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EFFECT OF FOOD RESTRICTION AND PROTECTED AMINO ACIDS ADDITION ON THE COMPOSITION OF AWASSI LAMBS CARCASSES

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ABSTRACT

Feeding systems for fattening lambs are ad-libitum, restricted feeding or mixing between them. This study aimed to investigate the effect of feed restriction during various stages of fattening with the addition of protected essential amino acids, methionine and lysine, on the productive performance in Awassi lambs. Twenty lambs were divided into four groups, the control (group 1, G1) was fed standard diet by 4% of body weight for (90) days. Both G2 and G3 were fed similar to G1 during the first 45 days, lowered to 3.3% during the following 45 days, with the addition of protected methionine 5 gm and lysine 10 gm per lamb daily for the third group only. The fourth group (G4) were fed by 3.3% of body weight during the 90 days and was supplemented with methionine and lysine similar to G3. Results indicated no significant differences between treatments in body weight and total gain in first 45 day of study. While highest total body gain ($P \leq 0.05$) was recorded in (G4) 9.94 kg through the second period, compared with the lowest (G2) 7.75 kg. Carcass weight decreased ($P \leq 0.05$) in (G3) 26.26 kg compared with (G1 and G2). Adding protected amino acids in (G3 and G4) accompanied by a decline in dressing percentage 53.99 and 53.11% ($P \leq 0.05$) compared to (G1 and G2). The total fat percent in the carcass rose in (G3) to 30.94% than other groups. In conclusion, the combination of the restricted feeding system and supplementation of protected amino acids help improve carcass composition by enhancing muscle development while limiting fat deposition resulting in a good quality carcasses with a higher weight and a favorable fat ratio for the customer.

Key words: Carcass, restricted feeding, protected amino acids, lambs.

INTRODUCTION

Using ad-libitum feeding system for fattening lambs affects positively lambs' growth, and therefore, it is the most used feeding program in animal fattening projects. Also, the carcasses produced from this pattern of feeding are usually thick with fat. In order to maximize economic incomes, a restricted feed intake of 10-20% is sometimes followed to reduce feeding costs through forcing animals to reduce maintenance needs and flow rate of food to increase digestion in the digestive tract. Using a mixed feeding system that combines between restricted feeding during

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the first period of fattening, followed by ad-libitum feeding system to exploit the compensatory growth state of the body and thus achieve growth close to ad-libitum feeding at a lower cost (Abouheif *et al.,* 2013; Abouheif *et al.*, 2016; Luzardo *et al.*, 2019). Moreover, feeding system can affect carcasses composition especially the content of protein and fat (Murphy *et al.*, 1994; Atti and Ben 2008; Addah *et al.*, 2017). On the other hand, it is well known that tissue deposition during fattening is closely related to the availability of appropriate nutrients, especially energy and protein.

The appropriate requirements of amino acids is important to achieve a high level of protein synthesis and muscle building during growth or early fattening period. Some amino acids are critical for protein synthesis through growing stage, so they are called limiting amino acids. Methionine considered first limiting amino acid in growing animals because it acts a donor of the methyl group that contribute in deoxyribose nucleic acid and protein methylation and gene expression. As well as methionine may play a role beyond a protein constituent (Wu *et al.*, 2006; Wang *et al.*, 2012). There is evidence that lysine deficiency may limit the synthesis of protein (Li *et al.*, 2007).

Protected methionine and lysine are widely supplemented in ruminant's ration to support tissues with suitable quantities for different physiological needs. Moreover, the ability to improve production performance by adding protected amino acids provides an opportunity to meet sustainability requirements in achieving an environ-ment less polluted by nitrogenous waste and fermentation gases (McCoard *et al.,* 2016; Sajid *et al.,* 2024). We proposed this study to investigate the effect of feed restriction during various stages of fattening with the addition of the protected amino acids methionine and lysine on the productive performance and tissue deposition in Awassi lambs.

MATERIALS AND METHODS

Experiment Location

The experiment was located at the Animal production farm, Department of Animal production, College of Agriculture and forestry, University of Mosul, Iraq.

Animals and Experimental design

Twenty Awassi male lambs were obtained from the local market to be used in this study. Their age was 4 months old, with an initial body weight 30.00±0.26 kg. After an adaptation period lasted for 10 days, lambs were randomly allocated into four groups (5 lambs per group), the 1st group was the control (G1) and fed on basal concen-trate diet by a ratio of 4% of their body weight. The 2nd and 3rd groups were fed 4% concentrate of body weight during the first 45 days of the study and then after 45 days restricted to 3.3% till the end of study and the 3rd group only were supplement with protected methionine (5 gm) and lysine (10 gm) per lamb daily. Lambs in the 4th group were fed with restricted feed of 3.3% of body weight throughout the study period (90 days) with the addition protected methionine (5 gm) and lysine (10 gm) per lamb daily. The concentrate feed ingredients, (Table 2), were purchased from Erbil feed company, Erbil, Iraq. The concentrate feed and roughage feed (wheat straw 250g/lamb/day) were offered two times a day, at (8:00 a.m.) and (04:00 p.m.). In addition, mineral blocks and clean water were continually available. The concentrate feed intake was prepared every week according to the control group.

Table 1: Percentages of nutrients of concentrated diet

Feedstuffs	percentage
Soybean meal	17
Sunflower meal	5
Crushed chickpea	7
Soya bean hulls	4
Yellow corn	20
Wheat bran	10.475
Wheat flour	6.5
Barley	23
Molasses	4
Limestone	1
Ruminant premix	0.5
Salt	1
Appetite	0.025
Sodium bicarbonate	0.5
Total	100
Chemical analysis % of dry matter	
Dry matter	90.34
Crude protein	17.85
Crude fiber	6.82
Crude fat	1.92
Crude Ash	5.15
Nitrogen Free Extract	58.59
Metabolic energy Kcal/k	2799.55

Chemical analysis of feed was done according to (AOAC, 2000) in Erbil Feed Company laboratory.

Slaughtering

Lambs were weight weekly and at the end of fattening period (90 days). After fasting for 12 hr., they were slaughtered in a commercial abattoir. Hot carcasses weight was recorded, as well as tail fat, kidney fat, pelvic fat, mesenteric fat, and heart fat. Different organs (heart, liver, kidneys, lungs, spleen and testicles) were weighed also. In addition to the weight of head, feet and pelt as nonedible parts. Dressing percentages were calculated using the formulas according (Duckett *et al.*, 2007). The carcasses were carefully split longitudinally into two equal parts along the dorsal midline. From the left side of the carcass 9-10-11 ribs were dissection for the physical separation of lean, fat and bone tissues. Likewise, longissimus muscle area and fat thickness were measured at 12th rib, according to the procedure of (Camacho *et al.*, 2017).

Statistical analysis

The data statistically analyzed by the SAS program (SAS, 2003) using the (CRD) design, according to the following model,

Yijk = μ + ti + eijk

Yij: the observations of each value.

μ: the overall mean.

ti: the effect of diet.

eij: the standard error associated with each observation.

The differences between treatments were calculated according to Duncan, (1955).

RESULTS

Results in Table (2) indicated no significant differences between the 4 groups through the first period (1-45 days) of the study in lamb weight 41.10, 43.70, 41.30 and 42.10 kg, as well as in the total gain, the values reached 11.10, 13.40, 11.10 and 12.10 kg, and daily gain 0.246, 0.297, 0.246 and 0.269 in G1, G2, G3 and G4, respectively. During the second period (46-90 days) of the study, the highest total and daily gain ($P \leq 0.05$) 9.94 and 0.22 kg was in (G4). Whereas the lowest total and daily gain, 7.72 and 0.171 kg, was recorded in (G2). After the entire period 1-90 days, there were no significant changes recorded in lambs' weight between the 3 groups (G2, G3 and G4) 51.42, 50.20 and 52.00 kg, and the improved total and daily gain was 8.22, 2.53 and 11.67% compared with control (G1).

Dry matter intake was 1.277, 1.228, 1.129 and 1.075, respectively. The feed conversion ratio improved by 10.15% when restricted feed intake in the (G2) compared to the control. An additional improvement (3.45%) was recorded when the protected methionine and lysine added to the feed in (G3), compared to the (G2). While using restricted feed intake with protected amino acids system through the overall experiment period led to highest improvement in feed utilization reached 24.21% compared with the control.

Table 2: Effect of the restriction and the addition of protected amino acids on productive performance.

Traits	Groups			
	G1	G2	G3	G4
Initial weight. Kg	30.00 ± 1.24	30.10 ± 1.38	30.00 ± 1.37	30.00 ± 0.79
Weight at 45 days. Kg	41.10 ± 1.57	43.70 ± 1.91	41.30 ± 1.37	42.10 ± 0.71
Total gain 1-45 days	11.10 ± 0.73	13.40 ± 1.04	11.10 ± 0.91	12.10 ± 0.68
Daily gain 1 -45 days	0.246 ± 0.016	0.297 ± 0.02	0.246 ± 0.020	0.269 ± 0.014
Weight 90 days. Kg	49.70 ± 1.83	51.42 ± 1.79	50.20 ± 1.61	52.00 ± 1.23
Total gain 45-90. Kg	8.60 ± 0.55 ab	7.72 ± 0.26 b	8.90 ± 0.33 ab	9.94 ± 0.55 a
Daily gain 45-90. Kg	0.191 ± 0.01 ab	0.171 ± 0.02 b	0.198 ± 0.06 ab	0.22 ± 0.012 a
Total gain 1-90 days. Kg	19.70 ± 0.49	21.32 ± 0.92	20.20 ± 0.91	22.00 ± 0.64
Daily gain 1-90 days. Kg	0.218 ± 0.005	0.232 ± 0.01	0.224 ± 0.01	0.244 ± 0.007
Feed intake DM. kg / day	1.277	1.228	1.129	1.075
Feed conversion ratio	5.848	5.254	5.073	4.432

a,b means of the same raw with different subscript are significant (P≤0.05).

Data in Table (3) showed significant decrease in carcass weight in (G3) 26.26 kg, compared with (G1 and G2) 28.88 and 29.41 kg. In general, dressing percentage decreased (P≤0.05) with the addition protected amino acids in (G3 and G4) 53.99 and 53.11%, compared with (G2) 57.71% or (G1) 56.01%. Also, tail fat weight decreased in (G3 and G4) 5.01 and 4.86 kg, compared with control (G1) and (G2) 5.78 and 5.59 kg, however these differences were not significant. Although the decrease in weight of the third group is associated with a decrease in carcass weight, but in the fourth group the carcass weight was close to control, while tail fat was lowered by 0.920 kg, which represents 15.9%. In contrary, the highest mesenteric fat weight was in the (G4) 0.51 kg significantly (p≤0.05) when compared to the lowest (G2) 0.283 kg and merely numerically when compared to the (G1 and G3), 0.365 and 0.420 kg, respectively. A significant increase (P≤0.05) in visceral fat appeared in (G3) 2.33 kg compared to the other groups 0.601, 0.491 and 0.77 kg in G1, G2 and G4, respectively. There was also an increase in fat deposition around the pelvic and kidneys in (G3 and G4), 0.265 and 0.256 kg when compared with (G1 and G2) 0.175 and 0.136, with a significant difference only between G2 and G3. No significant differences between groups in heart and total fat. However, when the relative total fat weight (was calculate as a percent of carcass), we noticed a significant (P≤0.05) increase in (G3) 30.94% when compared with (G2 and G4) 22.25 and 22.92%, but not with (G1) 24.40%.

Table 3: Effect of the restriction and the addition of protected amino acids on some carcass traits

Traits	Groups			
	G1	G2	G3	G4
Carcass weight .kg	28.88 ± 1.01 a	29.41 ± 0.72 a	26.26 ± 0.59 b	28.03 ± 0.79 ab
Dressing percentage %	56.01 ± 0.56 ab	57.71 ± 1.22 a	53.99 ± 0.68 bc	53.11 ± 0.61 c
Fat tail .kg	5.78 ± 0.83	5.59 ± 0.78	5.01 ± 0.57	4.86 ± 0.53
Mesenteric fat.kg	0.365 ± 0.02 ab	0.283 ± 0.01 b	0.420 ± 0.02 ab	0.51 ± 0.10 a
Visceral fat.kg	0.601 ± 0.07 b	0.491 ± 0.11b	2.33 ± 0.23 a	0.77 ± 0.08 b
kidney and pelvic fat.kg	0.175 ± 0.01 ab	0.136 ± 0.03 b	0.265 ± 0.05 a	0.256 ± 0.03 ab
heart fat .kg	0.065 ± 0.01	0.066 ± 0.01	0.092 ± 0.00	0.063 ± 0.00
Total fat.kg	6.98 ± 0.82	6.575 ± 0.78	8.11 ± 0.35	6.451 ± 0.62
total fat to carcass % of the carcass	24.40 ± 2.77 ab	22.25 ± 2.18 b	30.94 ± 1.68 a	22.92 ± 1.93 b

a,b means of the same raw with different subscript are significant (P≤0.05).

Weights of edible organs Table (4), the statistical analysis showed no significant differences between the groups in the case of the weight of liver, lungs, kidneys, testis and heart weight. Also, no significant differences were observed in the total weight of edible parts and its percentage to the animal weight. However, the spleen was the only organ whose weight for the fourth group, 0.115 kg was statistically higher than the control 0.076 kg.

Table 4: Effect of the restriction and the addition of protected amino acids on weights of edible parts.

Traits	groups			
	G1	**G2**	**G3**	**G4**
Liver weight .kg	0.878 ± 0.007	0.996 ± 0.105	0.996 ± 0.054	1.021 ± 0.046
Lung weight .kg	0.631 ± 0.031	0.680 ± 0.082	0.670 ± 0.047	0.526 ± 0.071
Heart weight .kg	0.201 ± 0.013	0.180 ± 0.002	0.195 ± 0.028	0.191 ± 0.007
Spleen weight.kg	0.076 ± 0.003 b	0.091 ± 0.014 ab	0.090 ± 0.007 ab	0.115 ± 0.011 a
Kidney weight .kg	0.120 ± 0.005	0.133 ± 0.018	0.126 ± 0.008	0.140 ± 0.005
Testicles weight .kg	0.306 ± 0.048	0.216 ± 0.008	0.250 ± 0.025	0.306 ± 0.014
Total weight of the edible parts	2.215 ± 0.037	2.300 ± 0.161	2.328 ± 0.110	2.301 ± 0.114
Edible carcass parts % to live weight.	4.39 ± 0.274	4.90 ± 0.501	4.78 ± 0.086	4.359 ± 0.170

a,b means of the same raw with different subscript are significant ($P \leq 0.05$).

The results in Table (5) showed no significant differences between the groups in the rib eye muscle area, the thickness of subcutaneous fat, the fat percentage, the muscle percentage and bone percentage.

Table 5: Effect of the restriction and the addition of protected amino acids on ribs 9-10-11physical dissection.

Characters	Treatments			
	T1	**T2**	**T3**	**T4**
area of rib eye muscle.cm^2	14.66 ± 0.72	16.16 ± 2.64	16.16 ± 0.88	14.00 ± 0.57
subcutaneous fat thickness.mm	1.67 ± 0.16	1.50 ± 0.28	1.43 ± 0.33	1.40 ± 0.05
Percentage of fat	29.33 ± 2.54	31.74 ± 2.64	3١.٩٥ ±2.29	27.95 ± 2.37
Percentage of muscle	43.30 ± 2.23	41.80 ± 2.68	4٢.74 ± 1.65	47.72 ± 1.31
Percentage of bone	27.35 ± 0.40	26.31± 0.81	25.28 ± 1.37	24.31 ± 1.49

Data in Table (6) showed no significant differences in head weight 2.741, 2.667, 2.683 and 2.850 kg, respectively, as well as the feet weight 1.033, 0.916, 0.928 and 0.985 kg, respectively, pelt weight 5.433, 4.850, 4.555 and 5.0116 kg and sum of the nonedible parts 9.208, 8433,8.166 and 8.915 kg respectively.

Table 6: Effect of food restriction and addition of protected amino acids on nonedible parts weight.

Traits	groups			
	G1	**G2**	**G3**	**G4**
Head weight .kg	2.741±0.25	2.667±0.20	2.683±0.09	2.850±0.16
feet weight .kg	1.033±0.09	0.916±0.08	0.928±0.05	0.985±0.02
pelts weight .kg	5.433±0.34	4.850±0.36	4.555±0.45	5.116±0.24
Total inedible parts weight. kg	9.208±0.58	8.433±0.61	8.166±0.59	8.951±0.39

DISCUSSION

The variance in animal performance in different growth traits (Table 2) may be related to genetic differences between individuals that affect fat deposition or health status. The restriction of feed intake in the second treatment during the second half of the study led to a lower weight gain than control due to the fact that domestic animals at these weights tend to deposit fat in a larger amount in the body and this requires higher energy intake per kg weight gain. However, the addition of amino acids in the third treatment gave similar results to the control. Moreover, the fourth group gave the best productive performance during the study periods because protected amino acids could improve the utilization of nitrogen intake (Archibeque *et al.,* 2002; Arriola *et al.* 2014).

With regard to the role of restriction on production performance, the restriction of feed intake of sheep to 85% (Sharifabadi *et al.,* 2016) to 80% (Tayeb, 2008; Roberts *et al.,* 2007; Abouheif *et al.,* 2015), Najdi lambs by 25 and 40% (Sami *et al.,* 2013) resulted in a decrease in final weight and overall weight gain, while the efficiency of feed utilization improved significantly.

In a different view, Shadnoush *et al.* (2011) noted that restricting feed and increasing the amount of feed intake after restriction from 40 to 48 g per kg of body weight led to a significant improvement in weight gain and efficiency of utilization of the feed intake. In general, it can be noted that the restriction ratio and the components of the diet have an important role in the results obtained from previous studies.

Feeding lactating Shami goats with protected methionine in different proportions led to a significant increase in the weights of their bucks at weaning, as well as their weight gain (AL-Qaisi *et al.,* 2014). The weights of Awassi ewes in the stages of milk production were higher when methionine and protected lysine were added to the feed, compared to the control (Kasim *et al.,* 2020).

Supplementation of Arabi lambs with protected amino acids (Kassim *et al.,* 2019; Al-Badri and Hassan 2020), Awassi lambs protected methionine (Almallah *et al.,* 2021) and calves with 10 g/day of protected methionine (Maty 2021) led to a significant increase in their weights, weight gain, as well as an improvement in the efficiency of food conversion at slaughter, compared to the control.

Van Soest (1994) pointed out that the addition of fishmeal in the diet led to an increase in microbial and non-microbial nitrogen flowing into the duodenum because of increased utilization of nitrogen decomposition by rumen. Moreover, it has been shown that amino acids, such as methionine, are mainly involved in metabolic activities in cells and produce carbon mono compounds which contributes to an increase in energy inputs (Bequette *et al.,* 1999, Yin *et al.,* 2016, Bröer *et al.,* 2017), and this may have been achieved in this study in spite of the reduction in nitrogen intake as a result of restricted feeding. Furthermore, the protected amino acids lysine and methionine have a stimulating role in the vital and productive activities in the animal body as well as on the secretion of growth hormone (Amrutkar *et al.,* 2015; Kassim *et al.,* 2019; Gavade *et al.,* 2019). The researchers attributed the reason for the improvement to an increase in the flow of methionine into the intestine and an increase in the efficiency of nitrogen utilization. On the contrary, the results of other studies have shown that the addition of amino acids to the diet led to an insignificant levels of improvement in the final weight, weight gain and efficiency of utilization of food (Oney *et al.,* 2016; Li *et al.,* 2019; Bracena-Gama *et al.,* 2020; Barido *et al.,* 2020; Cabzas *et al.,* 2023; Wang *et al.,* 2023).

The results presented in Table (3), about carcass traits, clearly indicate that the carcass weight was the lowest in G3 than other groups. Whereas surprisingly, it accompanied with the highest percentage of total fat. The dressing percentage also declined in G3 and G4, when compared with G1 and G2. Kassim *et al.* (2019) reported a significant increase in the hot carcass weight of the Arabi lambs which supplemented with 10 g/lamb per day of protected methionine relative to the control group.

These findings align partially with Li *et al.* (2019), who did not observe a significant effect of different propor-tions of protected methionine in the hot carcass weight of lambs. Nonetheless, carcass fat and tail fat increased significantly when fed 6 g of protected methionine/lamb attributing this to the excess of methionine for metabolism and fat deposition. On the other hand, some studies showed that carcass weight, dressing percentage and carcass fat were not affected by the addition of protected amino acids to the ration (Oney *et al.,* 2016, Barcena-Gama *et al.,* 2020, Barido *et al.,* 2020). Other studies have agreed that restricting the feed intake led to a decrease in carcass weight associated with a decrease in the thickness of subcutaneous fat and carcass fat. However, the dressing percentage was not affected significantly (Roberts *et al.,* 2007; Tayeb, 2008; Abouheif *et al.,* 2015). Luthfi *et al.* (2022) showed that the thickness of a reduction in the subcutaneous fat with restricted feeding, although the perineal fat increased, and the intestinal fat remained unaffected by the level of nutrition. It is also worth noting that the minimum percentage of feed intake from body weight equivalent to 4% was probably enough to meet the body's nutritional needs.

The results showed that the percentage of edible organs did not differ significantly among different groups. These findings are consistent with previous studies which reported no significant differences among lambs fed protected methionine (Kassim *et al.,* 2019; Almallah *et al.,* 2021). However, the later reported a significant increase in the weight the testicles and kidneys, compared to the control. However, Luthfi *et al.* (2022) reported that restricting feed intake by 20% led to a noticeable reduction in liver weight.

Through the distribution of tissue ratios in Table (5), feed restriction in the second half of the fattening period in G2 prompted the animals to increase fat deposition at the expense of muscle mass, although the difference was statistically insignificant. The inclusion of protected amino acids in G3 during the same restriction period in the second half of the fattening period did not significantly affect tissue distribution. However, the continuation of a restrictive diet supported with protected amino acids in G4 led to an increase in the muscle mass percentage and a decrease in the percentage of fat in the carcasses.

Most of the studies investigated the addition of protected amino acids agreed that there is no significant change in fat thickness and rib eye muscle area although the numerical increase (Oney *et al.,* 2016; Barceno-Gama *et al.,* 2020; Barido *et al.,* 2020; Cabezas *et al.,* 2023). Likely, Li *et al.* (2019) pointed out that the muscle of rib eye area was not significantly affected by feeding of different levels of protected methionine. However, the thickness of subcutaneous fat increased significantly in case of feeding 6 g methionine/lamb daily, compared to the control. Studies had also indicated a reduction in subcutaneous fat thickness and rib eye muscle area in animals fed restricted feed, compared to ad-libitum feeding (Roberts *et al.*, 2007; Tayeb, 2008; Luthfi *et al.,* 2022) and in the same context with our result. Therefore, the proportions of carcass tissues of fat, muscle and bone did not differ significantly between lamb carcasses that were fed restricted and those fed ad-libitum, but the percentage of fat was lower in the restriction groups (Tayeb, 2008; Sami *et al.*, 2013).

The absence of significant differences between the weights of (head, pelt and feet)

(Table 6) may be attributed to the fact that they are precocious, have a low growth momentum after birth and are not affected significantly by any dietary supplement (Al-Jassim and Al-saigh 1999).

CONCLUSION

It is clear from this study that the adoption of a restricted nutrition system leads mostly to the production of lower weight carcasses with low fat percentage, compared with ad-libitum feeding. In contrast, the addition of protected amino acids supports the metabolism of protein and fat in tissues, leading to the production of higher weight carcasses. The combination of the two factors in the current study help improve carcass composition by enhancing muscle development while limiting fat deposition resulting in a good quality carcass with a higher weight and a favorable fat ratio for the customer. This may be related to the role of protected amino acid to enhance metabolism and keep the weight of the internal organs, especially the liver. This can improve economic return up to 20%, and consistent with the programs of sustainable development in animal production.

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تأثير تقنين الغذاء واضافة بعض الاحماض الامينية المحمية على صفات ذبائح الحملان العواسية

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أنظمة تغذية حملان التسمين تشمل التغذية الحرة، أو التغذية المقيدة، أو المزج بينهما. هدفت هذه الدراسة إلى دراسة تأثير تقييد التغذية خلال مراحل التسمين المختلفة، مع إضافة الأحماض الأمينية الأساسية المحمية، الميثيونين والليسين، على الأداء الإنتاجي لحملان العواسي. تم استخدام عشرين حمل عواسي في هذه الدراسة، قسمت إلى أربع مجموعات، المجموعة الأولى (G1) تم تغذيتها على عليقة قياسية بنسبة ٤٪ من وزن الجسم لمدة (٩٠) يومًا، المجموعتان الثانية والثالثة (G2 وG3) تم تغذيتها بنسبة ٤٪ من وزن الجسم خلال أول ٤٥ يومًا، وخفضت إلى ٣,٣٪ خلال الفترة الثانية (٤٥ يومًا)، مع إضافة الميثيونين المحمي ٥ غرام واللايسين ١٠ غرام لكل حمل يوميًا للمجموعة الثالثة فقط، المجموعة الرابعة (G4) تم تغذيتها بنسبة ٣,٣٪ من وزن الجسم لمدة (٩٠ يومًا) مع إضافة الميثيونين المحمي ٥ غرام واللايسين ١٠ غرام لكل حمل يوميًا. أشارت النتائج إلى عدم وجود فروق معنوية بين المعاملات في وزن الجسم والزيادة الكلية في أول ٤٥ يومًا من الدراسة. بينما سجلت أعلى زيادة في الوزن الكلي ٩,٩٤ كجم في المجموعة الرابعة خلال الفترة ٤٥-٩٠ يوم من الدراسة معنويا ($P \leq 0.05$) مقارنة بالمجموعة الثانية ٧,٧٥ كجم. انخفض وزن الذبيحة معنويا ($P \leq 0.05$) في المجموعة الثالثة ٢٦,٢٦ كغم مقارنة بالمجموعتين (G1 وG2) ٢٨,٨٨ و٢٩,٤١ كجم، أما إضافة الأحماض الأمينية المحمية في المجموعتين (G3 وG4) كان مصحوبا بانخفاض في نسبة التصافي ٥٣,٩٩ و٥٣,١١٪ معنويا ($P \leq 0.05$) مقارنة بالمجموعتين (G1 وG2) ٥٦,٠١ و ٥٧,٧١ %على التوالي، ارتفعت نسبة الدهون الكلية في الذبيحة في المجموعة (G3) إلى ٣٠,٩٤٪ عن المجموعات الأخرى ٢٤,٤٠ و٢٢,٢٥ و٢٢,٩٢٪. لا توجد فروق ذات دلالة إحصائية في مساحة العضلة العينية وسمك الدهون تحت الجلد. وفي الختام، يساعد الجمع بين نظام التغذية المقيدة ومكملات الأحماض الأمينية المحمية على تحسين تكوين الذبيحة من خلال تعزيز نمو العضلات مع الحد من ترسب الدهون مما يؤدي إلى الحصول على ذبيحة ذات جودة جيدة ووزن أعلى ونسبة دهون مفضلة للمستهلكين.