Effect of adding low degradable nitrogen and energy to the ration on growth performance and some rumen liquid measurements of Awassi lambs.

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Abstract

This study was conducted at the Animal Production Fields, College of Agriculture and Forestry, University of Mosul, Iraq, to investigate the effect of supplementing low-degradable nitrogen (slow-release urea) and energy (slow-release glucose) in the diet on growth performance and selected rumen fluid parameters in Awassi lambs. A total of 24 Awassi lambs, aged 5–6 months with an average body weight of 23 ± 1.18 kg, were used in the experiment. The animals were randomly allocated into four groups, each consisting of six lambs.

All lambs were fed a standard diet composed of crushed barley, soybean meal, wheat bran, and wheat straw. A mixture of slow-release urea and slow-release glucose (1:1) was added at levels of 0, 10, 20, and 30 g/animal/day for the four experimental treatments. The results indicated no significant differences in final body weight, total weight gain, or daily weight gain among the treatments. However, a significant difference ($P \leq 0.05$) was observed in hot carcass weight in the fourth treatment, which reached 22.41 kg.

Total fat weight was also significantly higher in the fourth and third treatments compared with the first and second treatments, reaching 3.57, 3.22, 4.74, and 4.82 kg for the four treatments, respectively. In addition, significant increases were observed in some edible carcass parts. Liver weight was significantly higher in the fourth treatment compared with the second treatment, averaging 0.75 kg versus 0.52 kg. Similarly, kidney weight showed significant increases in the fourth and third treatments (0.13 and 0.12 kg, respectively) compared with the second treatment and the control group (0.09 and 0.10 kg, respectively).

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Chemical analysis of meat samples revealed significant increases in both fat and protein percentages. The fat percentage was higher in the fourth and second treatments (17.90% and 17.92%, respectively) compared with the control group (14.52%). Likewise, protein content was higher in the fourth, third, and second treatments (18.75%, 18.37%, and 19.61%, respectively) compared with the control group (16.10%).

Furthermore, significant differences were observed in bacterial counts two hours after feeding. The fourth treatment recorded the highest bacterial count (260×10^4 /ml) compared with the third treatment (120×10^4 /ml). The fourth treatment also showed higher concentrations of amino acids in meat samples compared with the control group.

These results suggest that supplementation of diets with higher levels of slow-release urea and slow-release glucose may yield positive outcomes in terms of economic efficiency, carcass characteristics, rumen fluid parameters, and meat palatability, likely due to the increased levels of amino acids.

Keywords:
Awassi lambs, slow-release urea, slow-release glucose, rumen fluid, amino acids, blood biochemical parameters.

Introduction

Livestock production plays a crucial role in enhancing national income by providing a wide range of animal products required for human consumption and various industrial uses. In Iraq, the total livestock population has reached 20,426,481 head, with sheep representing approximately 80% of the total livestock sector. The number of sheep is estimated at 16,520,727 head, of which 5,270,816 head are located in Nineveh Governorate, accounting for about 32.43% of the total sheep population in Iraq (31).

Nutrition represents one of the primary factors influencing the economic returns of animal production farms due to fluctuations in feed costs across different seasons. However, this effect can become positive when appropriate and balanced feeding conditions are provided, allowing animals to achieve optimal productive performance. In fattening enterprises, producers aim to

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obtain the maximum amount of muscle tissue at the lowest possible cost while maintaining an acceptable proportion of fat in the carcass to meet consumer preferences. Red meat and its products constitute an essential component of the human daily diet, as they provide high nutritional value through their content of minerals, vitamins, energy, protein, and fatty acids. Consequently, the growing demand for meat serves as a significant incentive for producers to enhance both the quantity and quality of animal growth and meat production (34).

Nutrition also exerts a major influence on animal production systems, as feeding costs constitute a substantial proportion of total production expenses, which may reach up to 75% of the overall project cost (23). Urea is considered one of the most important nitrogen sources used as a feed additive in ruminant diets, as rumen microorganisms can utilize it to synthesize microbial protein, which is subsequently digested in the small intestine (14). Nevertheless, urea is typically used at low inclusion levels due to its rapid conversion into ammonia, which limits the efficiency of its utilization. Moreover, its rapid degradation may lead to ammonia toxicity when supplied at high levels (4). For this reason, many studies have avoided increasing the levels of conventional urea in ruminant diets (47). In addition, the rapid degradation of urea in the rumen may reduce its utilization efficiency and represent a metabolic burden for ruminant animals (30).

Minogen is a synthetic nitrogen compound characterized by slow degradation. It is coated with lipid materials that gradually degrade in the rumen over a period of eight hours or more, allowing a more efficient utilization of available energy compared with conventional rapidly degradable urea. This property enables its use as a partial substitute for expensive protein sources, particularly cereal grains (17).

Glucose represents a fundamental source of energy derived from animal feed and is essential for animal growth, productivity, and health (35). Improving glucose metabolism can enhance feed conversion efficiency, improve growth performance, and strengthen resistance to metabolic disorders and stress. Therefore, maintaining glucose balance in farm animals is of considerable importance (28). However, due to ruminal fermentation processes, most soluble sugars and starches in low-starch diets are fermented in the rumen into volatile fatty acids. Consequently, very little glucose reaches the small intestine for absorption (41). To

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overcome this limitation, slow-release glucose (Minoclo) has been developed. This product consists of glucose coated with palm oil in the form of white, water-insoluble granules designed to reduce its degradation rate in the rumen and thereby improve its utilization.

Materials and Methods

This experiment was conducted using 24 male Awassi lambs to evaluate the effects of supplementing slow-release urea (Minogen) and slow-release glucose (Minoclo) on growth performance and selected rumen and blood characteristics. The lambs were 5–6 months of age with an average body weight of 23 ± 1.18 kg. The experimental period lasted 90 days.

During the adaptation period, which lasted 15 days, the animals were fed a basal diet composed of barley, wheat bran, soybean meal, sodium chloride, limestone, and wheat straw (Table 1). After the adaptation period, slow-release urea and slow-release glucose were added to the diet at a ratio of 1:1 at levels of 0, 5, 10, and 15 g/animal/day for the four treatments. Feed was offered twice daily at 06:00 a.m. and 06:00 p.m. throughout the 90-day experimental period, and water was provided ad libitum.

The first group (control) received the basal diet without any supplementation. The second group received the basal diet supplemented with 5 g slow-release urea and 5 g slow-release glucose per animal per day. The third group received the basal diet supplemented with 10 g slow-release urea and 10 g slow-release glucose per animal per day. The fourth group received the basal diet supplemented with 15 g slow-release urea and 15 g slow-release glucose per animal per day.

Rumen fluid samples were collected at two sampling times. The first sampling was performed before feeding after feed withdrawal for 12 hours. The second sampling was conducted two hours after feeding. Rumen fluid was collected using a suction pump, and the pH value was measured immediately using a pH meter. The samples were then filtered through medical gauze. According to the Breed's method, as described by (40) and (12), the samples were diluted by adding one part rumen fluid to nine parts formalin and stored in tightly sealed plastic containers under refrigeration until laboratory analyses were performed for bacterial and protozoal counts.

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For ammonia concentration determination, following the procedure described by (13), 20 ml of rumen fluid were mixed with 1 ml of dilute hydrochloric acid and stored in plastic containers at −18 °C until analysis.

Blood samples were collected during the tenth week of the experiment following the method described by (33). Approximately 5 ml of blood were drawn from the jugular vein of each lamb using a 5-ml sterile syringe. The samples were placed in dry test tubes without anticoagulants and immediately transported to the laboratory. Serum was separated from blood cells using an electric centrifuge at 4000 rpm for 5 minutes, after which biochemical analyses were conducted on the serum samples.

Slaughter procedures were carried out after a 12-hour fasting period. Hot carcass weights were recorded, and the weights of the compound stomach and intestines were measured both before and after emptying their contents in order to calculate dressing percentage based on empty body weight. The weights of several edible organs, including the liver, spleen, kidneys, testes, kidney fat, and visceral fat, were also recorded.

Each carcass was subsequently divided into two equal halves. Rib cuts (9–10–11) were separated from the left half of the carcass for physical dissection as described by (18) and (20). The area of the longissimus dorsi muscle (eye muscle area) was measured between the twelfth and thirteenth ribs by tracing the muscle outline on transparent graph paper and calculating the number of squares to estimate the area, as described by (45) and (32).

In addition, the weights of separated fat and tail fat were measured to estimate the total carcass fat. Subcutaneous fat thickness was determined at the twelfth rib using a standard measuring ruler according to the method described by Abdullah and Awawdeh (2004). Dressing percentage was calculated based on hot carcass weight relative to pre-slaughter live weight according to (9)

The concentration of amino acids in meat samples was determined following the method described by Rasmus (21). A 3 g meat sample was placed in a 25 ml volumetric flask, and 25 ml of 1 M hydrochloric acid were added. The mixture was incubated at 55 °C for 3 hours. The sample was then dried using a rotary evaporator, after which 5 ml of sodium citrate buffer (pH 2.2) were added. The sample was filtered using

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a 0.45 µm plastic filter before injection into the analytical instrument.

The experimental data were analyzed using a Completely Randomized Design (CRD) according to the method described by (22), using the following statistical model:

$Yij = \mu + Ti + eij$

Where:
Yij = observed value of the jth observation for the ith treatment
µ = overall mean
Ti = effect of the ith treatment
eij = random error

Statistical analysis included:

- Analysis of variance (ANOVA) for all experimental data
- Duncan's Multiple Range Test for comparison among treatment means (24)
- Significance level set at ($P \leq 0.05$)
- Statistical analyses performed using the SAS software package (version 2000)

Table (1) Ingredients and chemical composition of the experimental diets.

Feed ingredient	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Crushed barley (%)	58	58	58	58
Wheat bran (%)	20	20	20	20
Soybean meal (%)	10	10	10	10
Slow-release urea (g/animal/day)	0	5	10	15
Slow-release glucose (g/animal/day)	0	5	10	15
Wheat straw (%)	10	10	10	10
Salt + limestone (%)	2	2	2	2

- **Chemical composition of the experimental diets**

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Parameter	Treatment 1	Treatment 2	Treatment 3	Treatment 4
Dry matter (%)	93.25	93.25	93.25	93.25
Organic matter (%)	95.45	95.45	95.45	95.45
Crude protein (%)	16.59	16.59	16.59	16.59
Metabolizable energy (kcal/kg feed)	2.553	2.553	2.553	2.553

Results and Discussion

The results presented in Table (2) indicated no significant differences among treatments in final body weight, total weight gain, or average daily gain. The final body weights were 41.91, 40.83, 40.00, and 39.83 kg, respectively. Total weight gain reached 18.91, 17.83, 17.00, and 16.50 kg, while average daily gain was 0.20, 0.19, 0.18, and 0.18 kg/day, respectively. These findings are consistent with those reported by (3), (5), and dos (30). However, they differ from the results obtained by (7) and (26), who observed different responses when using varying levels of slow-release urea.

Table (2) also shows a numerical linear improvement in feed conversion efficiency, which resulted from the improvement in average daily weight gain despite the relatively similar daily feed intake among treatments, as shown in the same table. These results are consistent with those reported by (10), (25), and (37), but they differ from the findings of (7) and (44), who reported different outcomes when applying varying levels of slow-release urea.

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Table (2) Effect of slow-release urea and slow-release glucose on productive performance of Awassi lambs

Trait	Treatment 1 (Control)	Treatment 2 (Minogen 5 g + Minoclo 5 g)	Treatment 3 (Minogen 10 g + Minoclo 10 g)	Treatment 4 (Minogen 15 g + Minoclo 15 g)
Initial weight (kg)	23 ± 0.89	23 ± 1.14	23 ± 1.00	23.16 ± 1.65
Final weight (kg)	41.91 ± 0.80	40.83 ± 2.08	40.00 ± 1.52	39.83 ± 1.49
Total weight gain (kg)	18.91 ± 1.00	17.83 ± 3.07	17.00 ± 1.54	16.50 ± 1.68
Daily weight gain (kg/day)	0.20 ± 0.01	0.19 ± 0.03	0.18 ± 0.01	0.18 ± 0.01
Daily feed intake (kg)	1.38	1.35	1.28	1.21
Feed conversion efficiency (kg feed/kg gain)	6.16	6.90	6.36	5.38

Table (3) shows significant differences ($P \leq 0.05$) in hot carcass weight, particularly in the fourth treatment, which recorded values of 20.50, 18.13, 22.28, and 22.41 kg for the four treatments, respectively. These results are consistent with those reported by (48), (15), (36), and (19). However, they differ from the findings of (3), (38), and (46), who reported no significant differences.

No significant differences were observed in dressing percentage, which reached 48, 48.5, 48.66, and 47.50% for the four treatments, respectively. These results agree with those reported by (3), (38), (48), (15), and (46). However, they differ from the findings of (36), who observed significant differences ($P \leq 0.05$), and from (19), who reported a significant decrease in dressing percentage.

Furthermore, Table (3) shows no significant differences in eye muscle area, which measured 13.36, 14.86, 15.63, and 15.66 cm^2, respectively. These findings are consistent with those reported by (6), (38), (16), and (25).

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Table (3) Effect of slow-release urea and slow-release glucose on some carcass traits

Trait	Treatment 1 (Control) Without additives	Treatment 2 Minogin 5 g + Minoclo 5 g	Treatment 3 Minogin 10 g + Minoclo10g	Treatment 4 Minogin 15 g + Minoclo15g
Hot carcass weight (kg)	20.50 ± 0.40 b	18.13 ± 0.53 b	22.28 ± 1.40 ab	22.41 ± 0.74 a
Dressing percentage (%)	48 ± 0.76	48.50 ± 0.76	48.66 ± 2.90	47.50 ± 0.28
Eye muscle area (cm^2)	13.36 ± 0.52	14.86 ± 0.75	15.63 ± 1.31	15.66 ± 0.41

Table (4) indicates no significant differences in triglyceride concentrations, which were 36.66, 25.00, 20.33, and 23.00 mg/100 ml, respectively. These findings agree with those reported by (6), (11), and (44), but differ from the results of (3) and (10).

Similarly, no significant differences were observed in cholesterol concentrations, which were 53.33, 56.00, 51.66, and 51.00 mg/100 ml, respectively. These results differ from those reported by (3) and (6), who observed significant differences, but are consistent with the findings of (2) and (8), who also reported no significant differences. This may be attributed to improved rumen conditions resulting from the gradual degradation of Minogen and Minoclo, which may contribute to maintaining stable cholesterol levels in the blood.

No significant differences were also observed in blood glucose concentrations among the four treatments, with values of 75.00, 72.33, 73.00, and 85.33 mg/100 ml, respectively. These findings agree with (49) but differ from those reported by (27). The stability in glucose levels may be attributed to the slow degradation of Minoclo, which allows gradual utilization in the body without excessive accumulation in the blood.

Similarly, urea concentrations showed no significant differences, with values of 52.40, 47.10, 41.30, and 53.30 mg/100 ml, respectively. These results agree with (49) and (35), but

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differ from the findings of (27), who reported significant differences.

Additionally, no significant differences were observed in the activities of ALT and AST enzymes. ALT values were 18.10, 17.66, 13.50, and 18.66 IU/L, respectively, while AST values were 118.73, 106.93, 103.03, and 118.90 IU/L, respectively. These enzymes are important indicators of liver health, and the absence of significant differences indicates that the addition of slow-release urea and glucose did not adversely affect liver function. These findings are consistent with the results reported by (43) and (52), but differ from those of (3) and (6).

Moreover, Table (4) shows no significant differences in total protein concentrations among the treatments, which were 5.20, 4.60, 5.10, and 5.86 g/100 ml, respectively. Likewise, no significant differences were observed in albumin and globulin concentrations, which were 3.73, 3.26, 3.46, and 3.66 g/100 ml for albumin, and 1.50, 1.60, 1.86, and 2.36 g/100 ml for globulin. These findings agree with those reported by (49) and (51), but differ from those of (50) and (39), who observed significant differences. Overall, the results indicate that supplementation with slow-release urea and slow-release glucose helped maintain stable blood biochemical indicators without causing undesirable physiological changes, reflecting the efficiency of this feeding system in supporting the physiological performance of lambs.

Table (4). Effect of Slow-Release Urea and Slow-Release Glucose on Some Blood Parameters in Awassi Lambs

Parameter	Treatment 1 (Control) Without additives	Treatment 2 Minogin 5 g + Minoclo 5 g	Treatment 3 Minogin 10 g + Minoclo 10 g	Treatment 4 Minogin 15 g + Minoclo 15 g
Triglycerides (mg/100 ml)	36.66 ± 10.26	25 ± 2.08	20.33 ± 1.45	23 ± 6.24
Cholesterol	53.33 ± 3.52	56 ± 3.46	51.66 ± 8.45	51 ± 4.16

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Parameter	Treatment 1 (Control) Without additives	Treatment 2 Minogin 5 g + Minoclo 5 g	Treatment 3 Minogin 10 g + Minoclo 10 g	Treatment 4 Minogin 15 g + Minoclo 15 g
(mg/100 ml)				
Glucose (mg/100 ml)	75 ± 4.35	72.33 ± 5.20	73 ± 8.14	85.33 ± 1.85
Urea (mg/100 ml)	52.40 ± 3.38	47.10 ± 4.70	41.30 ± 1.80	53.30 ± 6.68
ALT enzyme (IU/L)	18.10 ± 2.17	17.66 ± 7.05	13.50 ± 4.53	18.66 ± 2.33
AST enzyme (IU/L)	118.73 ± 11.37	106.93 ± 3.35	103.03 ± 2.62	118.90 ± 2.33
Total protein (g/100 ml)	5.20 ± 0.11	4.60 ± 0.60	5.10 ± 0.40	5.86 ± 0.43
Albumin (g/100 ml)	3.73 ± 0.12	3.26 ± 0.14	3.46 ± 0.23	3.66 ± 0.29
Globulin (g/100 ml)	1.50 ± 0.05	1.60 ± 0.50	1.86 ± 0.08	2.36 ± 0.26

With regard to amino acids, the results presented in Table (5) demonstrated significant increases ($P \leq 0.05$) in the fourth treatment compared with the control and two and three groups, indicating an improvement in the nutritional value of the produced meat. This increase in amino acid concentrations may be attributed to enhanced microbial protein synthesis, as well as a possible reduction in nitrogen loss within the rumen due to the gradual release of ammonia. These findings support the hypothesis that improving the synchronization between nitrogen and energy sources positively influences the protein composition of meat.

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Table (5). Effect of Slow-Release Urea and Slow-Release Glucose on Amino Acid Concentrations

Amino acid (mg/100 g)	Treatment 1 (Control) Without additives	Treatment 2 Minogin 5 g + Minoclo 5 g	Treatment3 Minogin 10 g +Minoclo 10 g	Treatment 4 Minogin 15 g + Minoclo 15 g
Threonine	40.97 ± 0.67 d	47.03 ± 0.54 c	50.77 ± 0.47 b	56.76 ± 0.18 a
Isoleucine	31.96 ± 0.66 d	39.85 ± 0.30 c	44.48 ± 0.28 b	50.92 ± 0.81 a
Glutamic acid	31.82 ± 1.42 d	39.02 ± 0.62 c	43.27 ± 0.37 b	49.40 ± 0.45 a
Glycine	51.20 ± 0.45 d	59.26 ± 0.60 c	63.10 ± 0.40 b	69.77 ± 0.03 a
Cysteine	40.76 ± 0.56 d	46.87 ± 0.57 c	50.87 ± 0.37 b	58.47 ± 0.27 a
Proline	12.26 ± 0.06 d	15.92 ± 0.32 c	21.67 ± 0.37 b	30.83 ± 0.61 a
Methionine	41.18 ± 0.58 d	46.82 ± 0.59 c	50.78 ± 0.45 b	59.03 ± 0.29 a
Serine	51.94 ± 0.38 d	59.10 ± 0.56 c	62.72 ± 0.52 b	70.70 ± 0.59 a
Leucine	50.12 ± 0.02 d	58.17 ± 0.57 c	63.76 ± 0.35 b	69.47 ± 0.17 a
Lysine	56.08 ± 0.83 d	63.25 ± 0.62 c	69.06 ± 0.26 b	73.22 ± 0.42 a
Tryptophan	30.42 ± 0.22 d	34.70 ± 0.70 c	40.09 ± 0.04 b	45.39 ± 0.49 a
Arginine	25.54 ± 0.44 d	29.07 ± 0.57 c	36.05 ± 0.45 b	40.12 ± 0.02 a
Aspartic acid	36.64 ± 0.34	40.87 ± 0.27	48.45 ± 0.25	52.60 ± 0.05 a

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Amino acid (mg/100 g)	**Treatment 1 (Control) Without additives**	**Treatment 2 Minogin 5 g + Minoclo 5 g**	**Treatment3 Minogin 10 g +Minoclo 10 g**	**Treatment 4 Minogin 15 g + Minoclo 15 g**
	d	c	b	
Alanine	38.17 ± 0.57 d	42.00 ± 0.65 c	49.22 ± 0.42 b	53.34 ± 0.31 a
Phenylalanine	40.92 ± 0.32 d	46.19 ± 0.79 c	49.92 ± 0.32 b	55.17 ± 0.57 a
Histidine	44.17 ± 0.47 d	48.30 ± 0.70 c	53.67 ± 0.47 b	61.17 ± 0.12 a
Valine	29.22 ± 0.62 d	33.02 ± 0.62 c	42.28 ± 0.38 b	49.99 ± 0.11 a

Different letters within the same row indicate significant differences at (P<0.05).

Table (6) showed no significant differences in rumen fluid pH before or after feeding. The pH values before feeding were 7.23, 7.18, 7.10, and 6.73 for the respective treatments, whereas after feeding the values were 6.36, 6.13, 6.41, and 6.37. These findings indicate that the addition of slow-release urea did not significantly influence rumen acidity within the normal physiological range.

Conversely, the table revealed a significant increase (P<0.05) in rumen ammonia concentration before feeding, with recorded values of 7.44, 10.19, 11.36, and 13.52 mg/100 ml, respectively. However, ammonia concentrations after feeding were not significantly affected, reaching 10.18, 10.18, 10.58, and 13.52 mg/100 ml. The observed pattern can be attributed to the improvement in rumen conditions following feed intake, where the availability of readily fermentable carbohydrates increases. This, in turn, enhances microbial activity and their efficiency in utilizing ammonia for microbial protein synthesis. As a result, a dynamic balance is established between the rates of ammonia production and utilization.

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Regarding bacterial counts, no significant differences were observed before feeding, with values of 16.50, 19.00, 16.50, and 16.00 $\times 10^4$ /ml. In contrast, significant differences ($P<0.05$) were observed after feeding, with counts of 164, 202, 120, and 260 $\times 10^4$ /ml, respectively. This finding suggests that rumen microorganisms responded positively to the availability of nitrogen released following feed intake.

As for protozoal numbers, no significant differences were recorded either before or after feeding. The counts before feeding were 5.50, 7.50, 8.50, and 7.00 $\times 10^2$/ml, while after feeding they were 26.00, 10.50, 20.50, and 18.50 $\times 10^2$/ml.

Overall, these results indicate that the use of slow-release urea and slow-release glucose contributed to regulating ammonia release without causing disturbances in rumen pH, while also stimulating bacterial populations after feeding, which may reflect improved microbial fermentation efficiency.

Table (6). Effect of Slow-Release Urea and Slow-Release Glucose on Selected Rumen Fluid Characteristics in Awassi Lambs

Parameter	Treatment 1 (Control) Without additives	Treatment 2 Minogin 5 g + Minoclo 5 g	Treatment3 Minogin 10 g +Minoclo 10 g	Treatment 4 Minogin 15 g + Minoclo 15 g
Rumen pH before feeding	7.23 ± 0.46	7.18 ± 0.11	7.10 ± 0.20	6.73 ± 0.36
Rumen pH two hours after feeding	6.36 ± 0.23	6.13 ± 0.27	6.41 ± 0.13	6.37 ± 0.12
Ammonia before feeding (mg/100 ml)	7.44 ± 2.35 b	10.19 ± 1.01 ab	11.36 ± 0.78 ab	13.52 ± 0.59 a
Ammonia after feeding (mg/100 ml)	10.18 ± 1.17	10.18 ± 0.78	10.58 ± 3.14	13.52 ± 0.20
Bacteria before feeding ($\times 10^4$ /ml)	16.50 ± 1.50	19 ± 3	16.50 ± 1	16 ± 2

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Parameter	Treatment 1 (Control) Without additives	Treatment 2 Minogin 5 g + Minoclo 5 g	Treatment3 Minogin 10 g +Minoclo 10 g	Treatment 4 Minogin 15 g + Minoclo 15 g
Bacteria after feeding ($\times 10^4$ /ml)	164 ± 51 ab	202 ± 13 ab	120 ± 5 b	260 ± 35 a
Protozoa before feeding ($\times 10^2$/ml)	5.50 ± 0.50	7.50 ± 0.50	8.50 ± 0.50	7 ± 2
Protozoa after feeding ($\times 10^2$/ml)	26 ± 5	10.50 ± 1.50	20.50 ± 2.50	18.50 ± 6.50

Different letters within rows indicate significant differences at (P<0.05).

The findings of the present study demonstrate that supplementation with slow-release urea and slow-release glucose improves feed utilization and rumen conditions by maintaining rumen pH, regulating ammonia concentration, and increasing bacterial numbers. These effects collectively contribute to improving rumen environment and productivity while maintaining normal blood characteristics. Further studies are recommended to investigate the effects of Minogin and Minoclo supplementation on milk production in dairy ewes.

Conclusion

The results of the present study demonstrated that supplementation of Awassi lamb diets with slow-release urea (Minogen) and slow-release glucose (Minoclo) did not significantly affect final body weight, total weight gain, or average daily gain. However, the higher supplementation level showed a positive effect on hot carcass weight and some carcass characteristics.

In addition, the supplementation improved certain meat quality traits

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through increasing amino acid concentrations in muscle tissue. The results also indicated that slow-release nitrogen and energy sources contributed to maintaining stable rumen pH and regulating ammonia concentration while stimulating bacterial populations after feeding.

Therefore, the use of slow-release urea and slow-release glucose in lamb diets may represent an effective nutritional strategy to improve rumen fermentation efficiency and enhance meat quality without negatively affecting blood biochemical parameters or animal health.

Further studies are recommended to evaluate the long-term effects of these additives on reproductive performance and milk production in ruminants.

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