 1998).

Feeding higher levels of urea to sheep and cattle will cause lower feed intakes, lower daily gain, poorer feed conversion, longer feeding period and less profit (Stanton, 2001). Javed *et al* (2002) reported that feed consumption at the third week of age was significantly higher

($p < 0.05$) in birds given 20 ml formalin alone or with 1% urea than the control group.

Growth performance

There were significant differences in the weight gain between the different treated groups and the control one as shown in table (6). Rabbits of the control and first two groups (T1 and T2) have nearly similar gain (1.547, 1.53 and 1.498 kg, respectively). While the rests of the groups (T3 and T4) showed lower gains (1.161 and 1.071 kg, respectively). These results are in agreement with that reported by Rakha (1985) and Stanton (2001) who found that lamb fed on ration supplemented with different levels of urea-nitrogen, recorded a marked decrease in the live weight gain specially with the high levels of urea. Also, Orskov *et al* (1972) reported that the daily body gain of early weaned lambs was high with the lowest level of urea. Similarly, Shain *et al*. (1998) reported that supplementing finishing cattle diets with an inexpensive source of rumenally degradable nitrogen (urea) improved animal performance.

A significant decreased growth rate (16.61&15.3) was observed in the groups received higher levels of urea (T3 and T4) in comparison with the control group (22.1) and the groups received low levels of urea (21.9 &21.4) respectively, and this may be attributed to the decreased feed intake.

Data of feed conversion (table 7) showed that the control diet and those contained low urea levels (T1 and T2) were more efficient (5.02,4.87 and 4.88, respectively) than those contained higher levels of urea (5.36 and 5.77, respectively). On the cotrary Stanton *et al*. (2001) found that feeding high levels of urea would cause proper feed conversion in lamb. Dinh *et al* (1991) showed that increasing the level of urea in the block decreased daily gain in growing rabbits.Several studies have shown little or no growth response in rabbits when urea or other NPN sources were used to supplement a low protein diet (Cheeke, 1972, King, 1971, Lebas and Colin, 1973).

Trakulchang and Balloun (1975) reported that the addition of urea to corn -soybean diets of broiler chicks from 4 to 8 weeks of age, increased weight gain in one experiment but did not affect gain in another. Kagan and Balloun (1976) reported that addition of soybean meal to broiler diets improved weight gain and feed conversion efficiency significantly, but urea had no such effects.

Biochemical parameters:

The mean values of cholesterol, total protein, glucose and urea in the serum of the experimental groups are shown in table (4). The total serum proteins of rabbits group fed on rations high in urea were non significantly increased in comparison with the control one. A result which are in agreement with that recorded by Abdel-Samme *et al* (1989) who found significant increase in serum total proteins in calves supplemented with urea. On the other hand, Kubesy (1987) found decreased levels of total protein in sheep fed on rations supplemented with urea.

The biochemical study declared significant decrease in the serum glucose level as the level of urea subistitution was increased in the ration. Propionic acid level which is the precursor of blood glucose was found to be decreased with feeding urea supplemented rations (Rakha, 1985). On the contrary several studies have shown increased glucose plasma level in animals fed diets supplemented with urea. (Abdel-Samme *et al.*, 1989 and Abdel-Hafez, 1995).The mean values of urea in the serum of rabbits were higher in the groups fed on diets containing urea in comparison with the control one. The same results were recorded by Fievez *et al.*, (2001) who found direct relationship between urea level in both serum and ration. The data also showed that there is no significant effect of urea substitution on the serum cholesterol levels.

Economical efficiency:

As shown in table (5) the cost of urea containing diet would be less than the cost of SBM and the use of urea obviously would reduce protein supplement cost. Concerning the feed cost, it could be noticed that, the feed cost producing one Kg gain with the first two tested rations was lower (5.20, 5.12 LE) than the control ration (5.47 LE) Subsequently, the economical efficiency for these tested rations were to some extent higher (111.2 and 114.6) than of control ration (100.4).). Performance in rabbits was better on the control diet, however in practical terms, the level of performance was acceptable on diets containing low levels of urea and these diets were more economical. In spite of this capabilities it appear that urea can be fed successfully as partial substrate for soybean protein up to 10% in the diets of growing rabbits and up to 20% in the diets of adult rabbits.

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Table 1 : Chemical composition of the ingredients used

Ingredients	DM%	OM	CP	EE	CF	NEF	Ash	ME(Kcal/kg)
Yellow corn ground	89.0	97.88	8.50	3.80	2.20	83.38	2.12	3350
Soybean meal	89.0	94.20	44.00	0.80	7.00	42.40	5.80	2230
Clover hay	90.0	93.00	15.30	3.10	27.00	47.60	7.00	1476
Wheat bran	89.0	93.90	15.70	3.00	11.00	64.20	6.10	1300
Corn starch	92.5	100.00	-----	-----	------	100	-----	4400

Table 2 : Physical and chemical composition of the experimental diets (%)

Items	Diets				
	contol	T1	T2	T3	T4
Ingredients:					
Ground Yellow corn	36.40	36.40	36.40	36.40	36.40
Soybean meal	20.20	18.13	16.06	14.00	11.93
Hay	30.30	30.30	30.30	30.30	30.30
Wheat bran	10.50	10.50	10.50	10.50	10.50
Corn starch	00.00	1.07	2.13	3.20	4.26
Urea	00.00	0.33	0.65	0.98	1.30
Dicalcium Phosphate	1.00	1.00	1.00	1.00	1.00
Limestone	1.00	1.00	1.00	1.00	1.00
Salt	0.30	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30	0.30
Sand (Filler)	0.00	0.67	1.36	2.02	2.71
Calculated Analysis:					
ME Kcal/Kg	2254	2255	2255	2256	2257
Dry Matter	89.43	89.54	89.63	89.14	89.85
Crude Protein	18.27	18.29	18.28	18.29	18.28
Ether Extract	2.80	2.78	2.77	2.75	2.74
Crude Fiber	11.55	11.41	11.26	11.12	10.98
Organic Matter	93.06	92.55	90.03	91.52	91.00
Nitrogen Free Extract	60.44	60.07	59.72	59.36	59.00

**Each Kg of premix contained: vit. A 8.000.000 IU; vit. D_3 1.600.000 IU; vit. E 7.000 mg; vit. K_3 1.500 mg; vit. B_1 1.000 mg; vit. B_2 3.500 mg; vit. B_6 1.000 mg, vit. B_{12} 10.000 mg; Nicotinic acid 20.000 mg; Pantothenic acid 7.000 mg; Folic acid 1.000.000 IU; Biotin 40.000 Iu Choline chloride 350.000 mg; Mn 40.000 mg; I 300 mg; Co 0.75 mg; Zn 40.000 mg; Cu 3.000 mg; Fe 25.000 mg; Se 100 mg; Ethoxyquin 3.000 mg; ascorbic acid 500*

Table 3 Digestion coefficients (%) of the nutrients of the different groups

Items	Diets				
	control	T1	T2	T3	T4
DM	79.28±3.64	78.67±2.35	77.56±2.87	78.60±1.93	77.79±1.3
OM	81.15±2.14	80.35±1.93	79.70±1.5	80.85±2.2	79.65±1.75
CP	81.70±1.24	84.20±1.15	83.95±1.86	82.90±2.05	81.18±1.73
EE	92.60±1.69	90.80±1.5	89.25±1.46	89.40±2.35	88.25±1.15
CF	49.80±2.37	50.15±2.49	52.80±2.11	51.15±3.1	51.35±2.95
NFE	86.45±1.93	84.58±2.34	83.03±2.45	85.38±2.87	84.04±3.19

There is no significant difference between different experimental groups

Table 4 : Serum biochemical values of the different experimental groups

Items	control	T1	T2	T3	T4
Cholesterol (mg/100ml)	72.36 ± 3.2^{a}	70.80 ± 4.9^{a}	72.40 ± 3.76^{a}	71.20 ± 2.8^{a}	71.75 ± 3.66^{a}
Total protein (gm/dl)	$6.9 \pm .08^{a}$	$6.42 \pm .15^{a}$	$7.67 \pm .33^{a}$	$7.25 \pm .25^{a}$	$7.38 \pm .27^{a}$
Urea-N (mg/dl)	$21.86 \pm .69^{b}$	$22.65 \pm .76^{b}$	$26.15 \pm .92^{a}$	$25.50 \pm .74^{a}$	$26.85 \pm .88^{a}$
Glucose (mg/100ml)	112 ± 3.25^{a}	115 ± 2.12^{a}	103 ± 3.6^{b}	98 ± 2.6^{b}	105 ± 1.3^{b}

Means in the same raw with different superscripts are significantly different ($p < 0.01$)

Table 5 : Economical efficiency of the different experimental groups

	control	T1	T2	T3	T4
Body weight gain	1.547	1.530	1.498	1.161	1.071
Price / feed (L.E.)	1.09	1.07	1.05	1.02	1.00
Feed intake (Kg)	7.77	7.45	7.31	6.23	6.18
Total feed cost (L.E.)	8.47	7.97	7.68	6.35	6.18
Price of BG (L.E.)	17.02	16.85	16.48	12.77	11.78
Net revenue (L.E.)	8.55	8.86	8.80	6.42	5.60
Economic efficiency	100.9	111.2	114.6	101.1	82.4
Relative efficiency	100	104	103	75	65

Table 6 : Body weights and body weight gains of growing rabbits in the different experimental groups

Treatments	Initial	6-8 wk			8-10 wk			10-12 wk			12-14 wk			14-16 wk			Total	
	BW	BW	BG	DBG	BW	BG	DBG	BW	BG	DBG	BW	BG	DBG	BW	BG	DBG	BG	DBG
control	890± 29.1	1148± 41.7^{a}	258± 19.1	18.4± 1.3	1448± 56.9^{a}	300± 28.2	21.4± 1.97	1795± 62.6^{a}	347± 21.3	24.8± 1.59	2129± 80.4^{a}	334± 20.6	23.9± 1.5	2437± 102^{a}	308± 19.4	22.0± 1.32	1547± 42.5^{a}	22.1± 1.1
T1	912± 21.4	1156± 51.2^{a}	244± 22.4	17.4± 1.83	1461± 38.8^{a}	305± 26.2	21.8± 1.59	1821± 58.1^{a}	360± 19.1	25.7± 1.17	2151± 78.5^{a}	330± 19.4	23.6± 1.37	2442± 99^{a}	291± 22.6	20.8± 1.56	1530± 56.8^{a}	21.9± 1.5
T2	887± 25.75	1147± 35.9^{a}	260± 20.5	18.6± 1.47	1461±4 9.2^{a}	295± 23.3	21.1± 1.83	1782± 85.9^{a}	340± 20.4	24.3± 1.29	2099± 86.2^{a}	317± 22.7	22.6± 1.6	2385± 103^{a}	286± 25.6	20.4± 1.69	1498± 39.3^{a}	21.4± 1.29
T3	905± 22.8	1137± 43.2^{a}	232± 16.7	16.8± 1.09	1397± 51.2^{b}	260± 20.8	18.6± 1.75	1669± 49.3^{b}	272± 22.1	19.4± 1.5	1884± 69.3^{b}	215± 21.3	15.4± 1.69	2066± 93^{b}	182± 18.2	13.0± 1.17	1161± 26.7^{b}	16.6± 1.25
T4	915± 23.2	1125± 26.8^{a}	210± 18.6	15.0± 1.46	1377± 36.1^{b}	252± 18.2	18.0± 1.12	1620± 38.1^{b}	243± 15.1	17.4± 0.92	1810± 57.2^{b}	190± 17.6	13.6± 1.07	1986± 75^{b}	176± 15.8	12.6± 1.08	1071± 35.1^{b}	15.3± 1.18

BW = Body weight BG = Body gain DBG = Daily body gain
Means in the same raw with different superscripts are significantly different ($p < 0.01$)

Table 7 : The effect of urea substitution on feed intake and feed conversion of growing rabbits at different periods of age

Treatments	6-8 week		8-10 week		10-12 week		12-14 week		14-16 week		Total	
	FI	FC	FI	FC	FI	FC	FI	FC	FI	FC	FI	FC
control	1238	4.80	1476	4.92	1762	5.08	1720	5.15	1577^{a}	5.12	7773^{a}	5.02
T1	1176	4.82	1422	4.66	1760	4.89	1629	4.94	1461^{a}	5.02	7448^{a}	4.87
T2	1238	4.76	1403	4.76	1658	4.88	1568	4.95	1446^{a}	5.06	7313^{a}	4.88
T3	1172	5.05	1349	5.19	1469	5.40	1215	5.65	1019^{b}	5.60	6225^{b}	5.36
T4	1138	5.42	1452	5.76	1439	5.90	1113	5.86	1047^{b}	5.95	6184^{b}	5.77

FI=Feed intake FC = Feed conversion