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EFFECT OF UREA LEVELS WITH ADDITIVE N-CARBAMYLGLUTAMATE ON FEED INTAKE AND GROWTH OF AWASSI LAMBS

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ABSTRACT

This study was conducted to evaluate four levels of urea, 0, 0.5, 1.0 and 1.5% with or without 3g /day /animal N-carbamylglutamate (NCG), on feed intake, daily and total gain. The experiment was conducted in animal field of the holy Abbasid shrine in Karbala from 10/14/2019 to 12/24/2019, experiment period was 70 days preceded by an adaptation period of 10 days, 32 female Awassi lambs aged 3-4 months were used with initial weight 24.02 ±0.44kg divided into two groups, each group has four treatments, first one fed four levels of urea, 0, 0.5, 1.0 and 1.5% without NCG, while the second group was fed urea, 0, 0.5, 1.0 and 1.5% with 3g NCG /day/animal. Completely Randomized Design, factorial experiment (2 × 4) was used for treatments T1, T2, T3, T4, T5, T6, T7, T8. Results of replacing soybean meal by urea with or without NCG showed no significant differences in dry matter intake of roughage and concentrated feed, as well as, initial and final weight of the experimental animals (kg). All urea levels had the superiority of feed efficiency, 12.63, 8.13, 8.72 and 8.32 for levels 0, 0.5, 1.0 and 1.5% respectively, low intake of ash, ether extract and crude fiber with increasing urea intake or adding NCG. Increasing efficiency ($p<0.05$) of crude protein to daily gain for urea treatments 1.61, 1.23, 1.34 and 1.28 for levels 0, 0.5, 1.0 and 1.5% respectively. Daily and total gains had superiority with urea and NCG in contrast without urea or without NCG, they were 1**10**.0, 132.86, 147.86, 125.71, 92.14, 145.0, 120.0, 150.36 g/day, and 7.7, 9.3, 10.35, 8.8, 6.45, 10.15, 8.4, 10.53 kg total gain respectively. It can be concluded positive responses of adding NCG or replacing urea and NCG with soya meal to produce highly daily gains, final body weight, crude protein intake and feed efficiency of Awassi lambs.

Keywords: Urea, soya, gain, feed efficiency, NCG, intake, Awassi lambs.

Introduction

Cost and efficiency of feeds are the main goal of feed manufacturers, breeders and ranchers. Ruminants are characterized by their ability to eat non-protein nitrogen (NPN) with daily feeds to support nitrogen and increase crude protein intake to provide dissolving nitrogen in rumen fluid, which is used by rumen microorganisms to growth and reproduction with presence of carbohydrates as sources of energy, represented by short-chain fatty acids, which available in 80% of ruminant feeds (Tawfeeq and Hassan, 2014). Therefore, protein or nitrogenous sources constitute the most necessity to provide an important aspect in formulation of ruminant feeds with significant cost of feeds, and if we replace it with lowest prices like urea, we definitely have cheapest ruminants feeds. Using urea in feeds leads to side effects to ruminants, like increasing ammonia in blood and urea, that's leads to stress or poisoning in high ammonia levels (Tawfeeq *et al*., 2017), N-carbamylglutamate (NCG) is an additive was developed by the China National Feed Engineering Research Center in 2014 and approved by China Ministry of Agriculture, works as metabolism regulation, a promoter for arginine production and polyamines (Morris, 2009), Arginine (ARG) essential amino acids and a key to urea cycle, essential for animal health, reproduction and growth with multiple physiological functions (Tan *et al*., 2011). Lack of arginine in feeds and/or insufficient production in animals body doesn't enough during early stages of growth or high production. N-carbamylglutamate has a lower degree of rumen degradation compared with Arginine (Chacher *et al*., 2012), thus, it will reach small intestine and meets requirements of maintenance and production (Sampaio *et al*., 2009) without negative side effects (Harper *et al*. 2009), and low-cost in contrast to arginine (Mahdi *et al*., 2021), increasing fetuses weights (Zhang *et al*., 2014) growth and reproductive performance in sheep (Zhang *et al*., 2016), goats (Wang *et al*., 2019), cows (Feng *et al*., 2018) and poultry (Hu *et al*., 2019). Therefore, this study aims to evaluate different levels of urea with or without 3g /day /animal N-carbamylglutamate (NCG), on feed intake, daily and total gain in Awassi lambs.

Materials and Methods

Experimental animal and management

Thirty-two Awassi female lambs aged 3-4 months with initial weight 24.02 ± 0.44 kg divided into two groups, each group has four treatments, first one fed four levels of urea, 0, 0.5, 1.0 and 1.5% without NCG, while the second group was fed urea, 0, 0.5, 1.0 and 1.5% with 3gm NCG/ day, animals were randomized distributed to eight treatments T1, T2, T3, T4, T5, T6, T7, T8 with four replicates for each in individual pens measuring **2× 1.5** m^2 . They were provided concentrate, roughage feed and clean water. Animals were given vaccines and kept continuous veterinary supervision all experimental days. Concentrated feed offered to lambs once a day at 8am

at 4% of live body weight as DM basis and adjusted weekly based on the change of weight, while roughage or straw offered 500gm/ head/ day as ad-libitum with remaining. To calculate the amount of daily feed intake, all remaining feeds were recorded.

Growth trial

The effect of level of urea with or without N-carbamylglutamate (NCG) on animal growth was studied using some parameters:

1- Total weight gain (Kg) = Final live animal weight – Initial weight.

2- Daily weight gain (gm) = Total weight gain / number of experimental days.

Chemical analyses

Formulation of concentrated feeds with chemical composition, N-carbamylglutamate and straw are presented in tables 1 and 2 as (A.O.A.C., 2005).

Statistical analysis

Data were statistically analyzed using 2×4 Completely Randomized Design (CRD), factorial experiment (SAS, 2012), Duncan's multiple range test was used to determine the significant differences ($p<0.05$) and ($p<0.01$) among treatments (Duncan, 1955).

$$Yijk = \mu + Ai + + Bj + AB(ij) + eijk$$

Results and Discussion

Dry matter and nutrients intake

There weren't negative side effects or health problems for all experimental animals. The results of feeding urea didn't effect on nutrients intake of straw with or without N-carbamylglutamate gm / day for main effects and interactions (Table 3), researchers aim to use additives that are low price with high content of amino acids, NCG is one of the nutritional additives that are used instead of arginine and important for maintenance, reproductive, growing in various types of animals (Feng *et al*., 2018). Due to high crude protein content of NCG (46.94 %) which may increase the amount of nitrogen entering rumen with presence of carbohydrate from straw, that importance to a suitable environment for rumen microorganisms. The absence of effects or the similarity of straw intake may be due to all treatments having the same roughage without any treatment.

Table 1 : Formulation and chemical composition of experimental concentration diets (% as DM basis).

Ingredients (%)	0 (gm/ day) NCG				3 (gm/ day) NCG			
	Urea %				Urea %			
	0	0.5	0	0.5	0	0.5	0	0.5
Treatments	T1	T2	T3	T4	T5	T6	T7	T8
Barley	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0
Corn	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Bran	30.0	32.5	35.5	36.5	30.0	32.5	35.5	36.5
Soybean meal	8.0	5.0	1.5	0	8.0	5.0	1.50	0
Urea	0	0.5	1	1.5	0	0.5	1	1.5
Salt &Vitamins	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Approximate analysis								
Dry matter (DM) %	92.80	93.98	92.87	93.74	93.99	94.01	93.79	93.36
Organic matter (OM) %	92.16	94.11	93.34	93.11	92.46	92.81	93.54	92.87
Crude protein (CP) %	14.36	14.43	14.35	14.02	14.32	15.18	15.51	16.18
Ether extract %	5.95	4.98	4.69	4.47	5.13	6.15	4.12	5.13
Crude fiber %	7.41	6.55	5.15	5.78	6.28	6.47	5.97	6.58
Ash %	7.84	5.89	6.66	6.89	7.54	7.19	6.46	7.13
*Metabolic energy (MJ/kg dry matter)	12.95	13.14	13.11	12.99	12.96	13.15	12.94	12.95
Nitrogen free extract	64.44	68.15	69.15	68.84	66.73	65.01	67.94	64.98
pH	5.64	5.65	5.84	5.79	5.58	5.51	5.77	5.71

* Metabolic energy (MJ/kg dry matter) = 0.012 × crude protein + 0.031× ether extract + 0.005× crude fiber + 0.014 × nitrogen free extract ……. (MAFF,1975).

T1= 0% urea, 0 (gm/ day) NCG ; T2 = 0.5% urea, 0 (gm/ day) NCG

T3= 1.0% urea, 0 (gm/ day) NCG ; T4 = 1.5% urea, 0 (gm/ day) NCG

T5= 0% urea, 3 (gm/ day) NCG ; T6 = 0.5% urea, 3 (gm/ day) NCG

T7= 1.0% urea, 3 (gm/ day) NCG ; T8 = 1.5% urea, 3 (gm/ day) NCG

Table 2 : Chemical composition of N-carbamylglutamate (NCG) and straw (% as DM basis).

Approximate analysis	NCG	Straw
Dry matter	94.5	93.91
Organic matter	86.21	88.78
Crude protein	46.99	2.19
Ether extract	----	1.08
Crude fiber		31.78
Ash	13.79	11.22
Nitrogen free extract	---	53.73
*Metabolic energy (MJ/kg dry matter)	---	9.7
pH	2.6	6.79

* Metabolic energy (MJ/kg dry matter) = 0.012 × crude protein + 0.031× ether extract + 0.005× crude fiber + 0.014 × nitrogen free extract ……. (MAFF,1975).

Mahdi *et al*. (2021) referred to the same results and there weren't any differences in straw intake between treatment when submitted 0, 2, 4, 6 gm/ day NCG with and without 1% urea. Results of concentrated daily intake referred to high significant decreases in EE and CF (%) daily intake with increasing urea levels (P <0.01) and significant decrease (P <0.05) for ash daily intake (table 4), while there was significant increase of crude protein intake with increasing levels of urea, and highly increase 182.59 gm/day (P<0.01) for 1.5% urea with 3gm/ day NCG (T8) in contrast without NCG. Researchers have shown a positive effect of NCG on embryos due to an increase the amount of protein intake and arginine in the body (Liu *et al*., 2012; Zhang *et al*., 2014), Kareem *et al.* (2018) indicated to use whey protein at 75% and 100% instead of soybean meal and reduced the economic cost of 1 kg gain by 7.22% and 7.08% respectively. Total daily feeds (gm / day) (table 5) referred to the effect of urea levels (%) with or without 3gm N-carbamylglutamate (NCG) on total nutrients intake, there were highly significant decrease for daily intake of EE (P <0.01) in contrast without urea, 55.73, 50.33 and 62.18 gm/ day for urea levels 0, 1, 1.5 % respectively, that because of replacement soya bean meal with urea (Mahdi *et al*., 2021). Interaction showed significant increases (P <0.05) in protein intake for urea intake and 3gm NCG (T8) 186.43 (gm/day) in contrast without urea and 3gm NCG (T5) 155.73 (gm/day) because of increasing OM intake in addition to CP content. Researchers referred to NCG as a precursor for muscle synthesis (Frank *et al*., 2007), protects the morphology of the small intestine (Xiao *et al*., 2016) and decreases the level of fat oxidative stress (Liu *et al*., 2016). Tawfeeq and Hassan (2014) referred to that feeding urea leads to increase the adequate proportions of fermented carbohydrates and increased the efficiency of N-NH4 to microbial protein synthesis, and increased the degradation of crude fiber by increasing rumen microorganisms growth (Sampaio *et al*., 2009), with high flow rate.

Growth and feed Efficiency

The effect of feeding different levels of urea (%) with or without 3 gm N-carbamylglutamate (NCG) on final weight (Kg), daily gain (gm/day) and total gain (Kg) showed highly increasing (P< 0.01) in daily gain and final weight with increasing levels of urea (table 6), while, the addition of 3 gm NCG with 1.5% urea (T8) leads to significant increases (P<0.05) in daily gain (150.36 gm/ day) and final weight (10.53 kg) in contrast with 110.0 gm/ day and 7.7 kg for control (T1) respectively.

Table 3 : Main effect of urea levels (%) with or without N-carbamylglutamate (NCG) (g/ day) on total nutrients intake from straw (g / day) ± Standard error.

Treat.	Dry matter	Organic matter	Crude protein	Ether extract	Crude fiber	Ash	Nitrogen free extract	Metabolic energy (MJ/day)
NCG								
0	181.23± 5.61 a	160.89± 4.98 a	3.97± 0.12 a	1.96± 0.06 a	57.60± 1.78 a	20.33± 0.63 a	97.37± 3.01 a	1.76± 0.05 a
3	180.23± 4.18 a	160.01± 3.71 a	3.95± 0.09 a	1.95± 0.04 a	57.28± 1.33 a	20.22± 0.47 a	96.84± 2.25 a	1.75± 0.04 a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Urea								
0	176.18± 6.82 a	156.42± 6.06 a	3.86± 0.15 a	1.90± 0.07 a	55.99± 2.17 a	19.77± 0.77 a	94.66± 3.67 a	1.71± 0.07 a
0.5	179.50± 6.44 a	159.36± 5.72 a	3.93± 0.14 a	1.94± 0.07 a	57.05± 2.05 a	20.14± 0.72 a	96.45± 3.46 a	1.74± 0.06 a
1	188.16± 9.12 a	167.05± 8.10 a	4.12± 0.20 a	2.03± 0.10 a	59.80± 2.90 a	21.11± 1.02 a	101.10± 4.90 a	1.83± 0.09 a
1.5	179.07± 5.21 a	158.98± 4.63 a	3.92± 0.11 a	1.93± 0.06 a	56.91± 1.66 a	20.09± 0.59 a	96.22± 2.80 a	1.74± 0.05 a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
NCG × Urea								
T1	175.83± 11.44 a	156.10± 10.16 a	3.85± 0.25 a	1.90± 0.12 a	55.88± 3.64 a	19.73± 1.28 a	94.47± 6.15 a	1.71± 0.11 a
T2	179.74± 10.52 a	159.57± 9.34 a	3.94± 0.23 a	1.94± 0.11 a	57.12± 3.34 a	20.17± 1.18 a	96.57± 5.65 a	1.75± 0.10 a
T3	186.77± 16.62	165.82± 14.76 a	4.09± 0.36 a	2.02± 0.18 a	59.36± 5.28 a	20.96± 1.87 a	100.35± 8.93 a	1.81± 0.16 a
T4	182.58± 9.49 a	162.09± 8.42 a	4.00± 0.21 a	1.97± 0.10 a	58.02± 3.02 a	20.49± 1.07 a	98.10± 5.10 a	1.78± 0.09 a
T5	176.54± 9.29 a	156.73± 8.25 a	3.87± 0.20 a	1.91± 0.10 a	56.11± 2.95 a	19.81± 1.04 a	94.85± 4.99 a	1.72± 0.09 a
T6	179.27± 9.09 a	159.15± 8.07 a	3.92± 0.20 a	1.94± 0.10 a	56.97± 2.89 a	20.12± 1.02 a	96.32± 4.89 a	1.74± 0.09 a
T7	189.55± 10.53 a	168.28± 9.35 a	4.15± 0.23 a	2.05± 0.11 a	60.24± 3.35 a	21.27± 1.18 a	101.85± 5.66 a	1.84± 0.10 a
T8	175.57± 5.36 a	155.87± 4.75 a	3.84± 0.12 a	1.90± 0.06 a	55.80± 1.70 a	19.70± 0.60 a	94.33± 2.88 a	1.70± 0.05 a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

n.s: non-significant, Different litters in same column means significant differences

T1= 0% urea, 0 (gm/ day) NCG ; T2 = 0.5% urea, 0 (gm/ day) NCG; T3= 1.0% urea, 0 (gm/ day) NCG ; T4 = 1.5% urea, 0 (gm/ day) NCG
T5= 0% urea, 3 (gm/ day) NCG ; T6 = 0.5% urea, 3 (gm/ day) NCG; T7= 1.0% urea, 3 (gm/ day) NCG ; T8 = 1.5% urea, 3 (gm/ day) NCG

Table 4 : Main effect of urea levels (%) with or without N-carbamylglutamate (NCG) (g/ day) on total nutrients intake from concentrate (g / day) ± Standard error

Treat.	Dry matter	Organic matter	Crude protein	Ether extract	Crude fiber	Ash	Nitrogen free extract	**Metabolic energy (MJ/day)
NCG								
0	1112.85± 22.15 a	1036.99± 20.86 a	159.03± 3.21 a	55.90± 1.98 a	69.29± 2.86 a	75.86± 2.44 a	752.77± 15.88 a	14.53± 0.29 a
3	1096.83± 26.06 a	1019.20± 24.32 a	167.94± 4.75 a	56.33± 2.48 a	69.41± 1.84 a	77.63± 2.07 a	725.52± 17.17 a	14.27± 0.34 a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Urea								
0	1086.05± 38.14 a	1002.49± 35.07 a	155.74± 5.49 a	60.27± 2.99 a	74.48± 3.87 a	83.56± 3.13 a	711.99± 24.38 a	14.08± 0.49 a
0.5	1117.00± 34.19 a	1044.02± 32.41 a	165.33± 5.12 a	62.10± 2.94 a	72.72± 2.25 a	72.98± 3.33 b	743.87± 24.48 a	14.69± 0.45 a
1	1096.15± 37.65 a	1024.24± 35.18 a	163.63± 6.10 a	48.30± 2.05 b	60.93± 2.69 b	71.91± 2.51 b	751.38± 25.95 a	14.28± 0.49 a
1.5	1120.15± 29.87 a	1041.62± 27.73 a	169.23± 6.71 a	53.80± 2.09 b	69.26± 2.62 a	78.53± 2.20ab	749.33± 20.92 a	14.54± 0.39 a
Significance	n.s	n.s	n.s	**	**	*	n.s	n.s
NCG × Urea								
T1	1111.60± 47.40 a	1024.45± 43.69 a	159.63± 6.81 ab	66.14± 2.82 a	82.37± 3.51 a	87.15± 3.72 a	716.32± 30.55 a	14.41± 0.61 a
T2	1127.60± 53.23 a	1061.19± 50.09 a	162.71± 7.68 ab	56.16± 2.65 b	73.86± 3.48ab	66.42± 3.13 c	768.46± 36.28 a	14.82± 0.70 a
T3	1100.40± 45.35 a	1027.11± 42.33 a	157.91± 6.51 ab	51.61± 2.13 bc	56.67± 2.33 c	73.29± 3.02bc	760.93± 31.36 a	14.43± 0.59 a
T4	1111.80± 50.50 a	1035.20± 47.02 a	155.88± 7.08 b	49.70± 2.26 bc	64.26± 2.92bc	76.60± 3.48abc	765.37± 34.77 a	14.45± 0.66 a
T5	1060.50± 64.07 a	980.54± 59.24 a	151.86± 9.17 b	54.40± 3.29 b	66.60± 4.02bc	79.96± 4.83ab	707.67± 42.75 a	13.75± 0.83 a
T6	1106.40± 50.47 a	1026.85± 46.84 a	167.95± 7.66 ab	68.04± 3.10 a	71.59± 3.27 b	79.55± 3.63ab	719.27± 32.81 a	14.56± 0.66 a
T7	1091.90± 67.43 a	1021.36± 63.07 a	169.35± 10.46 ab	44.99± 2.78 c	65.19± 4.02bc	70.54± 4.36bc	741.84± 45.81 a	14.14± 0.87 a
T8	1128.50± 39.58 a	1048.04± 36.75 a	182.59± 6.40 a	57.89± 2.03 b	74.26± 2.60ab	80.46± 2.82ab	733.30± 25.72 a	14.62± 0.51 a
Significance	n.s	n.s	*	**	**	*	n.s	n.s

n.s : non-significant, Different litters in same column means significant differences
* Significant differences at level 0.05; ** Significant differences at level 0.01
T1= 0% urea, 0 (gm/ day) NCG ; T2 = 0.5% urea, 0 (gm/ day) NCG; T3= 1.0% urea, 0 (gm/ day) NCG ; T4 = 1.5% urea, 0 (gm/ day) NCG
T5= 0% urea, 3 (gm/ day) NCG ; T6 = 0.5% urea, 3 (gm/ day) NCG; T7= 1.0% urea, 3 (gm/ day) NCG ; T8 = 1.5% urea, 3 (gm/ day) NCG

Table 5 : Main effect of urea levels (%) with or without N-carbamylglutamate (NCG) (g/ day) on total nutrients intake from total feed (g / day) ± Standard error.

Treat.	Dry matter	Organic matter	Crude protein	Ether extract	Crude fiber	Ash	Nitrogen free extract	Metabolic energy (MJ/day)
NCG								
0	1294.08± 24.76 a	1197.88± 23.17 a	163.00± 3.26 a	57.86± 1.99 a	126.88± 3.38 a	96.20± 2.62 a	850.14± 17.31 a	16.29± 0.32 a
3	1277.06± 26.67 a	1179.21± 24.91 a	171.88± 4.76 a	58.28± 2.47 a	126.68± 2.21 a	97.85± 2.06 a	822.36± 17.60 a	16.02± 0.35 a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
Urea								
0	1262.23± 37.46 a	1158.91± 34.45 a	159.60± 5.46 a	62.18± 2.98 a	130.48± 4.22 a	103.32± 3.09 a	806.65± 23.93 a	15.79± 0.49 a
0.5	1296.50± 33.56 a	1203.38± 31.84 a	169.26± 5.09 a	64.04± 2.93 a	129.77± 2.75 a	93.12± 3.30 b	840.31± 24.13 a	16.43± 0.44 a
1	1284.31± 44.35 a	1191.29± 41.11 a	167.75± 6.23 a	50.33± 2.10 b	120.73± 4.95 a	93.03± 3.27 b	852.48± 29.45 a	16.11± 0.56 a
1.5	1299.22± 33.15 a	1200.60± 30.66 a	173.15± 6.73 a	55.73± 2.10 b	126.17± 3.40 a	98.62± 2.54 a	845.55± 22.86 a	16.27± 0.42 a
Significance	n.s	n.s	n.s	**	n.s	*	n.s	n.s
NCG × Urea								

T1	1287.43± 51.60 a	1180.55± 47.37 a	163.48± 6.88 ab	68.04± 2.85 a	138.25± 5.68 a	106.88± 4.24 a	810.79± 32.70 a	16.11± 0.65 a
T2	1307.34± 54.12 a	1220.76± 50.83 a	166.65± 7.68 ab	58.10± 2.65 b	130.98± 4.80 ab	86.58± 3.33 b	865.03± 36.64 a	16.57± 0.71 a
T3	1287.17± 57.19 a	1192.93± 52.79 a	162.00± 6.74 ab	53.62± 2.24 bc	116.03± 6.98 b	94.25± 4.43 ab	861.28± 37.57 a	16.24± 0.71 a
T4	1294.38± 57.53 a	1197.29± 53.25 a	159.88± 7.23 b	51.67± 2.33 bc	122.28± 5.47 ab	97.09± 4.29 ab	863.46± 38.50 a	16.22± 0.73 a
T5	1237.04± 58.86 a	1137.27± 54.60 a	155.73± 9.05 b	56.31± 3.23 b	122.71± 3.23 ab	99.77± 4.28 ab	802.52± 39.90 a	15.47± 0.78 a
T6	1285.67± 47.43 a	1186.00± 44.11 a	171.88± 7.58 ab	69.98± 3.06 a	128.55± 3.34 ab	99.67± 3.34 ab	815.59± 31.10 a	16.30± 0.63 a
T7	1281.45± 76.82 a	1189.65± 71.40 a	173.50± 10.66ab	47.04± 2.88 c	125.43± 7.14 ab	91.81± 5.42 b	843.68± 50.84 a	15.98± 0.96 a
T8	1304.07± 42.46 a	1203.91± 39.31 a	186.43± 6.46a	59.79± 2.06b	130.05± 3.75ab	100.16± 3.16ab	827.63± 27.25 a	16.33± 0.54 a
Significance	n.s	n.s	*	**	*	*	n.s	n.s

n.s : non-significant, Different litters in same column means significant differences
* Significant differences at level 0.05; ** Significant differences at level 0.01
T1= 0% urea, 0 (gm/ day) NCG ; T2 = 0.5% urea, 0 (gm/ day) NCG ; T3= 1.0% urea, 0 (gm/ day) NCG ; T4 = 1.5% urea, 0 (gm/ day) NCG
T5= 0% urea, 3 (gm/ day) NCG ; T6 = 0.5% urea, 3 (gm/ day) NCG; T7= 1.0% urea, 3 (gm/ day) NCG ; T8 = 1.5% urea, 3 (gm/ day) NCG

Rumen epithelial cells and intestine utilized from N-carbamylglutamate in production of urea (Oba *et al*., 2005). Ruminally synthesized microbial protein from rumen degradable protein of food and short chain fatty acids, so the availability of amino acids from feed after rumen have great importance to ensure provision of maintenance and production requirements for host animals. Morris (2009) referred that arginine works on processing polyamines and regulating metabolism, while, N-carbamylglutamate enhances the production of arginine and the family of arginine amino acids, the advantages of cheap additive like NCG improved daily gain and feed efficiency in lambs (Mahdi, 2020; Mahdi *et al*., 2021). Weekly live weights showed increases when feeding NCG to lambs compared to control (figure 1), the same results for final live weights of animals (figure 2). Supplemented NCG during lactation affects positively on intestinal growth in lambs suffering from malnutrition during embryonic period (Zhang *et al*., 2015; 2018), so, it may improve absorptions of nutrients and leads to increases weekly and final weights. The results of feed different levels of urea (%) on feed efficiency (table 7) leads to significant increase ($P<0.05$) of efficiency for concentrate feeds, 10.94, 8.13, 8.72 and 8.32 when fed 0, 0.5, 1.0 and 1.5% urea respectively, as well as for total feeds, 12.73, 9.43, 10.23 and 9.66 respectively, while, feed efficiency (concentrate) increased when added urea and NCG 3gm/day, 11.75, 7.67, 9.72 and 7.52 for T5, T6, T7 and T8 respectively, and the same way for efficiency of total feeds, 13.73, 8.91, 11.39 and 8.69 respectively. The results are consistent with Wu *et al*. (2004) and Frank *et al*. (2006; 2007) whom indicated to NCG supplementation could increase the growth of intestine and the production of muscles protein in ruminants, and agreed with Mahdi *et al*. (2021) for highly positive effects of urea with NCG on nutrients intake, feed efficiency, daily gain and final weight. Treated negative effects of malnutrition during pregnancy could be done by feeding N-carbamylglutamate and the additives of NCG had positive effects on intestinal integrity and immune function in lambs exposed to impaired intrauterine growth restriction, researcher indicated that NCG was able to enhance the digestive ability and general health of lactating lambs (Zhang *et al*., 2015; 2018).

Conclusions

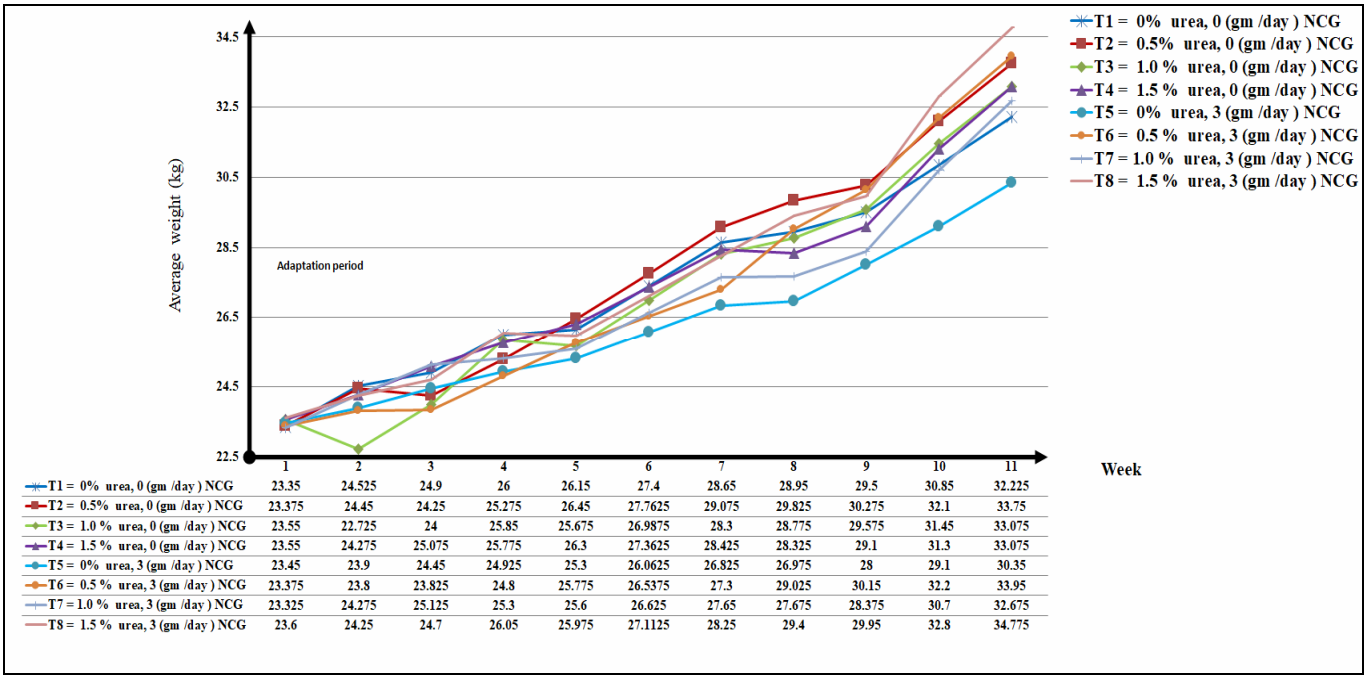
The results of feeding different levels of urea with and without 3gm N-carbamylglutamate for Awassi lambs leads to increased feed efficiency, increased daily gains and total weights and improves productivity of lambs.

Table 6 : Main effect of urea levels (%) with or without N-carbamylglutamate (NCG) (g/ day) on final weight (Kg), daily gain (gm/day) and total gain (Kg) ±Standard error.

Treat.	Initial weight (kg)	Final weight (kg)	Daily gain (gm/day)	Total gain (kg)
NCG				
0	23.99± 0.64a	33.03± 0.60a	129.11± 6.06a	9.04± 0.42a
3	24.06± 0.64a	32.94± 0.85a	126.88± 7.42a	8.88± 0.52a
Significance	n.s	n.s	n.s	n.s
Urea				
0	24.21± 0.97a	31.29± 1.19a	101.07± 5.69b	7.08± 0.40b
0.5	24.13± 0.98a	33.85± 0.84a	138.93± 4.49a	9.73± 0.31a
1	23.50± 0.99a	32.88± 1.10a	133.93± 11.96a	9.38± 0.84a
1.5	24.26± 0.77a	33.93± 0.83a	138.03± 7.64a	9.66± 0.53a
Significance	n.s	n.s	**	**
NCG × Urea				

T1	24.53± 1.21a	32.23± 1.27a	110.00± 3.87bc	7.70± 0.27bc
T2	24.45± 1.66 a	33.75± 1.28 a	132.86± 5.80 ab	9.30± 0.41 ab
T3	22.73± 1.29 a	33.08± 1.34 a	147.86± 16.64 a	10.35± 1.17 a
T4	24.28± 1.30 a	33.08± 1.34 a	125.71± 12.71 ab	8.80± 0.89 ab
T5	23.90± 1.68 a	30.35± 2.11 a	92.14± 9.12 c	6.45± 0.64 c
T6	23.80± 1.28 a	33.95± 1.28 a	145.00± 5.99 a	10.15± 0.42 a
T7	24.28± 1.58 a	32.68± 1.97 a	120.00± 16.17 abc	8.40± 1.13 abc
T8	24.25± 1.03 a	34.78± 0.95 a	150.36± 3.11 a	10.53± 0.22 a
Significance	n.s	n.s	*	*

n.s : non-significant, Different litters in same column means significant differences
* Significant differences at level 0.05 ; ** Significant differences at level 0.01
T1= 0% urea, 0 (gm/ day) NCG ; T2 = 0.5% urea, 0 (gm/ day) NCG; T3= 1.0% urea, 0 (gm/ day) NCG ; T4 = 1.5% urea, 0 (gm/ day) NCG
T5= 0% urea, 3 (gm/ day) NCG ; T6 = 0.5% urea, 3 (gm/ day) NCG; T7= 1.0% urea, 3 (gm/ day) NCG ; T8 = 1.5% urea, 3 (gm/ day) NCG



	1	2	3	4	5	6	7	8	9	10	11
T1 = 0% urea, 0 (gm /day) NCG	23.35	24.525	24.9	26	26.15	27.4	28.65	28.95	29.5	30.85	32.225
T2 = 0.5% urea, 0 (gm /day) NCG	23.375	24.45	24.25	25.275	26.45	27.7625	29.075	29.825	30.275	32.1	33.75
T3 = 1.0 % urea, 0 (gm /day) NCG	23.55	22.725	24	25.85	25.675	26.9875	28.3	28.775	29.575	31.45	33.075
T4 = 1.5 % urea, 0 (gm /day) NCG	23.55	24.275	25.075	25.775	26.3	27.3625	28.425	28.325	29.1	31.3	33.075
T5 = 0% urea, 3 (gm /day) NCG	23.45	23.9	24.45	24.925	25.3	26.0625	26.825	26.975	28	29.1	30.35
T6 = 0.5 % urea, 3 (gm /day) NCG	23.375	23.8	23.825	24.8	25.775	26.5375	27.3	29.025	30.15	32.2	33.95
T7 = 1.0 % urea, 3 (gm /day) NCG	23.325	24.275	25.125	25.3	25.6	26.625	27.65	27.675	28.375	30.7	32.675
T8 = 1.5 % urea, 3 (gm /day) NCG	23.6	24.25	24.7	26.05	25.975	27.1125	28.25	29.4	29.95	32.8	34.775

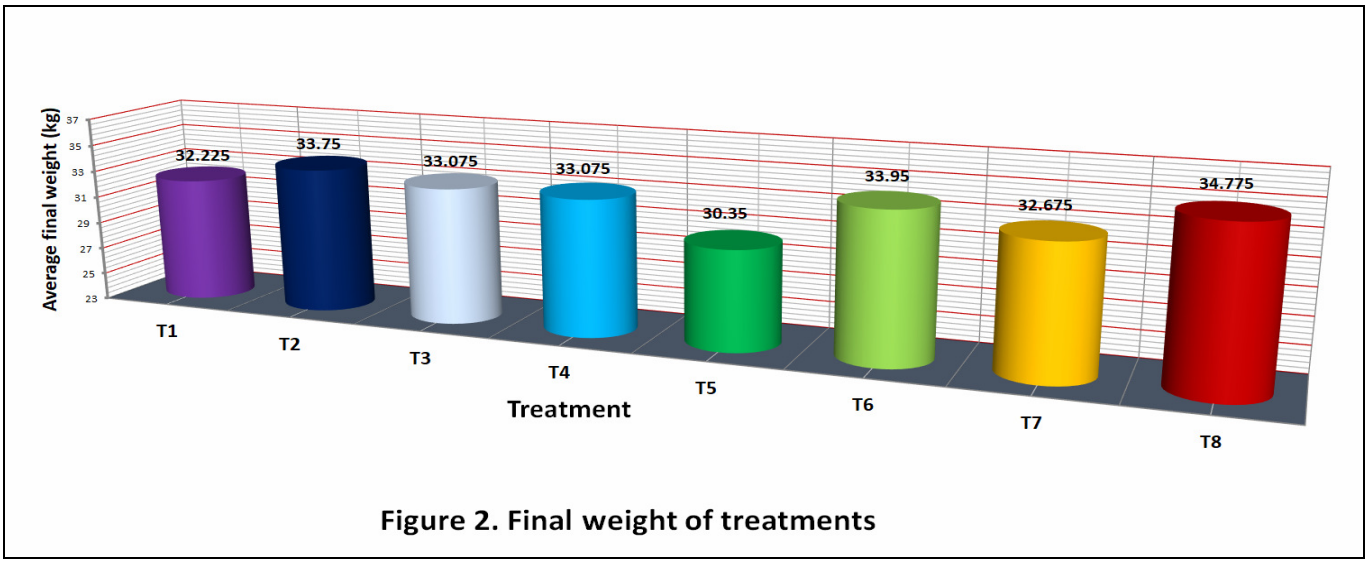


Figure 2. Final weight of treatments

Table 7 : Main effect of urea levels (%) with or without N-carbamylglutamate (NCG) (g/ day) on feed efficiency ± Standard error.

Treat.	Concentrated intake(gm/day) / daily gain (gm/day)	Total intake (gm/day) / daily gain (gm/day)	Metabolic energy intake (KJ/day) / daily gain (gm/day)	Protein intake (gm/day) / daily gain (gm/day)	Energy intake (KJ/day) / Crude protein intake (gm/day)
NCG					
0	8.90± 0.44 a	10.35± 0.51 a	0.13± 0.01 a	1.30± 0.06 a	0.10± 0.00 a
3	9.16± 0.64 a	10.68± 0.74 a	0.13± 0.01 a	1.43± 0.09 a	0.09± 0.00 b
Significance	n.s	n.s	n.s	n.s	**
Urea					
0	10.94± 0.61 a	12.73± 0.71 a	0.16± 0.01 a	1.61± 0.09 a	0.10± 0.00 a
0.5	8.13± 0.45 b	9.43± 0.50 b	0.12± 0.01 b	1.23± 0.06 b	0.10± 0.00 a
1	8.72± 0.95 b	10.23± 1.11 b	0.13± 0.01 b	1.34± 0.16 ab	0.10± 0.00 a
1.5	8.32± 0.61 b	9.66± 0.71 b	0.12± 0.01 b	1.28± 0.08 b	0.09± 0.00 b
Significance	*	*	*	*	**
NCG × Urea					
T1	10.14± 0.51 ab	11.73± 0.49 ab	0.15± 0.01 ab	1.49± 0.07 ab	0.10± 0.00 a
T2	8.59± 0.77 b	9.95± 0.85 b	0.13± 0.01 b	1.27± 0.11 b	0.10± 0.00 a
T3	7.73± 0.89 b	9.07± 1.13 b	0.11± 0.01 b	1.14± 0.13 b	0.10± 0.00 a
T4	9.13± 1.09 ab	10.63± 1.27 ab	0.13± 0.02 ab	1.31± 0.16 ab	0.10± 0.00 a
T5	11.75± 1.02 a	13.73± 1.19 a	0.17± 0.01 a	1.73± 0.15 a	0.10± 0.00 a
T6	7.67± 0.48 b	8.91± 0.51 b	0.11± 0.01 b	1.19± 0.07 b	0.09± 0.00 c
T7	9.72± 1.66 ab	11.39± 1.88 ab	0.14± 0.02 ab	1.54± 0.26 ab	0.09± 0.00 c
T8	7.52± 0.34 b	8.69± 0.36 b	0.11± 0.00 b	1.24± 0.06 b	0.09± 0.00 c
Significance	*	*	*	*	**

n.s : non-significant, Different litters in same column means significant differences
* Significant differences at level 0.05; ** Significant differences at level 0.01
T1= 0% urea, 0 (gm/ day) NCG ; T2 = 0.5% urea, 0 (gm/ day) NCG; T3= 1.0% urea, 0 (gm/ day) NCG ; T4 = 1.5% urea, 0 (gm/ day) NCG
T5= 0% urea, 3 (gm/ day) NCG ; T6 = 0.5% urea, 3 (gm/ day) NCG; T7= 1.0% urea, 3 (gm/ day) NCG ; T8 = 1.5% urea, 3 (gm/ day) NCG

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