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EFFECT OF ADDITIVES N-CARBAMYLGLUTAMATE WITH UREA ON FEED INTAKE AND DAILY GAIN OF AWASSI LAMBS

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ABSTRACT

This study was conducted to demonstrate the effect of four levels of N-carbamylglutamate (NCG), 0, 2, 4 and 6 g /day /animal with or without 1% urea 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 23.725 ± 0.478 kg divided into two groups, each group has four treatments, first one fed four levels of NCG, 0, 2, 4 and 6 g / day without urea, while the second group was fed NCG, 0, 2, 4 and 6g/ day with 1% urea. Two-factor experiment (2 × 4) Completely Randomized Design was used for experimental treatments T1, T2, T3, T4, T5, T6, T7, T8. Results of adding NCG with or without replacing soybean meal with urea 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), in-vitro and in-vivo digestibility of dry matter, organic matter and nutrients (%). There were superiority of NCG treatments for feed efficiency compared to control, 12.63, 9.07, 8.66 and 8.81 for NCG treatments 0, 2, 4 and 6 g / day, respectively, and the efficiency of energy to daily gain, 0.42, 0.29, 0.27 and 0.27, respectively, and efficiency of crude protein intake /daily gain, 0.49, 0.33, 0.31 and 0.31 respectively, as well as the daily weight gain 90.89, 128.39, 132.5 and 131.07 (g /day) and total weight gain, 6.36, 8.99, 9.28 and 9.18 (kg) for NCG respectively. It can be concluded that urea can be substituted instead of soybean meal with addition NCG without negative effects on animal, as well as increasing feed efficiency, increasing daily gains and total weights, and improving the productive characteristics of Awassi lambs.

***Keywords*:** Daily gain, Awassi lambs, intake, NCG, feed efficiency, urea.

Introduction

One importance of feeds as an environmental factor is to provide essential and non-essential amino acids to animals to ensure the requirements for maintenance and production. Arginine (ARG) one of the most essential amino acids, is a key to urea cycle, nitric oxide (NO) and polyamine as well as regulation metabolic pathways that essential for animal health, growth and reproduction. It is an amino acid with multiple physiological functions in animals (Tan *et al*., 2011). Lack of arginine in feeds may restrict growth and health of newborns, although it can be produced in ruminants, but internal production is not sufficient to meet special requirements during the early stages of growth or high production or detoxification. N-carbamylglutamate (NCG) is a feed additive was developed by the China National Feed Engineering Research Center in 2014 and approved by China Ministry of Agriculture, and works as a promoter for arginine production, polyamines and metabolism regulation (Morris, 2009), growth and maintenance of animals (Feng *et al*., 2018), NCG also a lower degree of rumen degradation compared with Arginine (Chacher *et al*. 2012), thus, it will reach small intestine and meets the needs of maintenance and production to host animal (Sampaio *et al*. 2009). Research has also proven that the physiological functions of NCG are non-toxic and free side effects (Harper *et al*. 2009), new and low-cost additives instead of arginine, without catabolism by digestive enzymes or cause any nutritional complications against other amino acids, especially Lysine, Tryptophan and Histidine (Wu *et al*., 2004ab, 2007), increasing gain of fetuses (Liu *et al*. 2012; Zhang *et al*., 2014), promoting growth and improving reproductive performance in different species of animals including sheep (Zhang *et al*., 2016), Cows (Feng *et al*., 2018), goats (Wang *et al*., 2019) and poultry (Hu *et al*., 2019). The use of urea in ruminant feeding can reduce dependence on ingredients or protein concentrates (Holder *et al*. 2015; Medeiros *et al*. 2018), improve the nutritional value of roughages (Cardoso *et al*., 2018). Therefore, this study aims to evaluate the use of different levels of N-carbamylglutamate (NCG) in feeding Awassi lambs with or without urea and its effect on feed intake, daily gain and total weight increases.

Materials and Methods

Experimental animal and management

Thirty-two Awassi female lambs aged 3-4 months with initial weight 23.725 ± 0.478Kg divided into two groups, each group has four treatments, first one fed four levels of NCG, 0, 2, 4 and 6 g / day without urea, while the second group was fed NCG, 0, 2, 4 and 6g/ day with 1% urea, animals were randomized distributed to eight treatments T1,

T2, T3, T4, T5, T6, T7, T8 with four replicates for each in individual pens measuring 2x1.5 m^2. They were provided concentrate, roughage feed and clean water. Animals were given vaccines and keep 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 N-carbamylglutamate (NCG) with or without urea on animal growth 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 and chemical composition of eight concentrated feeds, 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, 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

All animals finished the experiment without any health problems. There were no effects of N-carbamylglutamate (NCG) (g / day) with or without urea on nutrients intake of straw (Table 3), the main goal of researchers is to use feed additives that are low in cost with high content of amino acids or nutrients and substitute with high-cost Ingredients, NCG is considered one of the nutritional additives that are used instead of arginine and important for maintenance, growing and improving reproductive performance in various types of animals (Feng *et al*., 2018). Due to high nitrogen content of NCG (7.51) %, which may increase the amount of nitrogen entering the rumen and crude fibers from straw, that importance to suitable environment for rumen microorganisms, besides that, there weren't any treated for straw, so that, didn't affect the average amount of dry matter intake by different treatments, Hassan and Suzan (2008) referred to no significant affect for untreated straw with urea.

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

Ingredients (%)	0% Urea				1% Urea			
	NCG (gm/ day)				NCG (gm/ day)			
	0	2	4	6	**0**	2	4	6
Treatments	T1	T2	T3	T4	T5	T6	T7	T8
Barley	50.00	50.00	50.00	50.00	50.00	50.00	50.00	50.00
Corn	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Bran	30.00	30.00	30.00	30.00	35.5	35.5	35.5	35.5
Soybean meal	8.00	8.00	8.00	8.00	1.5	1.5	1.5	1.5
Urea	0	0	0	0	1	1	1	1
Salt	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Vitamins	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Approximate analysis								
Dry matter (DM) %	92.80	93.60	93.70	93.94	92.88	92.90	93.11	92.71
Organic matter (OM) %	92.16	92.88	91.85	91.89	93.04	93.1	92.13	93.09
Crude protein (CP) %	14.36	14.82	14.64	14.93	15.21	15.52	15.72	16.20
Ether extract %	5.95	5.78	5.95	5.77	6.45	5.53	6.34	6.30
Crude fiber %	7.41	7.08	8.19	6.97	6.18	6.47	6.78	6.52
Ash %	7.84	7.12	8.15	8.11	6.96	6.90	7.87	6.91
*Metabolic energy (MJ/kg dry matter)	12.95	13.05	12.84	12.91	13.26	13.08	13.05	13.19
Nitrogen free extract	64.44	65.2	63.07	64.22	65.2	65.58	63.29	64.07
pH	5.64	5.78	5.45	5.39	5.95	5.71	5.92	5.78

* 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 (gm/ day) NCG, 0% urea ; T2 = 2 (gm/ day) NCG, 0% urea
T3= 4 (gm/ day) NCG, 0% urea ; T4 = 6 (gm/ day) NCG, 0% urea
T5= 0 (gm/ day) NCG, 1% urea ; T6 = 2 (gm/ day) NCG, 1% urea
T7= 4 (gm/ day) NCG, 1% urea ; T8 = 6 (gm/ day) NCG, 1% urea

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).

The results of concentrated feeds showed significant decrease in CF and ash daily intake with 1% urea (P <0.05) in contrast without urea, 80.8 and 69.58 g/day in contrast with 85.06 and 76.73 g/day respectively, that because of replacement urea with soya bean meal, while, the additives of N-carbamylglutamate, 4 and 6 (g /head/ day) leads to increases CF and ash intake (P <0.05), which mean increases in DM intake (table 4), the interactions between treatments showed increases in crude protein intake with high levels of NCG, which mean increasing dry matter and organic matter intake in addition to nitrogen content of NCG (46.99%) and may increase sources of nitrogen entering the rumen. Researchers have shown a positive effect of NCG on embryos (Liu *et al*., 2012; Zhang *et al*., 2014) due to an increase in the amount of crude protein intake as well as an increase in the amount of arginine in the body, Kareem *et al* (2018) referred to use of dried whey at 75% and 100% instead of soybean meal and reduced the economic cost of producing 1 kg gain by 7.22% and 7.08% respectively. The same results for effect of N-carbamylglutamate (NCG) (g / day) with or without urea on nutrients intake from total daily feeds (g / day) (table 5), highly significant increases for daily intake of CF and ash (P <0.01) without urea (T1) 136.5 and 104.72 g/day in contrast with feeding 1% of urea 126.6 and 96.87 (g/day), that because of replacement soya bean meal with urea. Interaction showed significant increases (P <0.05) in crude protein intake for 6 (g/ day) NCG treatment (T8) 185.99 (g/day) in contrast with control (T1) 155.64 (g/day) because of increasing OM intake in addition to CP content in T8 (16.20 %) in contrast with T1 (14.36%) (table1). Researchers referred to NCG as a precursor for protein muscle synthesis (Frank *et al*., 2007), protects the morphology of small intestine (Xiao *et al*., 2016) and decreases the level of fat oxidative stress (Arg or NCG) (Liu *et al*., 2016b). Adding urea leads to increase the adequate proportions of fermented carbohydrates and increase the efficiency of N-NH4 to produce microbial protein (Tawfeeq and Hassan, 2014), which increased the degradation of fiber by increasing the number of microorganisms in the rumen (Sampaio *et al*., 2009), thus increasing the rate of feed flow rate.

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

Treat.	Dry matter	Organic matter	Crude protein	Ether extract	Crude fiber	Ash	Nitrogen free extract	**Metabolic energy (MJ/day)
Urea								
0	175.26± 6.97a	155.59± 6.19a	3.83±0.15a	1.89± 0.07a	55.69±2.21a	19.66±0.78a	94.16± 3.74a	1.69± 0.06a
1	179.43±6.2a	159.3±5.5a	3.93± 0.13a	1.93±0.06a	57.02±1.97a	20.13±0.69a	96.41±3.33a	1.74±0.06a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
NCG								
0	181.61±8.51a	161.23±7.56a	3.97±0.18a	1.96±0.09a	57.71±2.7a	20.37±0.95a	97.58±4.57a	1.76±0.08a
2	165.24±10.4a	146.7± 9.2a	3.61±0.22a	1.78±0.11a	52.51±3.3a	18.53±1.17a	88.78±5.6a	1.6±0.1a
4	182.74±10.25a	162.24±9.1a	4.0±0.22a	1.97±0.11a	58.07±3.25a	20.5±1.15a	98.18±5.51a	1.77±0.09a
6	179.79±7.77a	159.62±6.9a	3.93±0.17a	1.93±0.08a	57.14±2.47a	20.17±0.87a	96.6±4.17a	1.74±0.07a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s
NCG Urea ×								
T1	171.84±13.9a	152.56±12.4a	3.76±0.3a	1.85±0.1a	54.61±4.4a	19.28±1.5a	92.33±7.5a	1.66±0.13a
T2	163.13±13.9a	144.82±12.4a	3.57±0.3a	1.76±0.15a	51.84±4,4a	18.3±1.56a	87.65±7.5a	1.58±0.13a
T3	188.54±17.1a	167.39±15.2a	4.13±0.37a	2.03±0.18a	59.92±5.4a	21.15±1.9a	101.3±9.2a	1.82±0.16a
T4	177.51±13.1a	157.6±11.6a	3.88±0.28a	1.91±0.14a	56.41±4.17a	19.91±1.47a	95.38±7.06a	1.72±0.12a
T5	191.37±8.8a	169.9±7.8a	4.19±0.19a	2.06±0.09a	60.82±2.8a	21.47±0.99a	102.82±4.77a	1.85±0.08a
T6	167.34±17.6a	148.57±15.6a	3.66±0.38a	1.8±0.18a	53.18±5.5a	18.77±1.9a	89.91±9.4a	1.62±0.16a
T7	176.94±13.1a	157.09±11.6a	3.87±0.28a	1.91±0.14a	56.23±4.18a	19.85±1.47a	95.07±7.07a	1.72±0.12a
T8	182.08±10.2a	161.64±9.14a	3.99±0.22a	1.96±0.11a	57.86±3.2a	20.43±1.15a	97.83±5.5a	1.76±0.1a
Significance	n.s	n.s	n.s	n.s	n.s	n.s	n.s	n.s

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

n.s : non-significant

T1= 0 (gm/ day) NCG, 0% urea ; T2 = 2 (gm/ day) NCG, 0% urea

T3= 4 (gm/ day) NCG, 0% urea ; T4 = 6 (gm/ day) NCG, 0% urea

T5= 0 (gm/ day) NCG, 1% urea ; T6 = 2 (gm/ day) NCG, 1% urea

T7= 4 (gm/ day) NCG, 1% urea ; T8 = 6 (gm/ day) NCG, 1% urea

Table 4 : Main effect of N-carbamylglutamate (NCG) (g / day) with or without urea 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)
Urea								
0	1089.0±26.02a	1003.94±23.96a	159.97±3.95a	63.85±1.54a	80.8±2.49a	85.06±2.39a	699.33±16.57a	14.09±0.33a
1	1072.34±28.53a	995.61±26.65a	168.05±4.78a	66.0±2.02a	69.58±1.95b	76.73±2.21b	691.97±18.51a	14.10±0.38a
Significance	n.s	n.s	n.s	n.s	*	*	n.s	n.s
NCG								
0	1051.05±37.98a	973.25±35.23a	155.37±5.88a	65.15±2.57a	71.46±3.54b	77.81±3.3b	681.27±24.68a	13.78±0.5a
2	1070.85±56.18a	995.78±52.21a	162.44±8.54a	60.56±3.25a	72.56±4.09b	75.07±4.0b	700.23±36.69a	13.99±0.73a
4	1090.85±28.79a	1003.42±26.23a	165.39±3.94a	66.96±1.59a	81.91±4.32a	87.43±2.61a	689.16±17.99a	14.12±0.35a
6	1109.93±26.96a	1026.65±25.52a	172.85±5.37a	67.02±2.13a	74.83±1.89ba	83.28±2.93ba	711.95±17.24a	14.49±0.37a
Significance	n.s	n.s	n.s	n.s	*	*	n.s	n.s
NCG Urea ×								
T1	1057.6±25.45a	974.69±23.46a	151.87±3.66b	62.93±1.52a	78.37±1.89b	82.92±2.0bac	681.52±16.4a	13.71±0.33a
T2	1074.0±100.1a	997.53±92.97a	159.17±14.83ba	62.08±5.79a	76.04±7.09cb	76.47±7.13bc	700.25±65.26a	14.02±1.31a
T3	1128.0±12.71a	1036.07±11.68a	165.14±1.86ba	67.12±0.76a	92.38±1.04a	91.93±1.04a	711.43±8.02a	14.48±0.16a
T4	1096.4±42.26a	1007.48±38.84a	163.69±6.31ba	63.27±2.44a	76.42±2.95cb	88.92±3.43ba	704.11±27.14a	14.17±0.55a
T5	1044.5±77.81a	971.81±72.4a	158.87±11.84ba	67.37±5.02a	64.55±4.81c	72.7±5.42c	681.02±50.73a	13.86±1.03a
T6	1067.7±68.59a	944.03±63.85a	165.71±10.64ba	59.05±3.79a	69.08±4.44cb	73.67±4.73c	700.2±44.98a	13.97±0.9a
T7	1053.7±52.78a	970.77±48.62a	165.64±8.3ba	66.81±3.35a	71.44±3.58cb	82.93±4.16bac	666.89±33.4a	13.75±0.69a
T8	1123.45±38.53a	1045.82±35.87a	182.0±6.24a	70.78±2.43a	73.25±2.51cb	77.63±2.66bc	719.79±24.68a	14.82±0.51a
Significance	n.s	n.s	*	n.s	*	*	n.s	n.s

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

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

* Significant differences at level 0.05

T1= 0 (gm/ day) NCG, 0% urea; T2 = 2 (gm/ day) NCG, 0% urea

T3= 4 (gm/ day) NCG, 0% urea; T4 = 6 (gm/ day) NCG, 0% urea

T5= 0 (gm/ day) NCG, 1% urea; T6 = 2 (gm/ day) NCG, 1% urea

T7= 4 (gm/ day) NCG, 1% urea ; T8 = 6 (gm/ day) NCG, 1% urea

Table 5 : Main effect of N-carbamylglutamate (NCG) (g / day) with or without urea on 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)
Urea								
0	1264.26±26.8a	1159.54±24.52a	163.81±3.95a	65.74±1.54a	136.5±3.56a	104.72±2.63a	793.49±16.73a	15.79±0.34a
1	1251.78±31.93a	1154.91±29.64a	171.99±4.84a	67.94±2.05a	126.6±3.28b	96.87±2.58b	788.39±20.28a	15.84±0.41a
Significance	n.s	n.s	n.s	n.s	**	**	n.s	n.s
NCG								
0	1232.66±40.13a	1134.48±37.25a	159.35±5.94a	67.11±2.6a	129.17±4.07ba	98.18±3.35ba	778.85±25.86a	15.54±0.53a
2	1236.09±57.76a	1142.48±53.59a	166.06±8.57a	62.35±3.26a	125.07±5.28b	93.61±4.21b	789.01±37.47a	15.6±0.75a
4	1273.6±35.92a	1165.66±32.56a	169.39±4.07a	68.93±1.66a	139.99±6.44a	107.93±3.41a	787.35±21.78a	15.89±0.42a
6	1289.72±29.9a	1186.28±28.12a	176.78±5.42a	68.96±2.16a	131.98±3.37ba	103.45±3.11ba	808.56±18.74a	16.24±0.39a
Significance	n.s	n.s	n.s	n.s	*	**	n.s	n.s
NCG Urea ×								
T1	1229.45±39.22a	1127.25±35.68a	155.64±3.96b	64.79±1.66ba	132.98±6.3ba	102.2±3.54bac	773.85±23.79a	15.37±0.46a
T2	1237.13±92.11a	1142.36±85.85a	162.74±14.65ba	63.84±5.69ba	127.88±5.57b	94.77±6.28bc	787.9±60.9a	15.6±1.23a
T3	1316.55±28.0a	1203.46±25.21a	169.27±2.16ba	69.15±0.9ba	152.3±6.28a	113.08±2.79a	812.74±16.13a	16.31±0.31a
T4	1273.92±44.35a	1165.09±40.63a	167.58±6.32ba	65.18±2.44ba	132.84±5.13ba	108.84±3.74ba	799.49±28.1a	15.89±0.56a
T5	1235.88±77.25a	1141.71±71.88a	163.06±11.82ba	69.44±5.01ba	125.37±5.28b	94.17±5.39bc	783.84±50.39a	15.71±1.03a
T6	1235.05±84.17a	1142.6±77.67a	169.37±10.98ba	60.85±3.96ba	122.26±9.67b	92.45±6.51c	790.12±53.31a	15.59±1.05a
T7	1230.65±63.32a	1127.87±57.96a	169.52±8.52ba	68.72±3.46ba	127.67±7.28b	102.78±5.36bac	761.96±39.02a	15.47±0.79a
T8	1305.53±45.15a	1207.47±41.72a	185.99±6.37a	72.74±2.49a	131.11±5.13b	98.06±3.45bac	817.62±28.18a	16.59±0.57a
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 (gm/ day) NCG, 0% urea; T2 = 2 (gm/ day) NCG, 0% urea

T3= 4 (gm/ day) NCG, 0% urea; T4 = 6 (gm/ day) NCG, 0% urea

T5= 0 (gm/ day) NCG, 1% urea; T6 = 2 (gm/ day) NCG, 1% urea

T7= 4 (gm/ day) NCG, 1% urea ; T8 = 6 (gm/ day) NCG, 1% urea

Growth and feed efficiency

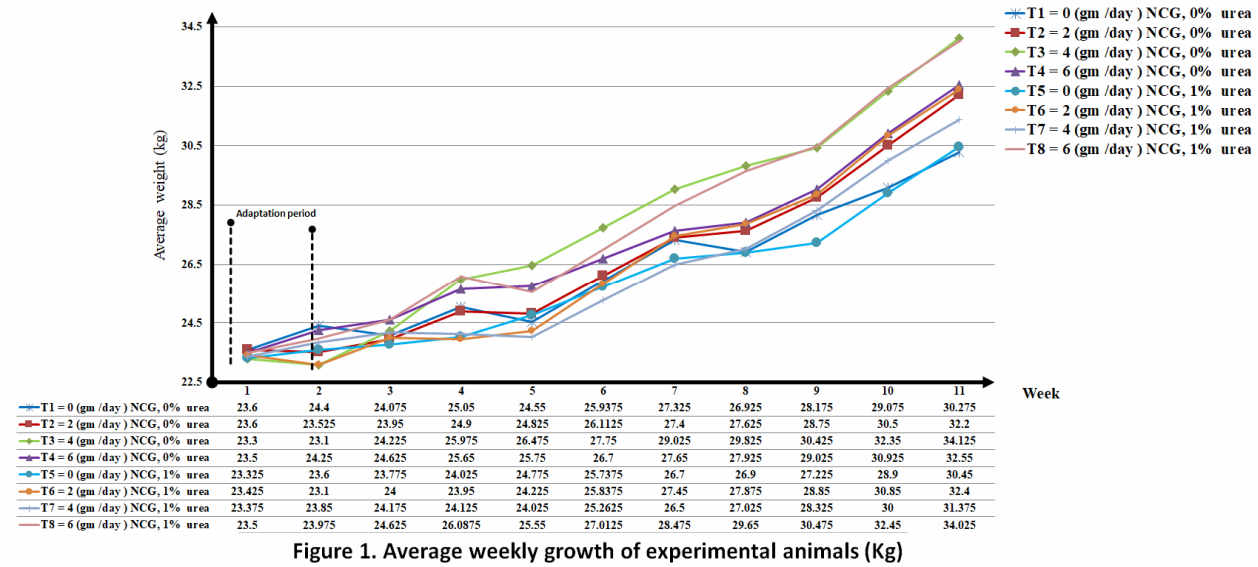
The results of studying effect of N-carbamylglutamate (NCG) (g /day) with or without urea on final weight (Kg), daily gain (gm/day) and total gain (Kg) showed no effect of urea 1% on final weight, daily and total gain (table 6), while, the addition of NCG% leads to significant increases for daily gain 90.89, 128.39, 132.5, 131.07 gm/ day and total gain 6.36, 8.99, 9.28, 9.18 Kg for NCG levels 0, 2, 4 and 6 gm/ head/ day respectively, the interaction between treatment showed that NCG treatments leads to significant increases in daily gain 83.93, 123.93, 157.5, 118.57, 97.86, 132.86, 107.5, 143.57 gm/ day and significant increases in total gain 5.88, 8.68, 11.03, 8.3, 6.85, 9.3, 7.53, 10.05 Kg for T1, T2, T3, T4, T5, T6, T7, T8 respectively. From the observation of figure (1) for weekly live weight, it is obviously that feeding NCG to lambs resulted in linear increases compared to control (T1), as well as the final live weights of experimental animals (figure, 2), from chemical analysis of (NCG), it contains a high crude protein (46.99)%, that is mean more source of protein into the rumen or small intestine, Zhang *et al*. (2015; 2018a b) found that supplements NCG during lactation affects positively on intestinal growth in lambs suffering from malnutrition during embryonic period, 7days old lambs were given arginine and NCG supplements at 1% for 28 day, then noticed improved daily gain and health in contrast with control (without NCG), The epithelial cells of rumen and intestine utilized from NCG in production of urea (Oba *et al*., 2005). The available of feed amino acids after rumen have great importance to ensure the provision of maintenance and production requirements for host animal, Arginine is an important amino acid works on processing polyamines and regulating metabolism (Morris, 2009), and N-carbamylglutamate (NCG) is food additives that enhance the production of arginine and the family of arginine amino acids, these advantages in addition to low price indicate that NCG is a cheap source of feed additives that improve production in ruminants. Results of the effect of N-carbamylglutamate (NCG) (g / day) with or without urea on feed efficiency showed that Awassi lambs fed NCG at levels 2, 4 and 6 gm/day leads to significant increase of feed efficiency 9.07, 8.66, 8.81 in contrast without NCG 12.63 (table 7), the same results for interactions between NCG × urea, it was 14.41 (0NCG, 0 urea) or T1 in contrast with 7.97 (6g/day NCG, 1% urea) or T8. These results are consistent with a study that NCG supplementation could increase intestinal growth and muscle protein production in ruminants (Wu *et al*. 2004a b; Frank *et al*. 2006, 2007).

Zhang *et al*. (2015, 2018a,b) indicated the possibility of treating the negative effects of nutrition during pregnancy by feeding N-carbamylglutamate (NCG), the study showed that additives NCG affected positively intestinal integrity and immune function in lambs that exposed to impaired intrauterine growth restriction (IUGR) as a result of malnutrition, and noticed that group was given NCG additives significantly increased daily gain ($p<0.05$), abundance of proteins and less mortality compared to control, the researcher indicated that additives NCG is able to counter negative effects and may enhance the digestive ability and general health of lactating lambs.

Table 6 : Main effect of N-carbamylglutamate (NCG) (g / day) with or without urea 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)
		Urea		
0	23.82±0.73a	32.29±0.77a	120.98±10.57a	8.47±0.74a
1	23.63±0.64a	32.06±0.84a	120.45±6.76a	8.43±0.47a
Significance	n.s	n.s	n.s	n.s
		NCG		
0	24.0±1.02a	30.36±0.91a	90.89±8.68b	6.36±0.61b
2	23.31±1.42a	32.30±1.6a	128.39±14.33a	8.99±1.0a
4	23.48±0.7a	32.75±0.84a	132.5±11.09a	9.28±0.78a
6	24.11±0.66a	33.29±0.9a	131.07±10.0a	9.18±0.7a
Significance	n.s	n.s	*	*
		NCG Urea ×		
T1	24.4±1.16a	30.28±0.52a	83.93±16.54c	5.88±1.16c
T2	23.53±2.7a	32.2±2.86a	123.93±29.09bac	8.68±2.04bac
T3	23.1±0.46a	34.13±0.14a	157.5±5.1a	11.03±0.36a
T4	24.25±1.26a	32.55±0.94a	118.57±13.45bac	8.3±0.94bac
T5	23.6±1.85a	30.45±1.89a	97.86±6.76bc	6.85±0.47bc
T6	23.1±1.43a	32.4±1.94a	132.86±9.95ba	9.3±0.7ba
T7	23.85±1.41a	31.38±1.41a	107.5±11.46bc	7.53±0.8bc
T8	23.98±0.67a	34.03±1.59a	143.57±13.47ba	10.05±0.94ba
Significance	n.s	n.s	*	*

Different litters in same column means significant differences
n.s : non-significant, * Significant differences at level 0.05
T1= 0 (gm/ day) NCG, 0% urea; T2 = 2 (gm/ day) NCG, 0% urea
T3= 4 (gm/ day) NCG, 0% urea; T4 = 6 (gm/ day) NCG, 0% urea
T5= 0 (gm/ day) NCG, 1% urea; T6 = 2 (gm/ day) NCG, 1% urea
T7= 4 (gm/ day) NCG, 1% urea ; T8 = 6 (gm/ day) NCG, 1% urea



	1	2	3	4	5	6	7	8	9	10	11
T1 = 0 (gm /day) NCG, 0% urea	23.6	24.4	24.075	25.05	24.55	25.9375	27.325	26.925	28.175	29.075	30.275
T2 = 2 (gm /day) NCG, 0% urea	23.6	23.525	23.95	24.9	24.825	26.1125	27.4	27.625	28.75	30.5	32.2
T3 = 4 (gm /day) NCG, 0% urea	23.3	23.1	24.225	25.975	26.475	27.75	29.025	29.825	30.425	32.35	34.125
T4 = 6 (gm /day) NCG, 0% urea	23.5	24.25	24.625	25.65	25.75	26.7	27.65	27.925	29.025	30.925	32.55
T5 = 0 (gm /day) NCG, 1% urea	23.325	23.6	23.775	24.025	24.775	25.7375	26.7	26.9	27.225	28.9	30.45
T6 = 2 (gm /day) NCG, 1% urea	23.425	23.1	24	23.95	24.225	25.8375	27.45	27.875	28.85	30.85	32.4
T7 = 4 (gm /day) NCG, 1% urea	23.375	23.85	24.175	24.125	24.025	25.2625	26.5	27.025	28.325	30	31.375
T8 = 6 (gm /day) NCG, 1% urea	23.5	23.975	24.625	26.0875	25.55	27.0125	28.475	29.65	30.475	32.45	34.025

Figure 1. Average weekly growth of experimental animals (Kg)

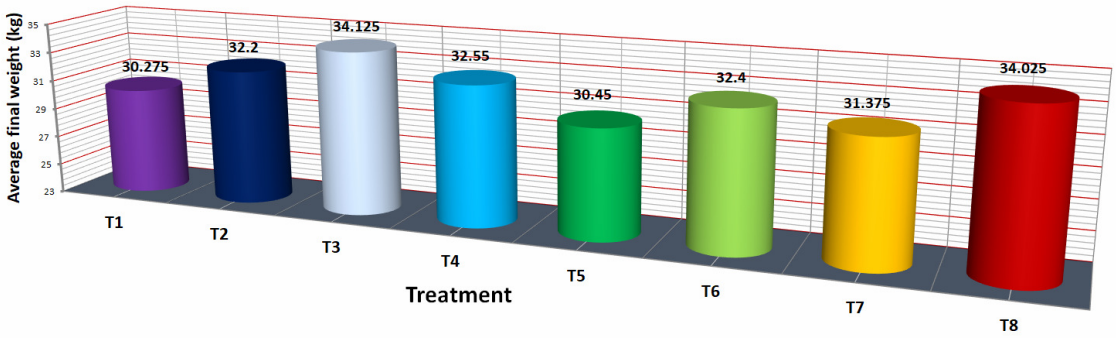


Figure 2. Final weight of treatments

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

Treat.	Concentrated feed intake(gm/day) / daily gain (gm/day)	Total feed 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)
Urea					
0	10.32±1.13a	12.01±1.32a	0.33±0.04a	0.38±0.05a	0.86±0.01a
1	9.26±0.51a	10.82±0.61a	0.29±0.02a	0.34±0.02a	0.86±0.01a
Significance	n.s	n.s	n.s	n.s	n.s
NCG					
0	12.63±1.66a	14.82±1.95a	0.42±0.06a	0.49±0.06a	0.85±0.01a
2	9.07±1.14b	10.48±1.32b	0.29±0.04b	0.33±0.05b	0.87±0.01a
4	8.66±0.79b	10.1±0.91b	0.27±0.03b	0.31±0.03b	0.86±0.01a
6	8.81±0.71b	10.26±0.84b	0.27±0.02b	0.31±0.03b	0.86±0.01a
Significance	*	*	*	*	n.s
NCG Urea ×					
T1	14.41±3.06a	16.79±3.64a	0.48±0.1a	0.56±0.12a	0.86±0.01a
T2	10.04±2.3ba	11.61±2.67ba	0.32±0.08ba	0.37±0.09ba	0.86±0.02a
T3	7.19±0.3b	8.4±0.41b	0.21±0.01b	0.25±0.01b	0.86±0.01a
T4	9.66±1.26ba	11.25±1.52ba	0.3±0.04b	0.35±0.05b	0.86±0.01a
T5	10.85±1.18ba	12.86±1.37ba	0.36±0.03ba	0.42±0.04ba	0.84±0.01a
T6	8.09±0.42b	9.34±0.43b	0.25±0.02b	0.29±0.02b	0.87±0.01a
T7	10.12±1.16ba	11.81±1.33ba	0.32±0.03ba	0.38±0.04ba	0.86±0.01a
T8	7.97±0.52b	9.26±0.6b	0.24±0.03b	0.28±0.03b	0.86±0.01a
Significance	*	*	*	*	n.s

Different litters in same column means significant differences
n.s : non-significant, * Significant differences at level 0.05
T1= 0 (gm/ day) NCG, 0% urea; T2 = **2** (gm/ day) NCG, 0% urea
T3= 4 (gm/ day) NCG, 0% urea; T4 = **6** (gm/ day) NCG, 0% urea
T5= 0 (gm/ day) NCG, 1% urea; T6 = **2** (gm/ day) NCG, 1% urea
T7= 4 (gm/ day) NCG, 1% urea ; T8 = **6** (gm/ day) NCG, 1% urea

Conclusions

The results of feeding N-carbamylglutamate (NCG) for Awassi lambs leads to increase feed efficiency, increase daily gains and total weights, and improve the productive characteristics of lambs and can be substituted urea instead of soybean meal with the addition of NCG without negative effects on animal.

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