IMPACTS OF CONCENTRATE FEEDING LEVEL WITH OR WITHOUT N-CARBAMYLGLUTAMATE ON PRODUCTIVE PERFORMANCE OF GOATS

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ABSTRACT

This study was conducted to evaluate the effect of feeding three levels of concentrate 2%, 3%, and 4% with or without additives of N-carbamylglutamate (NCG) on the digestibility, feed efficiency, and daily gain of Shami goats. Twenty-four male goats were used aged 8-10 months with an initial weight 32.687 ± 1.52kg divided into six treatments in a 2×3 factorial experiment/ Completely Randomized Design. Individual feeding was used for 70 days preceded by 14 days as an adaptation period. The results of increasing concentrate showed a non-significant increase in nutrients intake with superiority of NCG treatments and a significant increase (P<0.01) of ether extract intake. Non-significant increase in digestibility with increasing feed intake. Significant increases (P<0.01) in total and daily gain of 3% concentrate with or without NCG and non-significant increases for final weight. The better feed efficiency with 3% concentrate then 2% and 4% respectively. In conclusion: A level of feeding 3% had a positive effect on animal performance and the best for fattening.

Keywords: high concentrate, digestibility, feed additives, daily gain, ruminant.
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تأثير مستوى تغذية العلف المركز مع وبدون N-carbamylglutamate في الأداء الإنتاجي للماعز

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المستخلص

أجريت هذه الدراسة لتقويم تأثير استهلاك ثلاثة مستويات من العلف المركز 2٪، 3٪ و4٪ مع وبدون N-carbamylglutamate(NCG) على معامل الهضم، كفاءة التحويل الغذائي والزيادة الوزنية اليومية للماعز الشامي. أستخدم أربعة وعشرين من ذكور الماعز تتراوح أعمارهم بين 8-10 أشهر ووزن ابتدائي 32.687 ± 1.52 كغم مقسمة إلى ست معاملات في تجربة عاملية 2 × 3 / تصميم عشوائي كامل. استخدمت التغذية الفردية لمدة 70 يومًا سبقتها 14 ايام فترة تمهيدية. أظهرت نتائج زيادة العلف المركز زيادة غير معنوية في تناول العناصر الغذائية لصالح معاملات الـ NCG وتفوق عالي المعنوية (P<0.01) في تناول مستخلص الإيثر. وزيادة غير معنوية في معامل الهضم مع زيادة مستوى العلف المتناول. وزيادات معنوية (P<0.01) للزيادة الوزنية الكلية واليومية لمستوى العلف 3٪ مع وبدون الـ NCG وتفوق غير معنوي في الوزن النهائي. أفضل كفاءة تحويل غذائي عند تناول العلف بنسبة 3٪ ثم 2٪ و4٪ على التوالي. نستنتج ان مستوى التغذية 3٪ ذو تأثيرات ايجابية على أداء الحيوان والافضل للتسمين.

الكلمات المفتاحية: مستوى مرتفع علف مركز، معامل الهضم، إضافات غذائية، زيادة وزنية يومية، مجترات.
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INTRODUCTION

All researchers or producers aim to improve feed efficiency by synchronizing the degradation of protein with energy to reduce feed costs and increase production. Increasing concentrate level leads to insignificant increase in nutrient intake, low chewing, low rumen pH, and transfer blood bicarbonates reserve as rumen and blood pH were inversely related (14). High concentrate intake increased rumen volatile fatty acids (VFA's), ammonia, total bacteria, reduced acetate to propionate ratio and lowered production of methane without decreasing ruminal pH or dry matter intake and fiber digestibility (15). Hook et al. (18) stated that the high concentrate means highly fermented carbohydrates and leads to ruminal acidosis, especially in dairy cattle. The differences result due to adaptation period, type of feeds, crude fiber content, and individual differences between farm animals. To avoid these differences, additives are provided to enhance production without negative effects on animals like, Khalid and Al-Anbari (22) referred to enhance milk yield by adding 150 ml/ day glycerol to the rations of Holstein cows, while adding vitamin E enhanced growth (20), and adding fat-soluble vitamins pre- and post-mating of ewes led to improve the reproductive performance (1), and adding ajwain seeds to the rations enhance health and growth performance (12), while adding N-carbamylglutamate (NCG) leads to decrease blood urea (2; 3). NCG was used in agriculture to enhance the production of arginine or multiple amines and regulation of metabolism (27). NCG is safe for physiological functions, non-toxic, and without side effects (17). The NCG is low degraded in the rumen, and doesn't cause any nutritional complications with amino acids like lysine, tryptophan and histidine. It is considered an effective and inexpensive alternative supplement to arginine (35). The NCG is used with urea to decrease the stress of urea on ruminants (25). Urea is a cheap source of nitrogen, fast rumen degraded to ammonia, and is widely used in ruminant feeding, with preferably to treated the by-products with urea for positive increase rumen bacterial and fermentation characteristics (5) to reduce the dependence on protein concentrates (26) and improve the nutritional value of roughages (8), with attention to rapid hydrolysis to NH3-N by rumen microorganism's enzymes within 2h (19) and must be synchronized with rapid hydrolysis VFA's. Therefore, this study aimed to evaluate the use of N-carbamylglutamate (NCG) with different levels of concentrate, 2%, 3%, and 4% as a dry matter of live body weight on digestibility and productive performance of Shami goats.

MATERIALS AND METHODS

The ingredients of concentrated feed included: 55% barley, 31.5% wheat bran, 10% corn, 1.5% urea, and 2% mineral and vitamins. Chemical composition of concentrate and alfalfa hay (Table 1) as AOAC (6). The concentrate was fed at three levels, 2%, 3%, and 4% of body weight as a DM basis, while alfalfa hay was provided ad libitum with remaining.

Table 1. The proximate analysis of concentrate diet and alfalfa hay (%) as DM basis

Ingredients	Concentrate	Alfalfa hay
Dry matter (DM) %	92.02	85.17
Organic matter (OM) %	94.93	91.41
Crude protein (CP) %	14.90	15.54
Ether extract (EE) %	3.23	1.85
Crude fiber (CF) %	6.95	24.83
Inorganic matter (ash) %	5.07	8.59
Nitrogen free extract (NFE) %	69.85	49.18
*Metabolic energy (Me) (MJ/kg DM)	12.91	10.57
pH value	6.35	6.41

*Me (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fiber + 0.014 × nitrogen free extract (24)

Experimental animals and management

Twenty-four Shami goats males, aged 8-10 months and weighing 32,687 ± 1.52kg were randomly distributed to six treatments of three levels of concentrate 2%, 3%, and 4% of live body weight as DM basis with or without 6gm NCG/ head/ day. Clean water was provided. Individual feeding was conducted for 70 days preceded by 14 days as an adaptation period. The vaccines were provided under veterinary supervision. Alfalfa hay offered ad-libitum with remaining. Residual feeds were recorded to calculate daily intake and daily fecal were collected and weighted for five days to determine the digestibility of nutrients. All animals were weekly weighted before morning feeding to monitor live weight changes.

Statistical analysis: Three levels of feeding concentrate with or without NCG were statistically analyzed using a 2 × 3 factorial

experiment, a completely randomized design (CRD). One-way ANOVA analysis was performed using a statistical program (30). Duncan's multiple range test was used to determine significant differences ($p<0.05$) and ($P<0.01$) among treatments (11) using the following formula:

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

RESULTS AND DISCUSSION

Feed intake and digestibility: The increasing level of feeding showed a significant increase ($P<0.01$) for ether extract intake and a non-significant increase for all other nutrient intakes with superiority of NCG treatments (Table 2). Serment et al. (31) found that goats fed high levels of concentrate for 10 weeks led to reduced feed intake to the same as goats fed low levels, and referred to no significant differences in dairy goats having different levels of feeding. Reducing feed intake is a mechanism of adaptation by the goats to avoid the problems of rumen acidity as a result of feeding high concentrate, and the goats developed a kind of refusal to feed due to their severe acidosis (10). Al-Mamouri and Al-Ani (4) fed lambs 3% of complete feed diet consisting of three levels of concentrate to `alfalfa hay: 70%: 30%, 50%: 50%, and 30%: 70% and the high concentrate treatment has the superiority ($P<0.01$) for lamb performance and digestibility of nutrients. The effect of concentrate level with or without N-carbamylglutamate (NCG) on the digestibility of dry matter and nutrients are shown in table (3). The digestibility of metabolic energy was increased ($P<0.05$) in all treatments as compared with the fourth treatment (T4). In general, rumen digestibility controls feed intake and increases with high concentrate to meet their requirements for basal metabolism and production. Al-Mamouri and Al-Ani (4) stated that high concentrate treatment had better digestibility in contrast with low level, without exceeding 3% concentrate as DM basis of live body weight. Haddad et al. (16) indicated no differences between DM and OM digestibility of daily nutrient intake for different levels of concentrate. Kaya et al. (21) referred to no effect for the level of feeding in fattening lambs on nutrients digestibility, while crude protein digestibility increased ($P<0.05$) with increasing dietary crude protein from 10% to 16%. In dairy cows, a low level of feeding leads to a decrease in the digestibility of dry matter, organic matter, crude protein, and crude fiber (7), to meet the requirements of milk production, and the negative main effect of low concentrate due to lower dietary protein intake (36). In addition, the various effects of feeding levels on digestibility due to the differences in experimental conditions, animals, digestibility of nutrients, crude fiber content, and the activity of microorganisms in the rumen (9).

Table 2. Effect of concentrate level with or without N-carbamylglutamate on feed intake (g/day) (mean±SE)

Tret	DM	OM	CP	EE	CF	Ash	NFE	Me*
T1	1166.0±104.8	1099.9±95.0	176.5±15.8	31.1±2.9ab	164.5±13.4	75.6±6.5	717.3±66.6	13.9±1.2
T2	1467.5±170.8	1378.8±160.6	221.2±25.7	41.9±4.9ab	174.2±19.2	88.6±10.1	941.2±110.7	17.9±2.1
T3	1512.2±150.4	1423.8±141.4	227.4±22.6	44.2±4.3ab	164.5±17.6	89.3±9.8	987.6±96.8	18.7±1.8
T4	1122.0±119.2	1084.7±112.0	170.1±17.9	29.8±3.3b	160.8±14.5	73.1±7.2	687.8±76.1	13.3±1.4
T5	1439.2±181.6	1351.8±171.0	217.0±27.3	40.8±5.2ab	173.2±20.4	87.5±10.7	920.4±117.8	17.6±2.2
T6	1558.5±166.7	1421.0±156.2	234.1±24.9	45.1±5.0a	176.6±16.5	92.4±9.3	1009.7±111.5	19.2±2.0
Sign	NS	NS	NS	**	NS	NS	NS	NS

****Different litters in the same column means significant differences (P<0.01); NS= non-significant differences; Me*=MJ/ day; T1 = 2% concentrate, 0 NCG; T2 = 3% concentrate, 0 NCG; T3 = 4% concentrate, 0 NCG. T4 = 2% concentrate, 6 (g/day) NCG; T5 = 3% concentrate, 6 (g/day) NCG ; T6 = 4% concentrate, 6 (g/day) NCG .**

Table 3. Effect of concentrate level with or without N-carbamylglutamate on digestibility of nutrients and metabolizable energy (%) (mean ± SE)

Tret	DM	OM	CP	EE	CF	Ash	NFE	Me	TDN
T1	73.39±1.8	77.69±1.7	84.02±1.7	70.76±10.3	62.04±0.5	69.28±4.8	76.49±2.9	91.16±0.8ab	75.39±2.2
T2	82.74±2.5	85.24±2.3	85.69±2.5	84.40±6.0	67.06±4.0	74.28±2.0	82.66±2.8	92.46±1.0ab	81.21±2.5
T3	82.16±3.7	84.77±3.7	86.76±1.2	75.17±9.0	70.36±5.0	65.56±8.1	83.65±2.8	94.11 ±0.2a	82.35±2.7
T4	81.58±3.3	84.06±3.2	86.44±1.2	82.96±2.6	70.27±5.4	69.81±4.2	82.59±2.7	90.40 ±0.8b	81.31±2.5
T5	81.01±2.1	83.62±2.1	87.64±0.7	87.35±5.1	62.07±4.2	69.66±0.6	81.61±1.8	92.35±0.8ab	80.35±2.0
T6	79.40±2.3	81.94±2.6	86.67±0.6	80.39±8.7	63.09±2.9	70.24±3.8	80.26±2.3	92,91±1.2ab	78.88±1.9
Sign	NS	NS	NS	NS	NS	NS	NS	*	NS

***Different litters in the same column means significant differences (P<0.05); NS= non-significant differences; T1 = 2% concentrate, 0 NCG; T2 = 3% concentrate, 0 NCG; T3 = 4% concentrate, 0 NCG. T4 = 2% concentrate, 6 (g/day) NCG; T5 = 3% concentrate, 6 (g/day) NCG ; T6 = 4% concentrate, 6 (g/day) NCG .**

Growth performance and feed efficiency

The results of feeding three levels of concentrate with or without N-carbamylglutamate on growth performance showed non-significant differences among treatments in initial weight (Table 4), that's because of randomized distribution at the beginning of the experiment and led to a reduction in variation between treatments. Final weight showed a non-significant increase with increasing feeding level, with superior 3% concentrate indicated to the excellence of using 3% concentrated feed and its superiority over 4%, which causes wastage in feed and high production cost (Table 4). The 2% concentrate had negative effects on the quantity of production and leads to economic loss. This meant that the increase or decrease in providing feed to the animal led to economic loss. While daily and total gain for the treatments T2 and T5 or level feeding 3% with and without NCG was increasing significantly (P<0.01) compared to other treatments. Weekly gain referred to linear superiority to the level of feeding 3% with or without NCG in comparison to 2% and 4% levels (figure 1). Mahdi et al. (25) referred to increasing the final weight of lambs fed three levels of NCG 2, 4, and 6gm/day with superiority treatments of 1% urea, because of enhancing protein availability for maintenance and production. The increasing dietary protein leads to enhance protein availability and increase growth performance (29; 32) and final weight (28).

Table 4. Effect of concentrate level with or without N-carbamylglutamate on daily gain (g/day), final and total weight (kg) (mean ± SE)

Treat.	Initial weight (kg)	Final weight (kg)	Daily gain (gm/day)	Total gain (kg)
T1	32.62 ±3.83	39.62 ±3.55	100 ±17.25bc	7.00 ±1.20bc
T2	32.75 ±3.88	44.50 ±4.74	167.85 ±17.12a	11.75 ±1.19a
T3	32.62 ±4.00	42.00 ±3.12	133.92 ±13.16abc	9.37 ±0.92abc
T4	32.75 ±3.58	38.12 ±4.05	76.78 ±9.83c	5.37 ±0.68c
T5	32.62 ±3.76	43.75 ±5.56	158.92 ±26.14ab	11.12 ±1.83ab
T6	32.75 ±3.23	42.37 ±4.75	137.43 ±25.31abc	9.62 ±1.77abc
Sign.	NS	NS	**	**

****Different litters in the same column means significant differences (P<0.01); NS= non-significant differences; T1 = 2% concentrate, 0 NCG; T2 = 3% concentrate, 0 NCG; T3 = 4% concentrate, 0 NCG. T4 = 2% concentrate, 6 (g/day) NCG; T5 = 3% concentrate, 6 (g/day) NCG; T6 = 4% concentrate, 6 (g/day) NCG.**

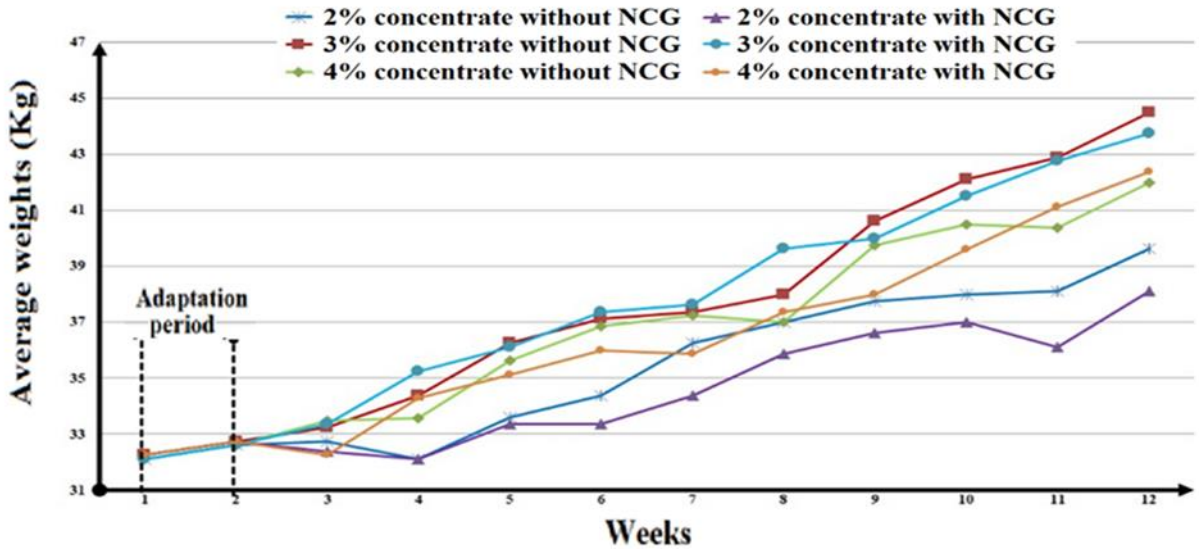

Figure 1. Average weekly weights of goats (Kg)

The results of feed efficiency supported growth response with a non-significant increase of 3% concentrate with and without NCG (Table 5). These results indicated the excellence of using a 3% level of feeding in contrast with 2% and 4% levels. We found feed efficiency was 6.32 and 6.58 for T2 and T5 in contrast with 8.2, 9.34, 8.62, and 9.05 for T1, T3, T4, and T6 respectively. Protein efficiency to daily gain was the best for 3%

concentrate 1.31 and 1.39 for T2 and T5 in contrast with 2.09, 1.8, 2.24, 1.8 for T1, T3, T4, and T6 respectively. While energy to protein intake increased (P<0.01) with increasing level of concentrate. These results confirmed that increasing concentrate (4%) leads to fat participation in the body, which needs more energy than lean (23). Mahdi et al. (25) referred to the same results and feed efficiency improved in lambs fed NCG. Wang et al. (33) reported decreased feed efficiency in goats fed low-level concentrate due to fed low protein and unmet amino acids requirements for protein synthesis and growth, the same result as Estrada et al. (13) and Wang et al. (34) when referred to better growth performance when lambs fed a high level of protein in contrast with low level.

Table 5. Effect of concentrate level with or without N-carbamylglutamate on feed efficiency (mean ± SE)

Treat	Concentrated feed intake/ daily gain	Total feed intake/ daily gain (gm/day)	Metabolic energy intake (KJ/day)/ daily gain (gm/day)	Protein intake/ daily gain	Energy intake (KJ/day) / Crude protein (gm/day)
T1	8.20 ±2.59	13.88 ±4.52	0.16 ±0.05	2.09 ±0.68	0.078±0.0d
T2	6.32 ±0.46	8.74 ±0.57	0.10 ±0.00	1.31 ±0.08	0.080±0.0bc
T3	9.34 ±1.83	12.00 ±2,44	0.14 ±0.03	1.80 ±0.36	0.082±0.0a
T4	8.62 ±0.64	14.83 ±1.05	0.17 ± 0.01	2.24 ±0.16	0.078±0.0d
T5	6.58 ±0.29	9.25 ±0.47	0.10 ±0.00	1.39 ±0.07	0.080±0.0c
T6	9.05 ±1.41	12.04 ±1.82	0.14 ±0.02	1.80± 0.27	0.081±0.0ab
Sign.	NS	NS	NS	NS	**

****Different litters in the same column means significant differences (P<0.01); NS= non-significant differences; T1 = 2% concentrate, 0 NCG; T2 = 3% concentrate, 0 NCG; T3 = 4% concentrate, 0 NCG. T4 = 2% concentrate, 6 (g/day) NCG; T5 = 3% concentrate, 6 (g/day) NCG ; T6 = 4% concentrate, 6 (g/day) NCG .**

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CONTRIBUTIONS OF AUTHORS

All the authors read and commented on the draft versions, and agreed to the published version of the manuscript, and there are no conflicts of interest.

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