Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

The Influence of Reducing Protein Diet with High Lysine Amino Acid Profile on Growth, Histomorphology, Carcass Characteristics, and Serum Biochemical Parameters in Broilers

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Abstract

This trial assessed the impacts of reducing crude protein (CP) by 1.5% with a high lysine amino acid profile, and adding 5% sunflower meal on broiler chickens' growth, intestinal histomorphology, serum biochemical parameters, and carcass traits. Six treatments (T1 to T6) of three hundred and sixty-day old ROSS 308 chicks were classified into completely random system, with 6 replicates of ten chicks per replicate. Sunflower meal was included at 5% in all groups except the control (T1). The diets were designed to provide the lysine recommended level (100%) for T1 and T2, and increased lysine levels (105%, 110%, 115%, and 120%) for T3 to T6, with the amino acid profile adjusted accordingly. The results revealed no significant variations ($p > 0.05$) in final BW, BWG, feed intake, and FCR. The results of liver, gizzard, abdominal fat, intestine, spleen, and heart percentages also showed non-significant differences. However, the weight of the bursa recorded high ($p < 0.05$) significant results in treatment T6. The results of total cholesterol were significantly decreased in T5 compared to other treatments, while HDL-C levels were highest in T2. Albumin levels were highest in T5, while AST levels were highest in T1 and lowest in T6. Uric acid and urea levels varied significantly, with T1 showing the highest levels. Groups T5 and T6 exhibited significantly wider and longer villi, deeper crypts in the duodenum, in addition to longer villus in the ileum. There were no significant variations in the villi length to crypt depth ratio. Overall, the dietary interventions had no negative impact on broiler performance, serum parameters and intestinal health.

Keywords: Broilers, crude protein, lysine, performance, carcass.

Introduction

Crude protein is a major cost component in poultry feed formulation [1]. To decrease the costs of feed and reduce the excretion of nitrogen (N), thereby minimizing environmental pollution one effective strategy is to reduce CP content while ensuring adequate amino acid (AA) levels [2-5]. Reducing CP can improve intestinal health by decreasing the flow of non-digested protein to the large intestine, which decreases the growth of opportunistic pathogens [6]. Furthermore, reduced CP led to a decrease in daily water intake and reduced litter humidity [7]. However, the efficacy of decreasing protein in the diets of broiler growth has yielded inconsistent results across studies; this is due to several factors including the degree of protein reduction, variations in dietary requirements, different needs for non-essential amino acids, and variations in acid-base balance [8, 9].

The requirements of protein and essential amino acid (EAA) outlined by the NRC (1994) do not fully satisfy the needs of modern broiler chickens for optimal performance. As a result, synthetic amino acids, available in their pure form, are often used in broiler diets to support better growth [10]. One important EAA, lysine is vital for body growth and is essential for protein synthesis [11]. Dietary amino acid balance is critical for broiler performance, as imbalanced ratios can lead to issues such as poor locomotion, feathering, and immune function [12]. Severe amino acid imbalances primarily affect feed consumption, which then influences growth rate and carcass composition [13]. Determining the appropriate lysine requirement is economically essential, because feeding diets lacking or abundant in lysine can lead to poor performance or needlessly high feed costs [14, 15].

Sunflower meal (SFM), a byproduct of sunflower oil extraction, is a cost-effective alternative protein

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(Received 03 March 2025, accepted 06 July 2025)
DOI: 10.21608/ejvs.2025.365275.2672

source compared to soybean meal [16]. Sunflower seeds are grown globally due to their adaptability to various climatic and soil conditions [17]. The increased production of sunflower seeds for oil produced more sunflower meal, offering a more affordable protein alternative to soybean meal, which is unavailable and expensive [18].

The goal of this trial is to discover the impacts of a reducing protein diet supplied with a high lysine amino acid profile, increasing lysine content above the breeder-recommended level, and including sunflower meal as an alternative protein source. The research focused on evaluating how these dietary modifications impacted broiler chickens' performance, histomorphology, carcass traits, and blood parameters.

Material and Methods

Design and housing

Animal Welfare and Research Ethics Committee approved the experiment (permission number: ZU-IACUC/2/F/8/2025) and it was applied at the Center of Nutrition at the Faculty of Veterinary Medicine, Zagazig University, Egypt, according to ethical principles. 360-day old ROSS 308 chicks were weighed at the beginning of the trail and again at the final day of the phase: starter (1-10 day), grower (11-24 day), and finisher (25-35 day) with a protein content of 23%, 21.5%, and 19.5%, respectively. The crude protein content was reduced by 1.5% as 21.5% at starter, 20% at grower, and 18% at finisher. The chicks were assigned to six treatments, each having six replicates of ten birds, in a completely random design. Six treatments (T1-T6) were formulated, with T1 serving as the control. Sunflower meal was included in all groups at 5%, except for the control treatment (T1). The control (T1) and second treatment (T2) were given a diet with the standard lysine level (100%). The lysine increased from T3 to T6 by levels 105%, 110%, 115%, and 120%, respectively. The average temperature was monitored during the trial. The chicks grew up under identical environmental, hygienic, and management circumstances. Vaccinations were administered for Gumboro disease on days 7 and 22 and Newcastle disease on days 4 and 14. Diets were created based on the breed's suggested nutritional requirements, Ross 308 management guide (2022), as demonstrated in Tables (1-3).

Growth

The initial body weight (IBW) of each treatment was detected by weighing each bird separately at the beginning of the trail, and the body weight gain (BWG) for each group was measured by subtracting IBW (W1) from the final BW (W2) at the final day of each period, The amount of feed that was initially supplied was subtracted from the amount of feed that was left over to determine feed intake (FI). By dividing the feed intake (FI) by the body weight gain (BWG), the feed conversion ratio (FCR) was determined [19].

Carcass features

The birds were given drinking water and fasted overnight on the final day of the feeding research. Before and after being killed, each bird was tagged and weighed to detect its live and bled weights. Weighing the liver, heart, and digestive system (including the intestine, gizzard, abdominal fat, bursa, and spleen) and expressing as a percentage of the live body weight was done. The dressing percentage was measured by using the following formula: Dressed weight / live weight × 100%.

Serum parameters measured

Serum levels of total cholesterol [20], triglycerides [21], high-density lipoprotein (HDL) concentration [22], and low-density lipoprotein (LDL) [23] were measured. Additionally, serum total protein [24], albumin [25], and globulin [26] levels were assessed. creatinine, urea, and uric acid concentrations [27] were also determined. Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) levels were analyzed following the method outlined by [28].

Histopathological technique:

Intestine specimens from chickens were immediately preserved in 10% buffered neutral formalin solution for 24 hours, dehydrated in gradual ascending ethanol (70, 80, 95, 95 and 100%), cleared in xylene, and then embedded in paraffin. The longitudinal and transverse sections each of 5 µm thickness paraffin sections were sliced using a Rotatory Microtome (Leica RM 2155, England). The sections were routinely stained with hematoxylin and eosin stains and subjected to microscopical examination [29].

Intestinal histomorphometry

Intestinal crypt depth (CD), intestinal villi width (VW), intestinal villi length (VL), and the VL/CD ratio were measured. These parameters were estimated on 50 well-aligned villi and matching crypts from each part of every intestinal segment and averaged for every bird. The villi widths were measured at the half-height point and their heights were detected from tip to base. A light microscope with a full HD microscopic camera and image analysis program was used to examine the tissue sections. The parameters were detected by an image analysis program for statistical analysis.

Statistical analysis

The data was analyzed by SPSS version 25. Mean ± SE was used to present the results. The Shapiro-Wilk test was used to assess normality after screening the data. Levene's test was employed to

assess variance homogeneity. Welch's ANOVA was performed to find factors that support the homogeneity assumption. To examine changes between groups, one-way ANOVA was employed on data that met the assumption of homogeneity. Tukey's honest significant difference test was used to determine whether the results were significant. Statistical significance was defined as P-values below 0.05.

Results

Growth

As presented in table (4), Overall performance revealed non-significant ($p > 0.05$) variations in final body weight, or body weight gain, feed intake, and feed conversion ratio. When comparing all groups with the control. This suggests that the different experimental diets did not have a measurable impact on these performance traits in the broilers.

Carcass features

As demonstrated in table (5), the % of the liver, intestine, spleen, gizzard, and heart in broiler carcasses was not significantly influenced by dietary measures ($p > 0.05$), Bursa relative weight was higher in T6 ($p < 0.05$).

Serum parameters measured

Table 6 illustrates that variation in total cholesterol levels was significant ($p < 0.05$) among the treatments. T5 (89.25 mg/dl) had significantly the lowest cholesterol levels compared to other groups ($P < 0.05$). T2, T3, T4, and T6 revealed non-significant differences ($p > 0.05$) when compared to the control. Triglycerides and LDL-C showed no significant variation between treatments ($p > 0.05$). T2 (68.5 mg/dl) had the highest HDL-C levels, which were significantly higher ($P < 0.05$) than other groups. T1 (44.5 mg/dl) had the lowest HDL-C levels, significantly lower than all other treatments. Other groups, such as T3, T4, T5, and T6, showed similar HDL-C levels. Total protein and globulin levels were relatively consistent across the treatments with non-significant ($P > 0.05$) variations detected. Albumin levels differ significantly across treatments. T5 (2.7 g/dl) has the highest albumin level, which is significantly higher ($P < 0.05$) than the other treatments. T1 (2.33 g/dl) has the lowest albumin levels. ALT revealed no significant ($P > 0.05$) variations among treatments. AST was significantly different between treatments, T1 (343 U/L) showing the highest level. T6 showed the lowest level ($P < 0.05$). Creatinine levels detected no significant variations ($P > 0.05$) among the treatments. Levels of Uric acid differed significantly ($P < 0.05$) across treatments, T1 (1.99 mg/dl) showing the highest uric acid level and T4 (1.8 mg/dl) showing the lowest. Urea levels were significantly different across the treatments, T1 (45.5 mg/dl) showing the highest urea levels, significantly higher than the other treatments. Treatments 4, 5, and 6 showed relatively lower urea levels ($P < 0.05$).

Intestinal histomorphometry

As shown in table (7) and figure (1):

Duodenum: T5 (1485 μm) and T6 (1479.67 μm) showed the highest villus length, significantly greater than the other treatments ($P < 0.05$). T1 (854.33 μm) had the shortest villi. VW Similar to VL, T5 (189.33 μm) and T6 (191.33 μm) showed the widest villi, significantly larger than T1 (106.67 μm) and T2 (117.33 μm) ($P < 0.05$). T5 (314.67 μm) and T6 (343.67 μm) showed the deepest crypts, significantly deeper than T1 (157.33 μm) and T2 (272.33 μm). T1 exhibited the shallowest crypts ($P < 0.05$). No significant variations were recorded across groups for VL/CD ratio ($P > 0.05$).

Jejunum: treatment 6 (1299.33 μm) had the longest villi, significantly greater than the other groups ($P < 0.05$). T1 (818.33 μm) showed the shortest villi. VW and CD and ratio between them recorded no significant variations ($P > 0.05$) between the groups.

Ileum: treatment 6 (851.67 μm) had the longest villi, significantly greater than control (680.67 μm) and other intermediate groups ($P < 0.05$). T1 exhibited the shortest villi. T6 (281 μm) had the widest villi, significantly greater than T1 (122.67 μm) ($P < 0.05$). VW and CD and ratio between them detected no significant variations ($P > 0.05$) between the groups.

Discussion

Our trial showed no negative impacts on broiler performance, these results aligned with Wang *et al*. [30], who discovered that decreasing dietary crude protein (CP) by1.5%, did not adversely affect broiler performance. Similarly, Shao *et al*. [4] demonstrated that decreasing CP by 2%, while ensuring adequate amino acid (AA) levels, resulted in reduced footpad dermatitis and nitrogen loss without affecting broiler growth or meat quality. Mousa *et al*. [2] also reported that a 1% or 2% lowering in CP, while maintaining standard AA levels, did not alter the performance significantly compared to the control. These results are aligned with those of Shazali *et al*. [31], Shao *et al*. [4], and Van Harn *et al*. [5], who revealed that reducing CP diets (with reductions ranging from 1–3%) and balanced AAs did not influence body weight gain (BWG), feed intake (FI), or mortality in broilers. The absence of significant effects on feed intake can be related to the iso-caloric and iso-nitrogenous nature of the diets across all treatments as suggested by [32]. However, Chrystal *et al*. [33] reported that reducing CP from 21% to 18% did not affect broiler performance badly; moreover, decreasing to 16.5% impaired FCR, even though essential AA levels were adequate. This indicates that extremely low CP levels may begin to negatively affect FCR, even when AAs are sufficiently

provided. Nitrogen retention and sustained growth performance were linked to a crude protein (CP) reduction of 1.62% on average and up to 3.22% on maximum, while maintaining sufficient amounts of amino acids (AA).

Currently, the nutritional needs of modern broilers require the feed to be formulated based on digestible amino acids, particularly because these birds need high lysine during the first two to four weeks of age [35]. Lysine is vital for body development and protein synthesis [11]. The balance of dietary amino acids is vital, as imbalances can negatively impact broiler performance and cause issues such as locomotion, feathering, and immune function problems [12]. Supplementing lysine above the NRC (1994) recommended level has been proven to increase feed consumption and body weight gain (BWG) without affecting the feed conversion ratio (FCR) [10]. About 1.24% digestible lysine is advised for the best BWG during the first 21 days of broiler growth, and 0.97% is enough for the latter 22–42 days without affecting performance [36]. Additionally, adding lysine to broiler diets enhances the ileal digestibility of lysine and other amino acids [37].

Additionally, it was noted that replacing 10–30% of soybean meal with sunflower meal did not impact broiler body weights, although a significant decrease was observed with higher replacement percentages [17, 38]. Other studies reported no effect on broiler performance when sunflower meal replaced 5–20% of soybean meal [39, 40]. These findings support the inclusion of sunflower meal as an effective source of protein in broiler diets.

Characteristics of the carcass are especially crucial for the production of broilers. The current study demonstrated that nutritional diets had no discernible impact on the carcass characteristics of broilers like liver, gizzard, intestine, spleen, and heart percentages. Slaughter body weight and carcass yield, key critical characteristics of economic significance, were unaffected by dietary crude protein (CP) reductions of up to 3.0% [6]. Additionally, other research has demonstrated that lowering the CP level to 17.8% during the grower period and 16.8% during the finisher period did not effect on carcass yield though supplementing diets with free AA. Lambert *et al*. [41] further demonstrated that decreasing CP content to 17% during the grower period and to 15.3% during the finisher period did not negatively impact carcass yield, as long as standardized ileal digestible (SID) lysine was maintained at appropriate levels (1.04% vs. 1.0% in the grower phase and 0.93% vs. 0.95% in the finisher phase).

Serum biochemical parameters are commonly measured to assess both the health and nutritional status of chickens. Hernández et al. [42] found no difference in serum total protein (TP) when broilers were provided with a reduced crude protein (CP) diet. The study of Corzo et al. [43] revealed that TP levels were only influenced when broiler diets were deficient in amino acids (AAs). This suggests that providing the AA requirements is more critical than the CP content itself. However, a study by Law et al. [44] found a significant decrease in serum albumin (Alb) and TP when dietary CP was reduced, with or without exogenous protease. This decline was related to an AA deficiency resulting from reduced feed consumption. Additionally, Wang et al. [30] and Elshafey et al. [45] showed a reduction in serum uric acid (UA) levels when CP content in the diet was decreased. As uric acid is the by-product of the protein breakdown, the reduction in UA was linked to insufficient AA intake, leading to decreased AA catabolism.

Villus and crypts are vital parts of the small intestine, and their structure reflects the intestine's absorptive capacity [46]. Villi height to crypt depth (VH/CD) ratio is a key indicator of gut health in poultry, providing insight into the functionality and overall condition of the intestinal mucosa [47]. Our results showed an improvement in intestinal histomorphology. Increased villus length is linked to enhanced nutrient absorption and digestion, in addition to increased activity of nutritional transport systems and brush border enzymes [48]. Macelline et al. [49] revealed a significant increase in both villus height and crypt depth when broilers were fed a low-protein (LP) diet (18% in the starter phase and 17% in the grower phase) supplemented with commercial amino acids, achieving results identical to those of broilers supplied with high protein diet. This is related to the improvement of the appropriate balance of amino acids which is critical for gut epithelial growth and the synthesis of digestive mucin and secretions. In addition, Abbasi et al. [50] discovered that decreasing dietary crude protein (CP) levels to 18.89% while supplementing threonine at 110% of the required amount led to a significant increase in the height of villi and depth of crypt in the jejunal epithelial cells. This was attributed to enhanced threonine metabolism, which improved the intestinal absorptive surface.

Conclusion

This study revealed that reducing crude protein by 1.5% with a novel amino acid profile based on high lysine levels and inclusion of 5% sunflower meal had no significant impacts on broiler growth and carcass traits however improved the intestinal health and blood biochemical parameters.

Acknowledgments

Not applicable.

Funding statement

This study didn't receive any funding support

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

The Animal Welfare and Research Ethics Committee approved the experiment (permission number: ZU-IACUC/2/F/8/2025).

TABLE 1. Analysis of experimental diets during the starter period.

Ingredients,%	Experimental diets					
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
Yellow corn	52.42	53.65	54.61	55.27	55.73	56.07
Soybean meal, 46%	34.15	29.91	28.82	28.22	28.00	28.00
Sunflower meal	0.00	5.00	5.00	5.00	5.00	5.00
Corn gluten, 60%	5.03	2.00	2.00	1.69	1.13	0.43
Soybean oil	3.00	3.82	3.54	3.39	3.32	3.31
Calcium carbonate	0.37	0.53	0.54	0.54	0.54	0.53
Calcium dibasic phosphate	2.95	2.64	2.64	2.65	2.66	2.66
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Sodium bicarbonate	0.25	0.25	0.25	0.25	0.25	0.25
Premix (Muvco premix)[1]	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine HCL, 78%	0.41	0.51	0.63	0.73	0.83	0.91
DL-Methionine, 98%	0.33	0.38	0.44	0.50	0.57	0.64
L-Threonine, 98.5%	0.13	0.20	0.25	0.32	0.37	0.43
L-Valine, 96.5%	0.02	0.11	0.18	0.25	0.32	0.39
L-Arginine, 95%	0.09	0.15	0.25	0.35	0.44	0.53
Choline chloride, 60%	0.10	0.10	0.10	0.10	0.10	0.10
Antimycotoxin	0.10	0.10	0.10	0.10	0.10	0.10
Anticoccidial	0.05	0.05	0.05	0.05	0.05	0.05
Chemical analysis %						
ME (kcal/kg diet)	2975	2975	2975	2975	2975	2975
Crude protein	23	21.5	21.5	21.5	21.5	21.5
Calcium	0.95	0.95	0.95	0.95	0.95	0.95
Available Phosphrus	0.5	0.5	0.5	0.5	0.5	0.5
D. Lysine HCL	1.32	1.32	1.39	1.45	1.52	1.58
D. Methionine	0.66	0.69	0.75	0.80	0.86	0.91
D. Threonine	0.88	0.88	0.92	0.97	1.01	1.06
D. Methionine + cysteine	1	1	1.05	1.10	1.15	1.20
D-Valine	1	1	1.05	1.10	1.15	1.20
D-Arginine	1.4	1.4	1.4 7	1.54	1.61	1.68

[1]Muvco premix: Each 2.5kg contain vit. A (10, 000000 IU),vit. D3 (2, 000000 IU), vit. E (10 g),vit.k3 (1000 mg), vit. B1 (1000 mg), vit. B2(5 g) ,vit.B6 (1.5 g) , pantothenic acid(10 g) ,vit. B12 (10 mg),niacin(30 g) ,folic acid (1000 mg), biotin(50 g) , fe (30 g) ,Mn (60 g) ,Cu (4 g), I (300 mg), Co(100 mg) , Se (100 mg) and Zn(50 g). T1 (control), T2 (100%lysine), T3 (105% lysine), T4 (110% lysine), T5 (115% lysine), T6 (120% lysine).

TABLE 2. Analysis of experimental diets during the grower period.

Ingredients,%	Experimental diets					
	T1	T2	T3	T4	T5	T6
Yellow corn	55.78	57.67	57.70	58.28	58.81	59.60
Soybean meal, 46%	31.95	26.89	27.38	26.90	26.54	25.61
Sunflower meal	0.00	5.00	5.00	5.00	5.00	5.00
Corn gluten, 60%	4.15	1.71	0.76	0.42	0.00	0.00
Soybean oil	3.63	4.16	4.27	4.15	4.04	3.81
Calcium carbonate	0.30	0.32	0.32	0.32	0.32	0.33
Calcium dibasic phosphate	2.40	2.08	2.09	2.09	2.10	2.10
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Sodium bicarbonate	0.25	0.25	0.25	0.25	0.25	0.25
Premix (Muvco premix)[1]	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine HCL, 78%	0.30	0.42	0.49	0.59	0.68	0.78
DL-Methionine, 98%	0.28	0.33	0.40	0.45	0.51	0.56
L-Threonine, 98.5%	0.08	0.15	0.20	0.25	0.30	0.36
L-Valine, 96.5%	0.00	0.07	0.13	0.19	0.26	0.32
L-Arginine, 95%	0.03	0.10	0.16	0.26	0.34	0.43
Choline chloride, 60%	0.10	0.10	0.10	0.10	0.10	0.10
Antimycotoxin	0.10	0.10	0.10	0.10	0.10	0.10
Anticoccidial	0.05	0.05	0.05	0.05	0.05	0.05
Chemical composition %						
ME (kcal/kg diet)	3050.03	3050.32	3050.03	3050.90	3049.93	3050.10

Ingredients,%	Experimental diets					
Crude protein	21.5	20.01	20.00	20.00	20.00	20.00
Calcium	0.80	0.75	0.75	0.75	0.75	0.75
Available Phosphrus	0.42	0.42	0.42	0.42	0.42	0.42
D. Lysine HCL	1.18	1.18	1.24	1.30	1.36	1.42
D. Methionine	0.60	0.63	0.68	0.73	0.78	0.83
D. Threonine	0.79	0.79	0.83	0.87	0.91	0.95
D. Methionine + cysteine	0.92	0.92	0.97	1.01	1.06	1.10
D-Valine	0.93	0.91	0.96	1.00	1.05	1.09
D-Arginine	1.27	1.27	1.33	1.40	1.46	1.52

[1]Muvco premix: Each 2.5kg contain vit. A (10, 000000 IU),vit. D3 (2, 000000 IU), vit. E (10 g),vit.k3 (1000 mg), vit. B1 (1000 mg), vit. B2(5 g) ,vit.B6 (1.5 g) , pantothenic acid(10 g) ,vit. B12 (10 mg),niacin(30 g) ,folic acid (1000 mg), biotin(50 g) , fe (30 g) ,Mn (60 g) ,Cu (4 g), I (300 mg), Co(100 mg) , Se (100 mg) and Zn(50 g). T1 (control), T2 (100%lysine), T3 (105% lysine), T4 (110% lysine), T5 (115% lysine), T6 (120% lysine).

TABLE 3. Analysis of experimental diets during the finisher period.

Ingredients,%	Experimental diets					
	T1	**T2**	**T3**	**T4**	**T5**	**T6**
Yellow corn	62.61	62.92	63.66	64.48	65.31	66.04
Soybean meal, 46%	25.93	23.67	22.82	21.88	20.91	20.08
Sunflower meal	0.00	5.00	5.00	5.00	5.00	5.00
Corn gluten, 60%	4.33	0.00	0.00	0.00	0.00	0.00
Soybean oil	3.00	4.24	4.02	3.78	3.54	3.33
Calcium carbonate	0.25	0.31	0.31	0.31	0.31	0.31
Calcium dibasic phosphate	2.00	1.67	1.68	1.69	1.70	1.70
Common salt	0.30	0.30	0.30	0.30	0.30	0.30
Sodium bicarbonate	0.25	0.25	0.25	0.25	0.25	0.25
Premix (Muvco premix)[1]	0.30	0.30	0.30	0.30	0.30	0.30
L-Lysine HCL, 78%	0.35	0.40	0.49	0.60	0.69	0.79
DL-Methionine, 98%	0.26	0.33	0.38	0.44	0.49	0.53
L-Threonine, 98.5%	0.08	0.15	0.20	0.24	0.30	0.34
L-Valine, 96.5%	0.00	0.09	0.14	0.20	0.27	0.32
L-Arginine, 95%	0.09	0.12	0.20	0.29	0.38	0.46
Choline chloride, 60%	0.10	0.10	0.10	0.10	0.10	0.10
Antimycotoxin	0.10	0.10	0.10	0.10	0.10	0.10
Anticoccidial	0.05	0.05	0.05	0.05	0.05	0.05
Chemical composition %						
ME (kcal/kg diet)	3100.01	3100.56	3100.13	3100.08	3099.98	3100.34
Crude protein	19.49	18	18	18	18	18
Calcium	0.69	0.65	0.65	0.65	0.65	0.65
Available Phosphrus	0.36	0.36	0.36	0.36	0.36	0.36
D. Lysine HCL	1.08	1.08	1.13	1.19	1.24	1.30
D. Methionine	0.56	0.59	0.64	0.69	0.74	0.77
D. Threonine	0.72	0.72	0.76	0.97	0.83	0.86
D. Methionine + cystiene	0.82	0.86	0.90	0.95	0.99	1.03
D-Valine	0.84	0.84	0.88	0.92	0.97	1
D-Arginine	1.17	1.18	1.23	1.29	1.35	1.40

[1]Muvco premix: Each 2.5kg contain vit. A (10, 000000 IU),vit. D3 (2, 000000 IU), vit. E (10 g),vit.k3 (1000 mg), vit. B1 (1000 mg), vit. B2(5 g) ,vit.B6 (1.5 g) , pantothenic acid(10 g) ,vit. B12 (10 mg),niacin(30 g) ,folic acid (1000 mg), biotin(50 g) , fe (30 g) ,Mn (60 g) ,Cu (4 g), I (300 mg), Co(100 mg) , Se (100 mg) and Zn(50 g). T1 (control), T2 (100%lysine), T3 (105% lysine), T4 (110% lysine), T5 (115% lysine), T6 (120% lysine).

TABLE 4. Performance parameters of broilers fed experimental diets (mean ± SE)

Trait studied*	Treatments + diets					
	(T1)	**(T2)**	**(T3)**	**(T4)**	**(T5)**	**(T6)**
BW (g)	2258.5 ±56.9	2261 ±76.99	2185 ±79	2269 ±69.17	2236.75 ±88.38	2255 ±41.12
BWG (g)	2213.25 ±57.17	2217.15 ±77.05	2140.9 ±79.18	2225 ±69.29	2192.85 ±88.5	2211.15 ±41.08
FI (g)	3226.39 ±19.96	3260.15 ±12.74	3206.1 ±64.28	3290.9 ±33.71	3233.2 ±13.02	3176.95 ±23.57
FCR	1.46 ±.04	1.48 ±.06	1.50 ±.07	1.48 ±.05	1.48 ±.05	1.44 ±.02

[a, b, c] Means on the same row with different superscripts are statistically different at $P<0.05$, according to Tukey's Honesty significant difference test. BW (body weight), BWG (body weight gain), FI (feed intake), FCR (feed conversion ratio).

TABLE 5. Carcass features relative to the live BW of broilers fed experimental diets (mean ± SE)

Traits	Treatments + diets					
	(T1)	**(T2)**	**(T3)**	**(T4)**	**(T5)**	**(T6)**
Live BW (g)	2031.67 ±50.69	2143.33 ±48.85	2060 ±40.41	2080 ±63.51	2110 ±10	2130 ±130
Dressing%	74.83 ±.79^{ab}	72.16 ±1.27^{bc}	77.99 ±.26^{a}	69.22 ±.42^{c}	74.20 ±..12^{ab}	70.25 ±2^{bc}
Liver%	2.13 ±.1	2.15 ±.2	2.11 ±.001	1.94 ±.04	2.04 ±.14	2.14 ±.11
Gizzard%	2.5 ±.17	2.59 ±.17	2.56 ±.15	2.67 ±.04	2.13 ±.19	2.34 ±.23
Intestine%	7.66 ±.05	6.79 ±.56	6.69 ±.26	6.38 ±.08	7.39 ±.2	7 ±.35
Spleen%	.13 ±.01	.17 ±.02	.17 ±.01	.14 ±.004	.17 ±.02	.19 ±.02
Heart%	.41 ±.04	.43 ±.04	.56 ±.003	.53 ±.02	.44 ±.04	.47 ±.06
Abdominal fat%	1.56 ±.37	1.45 ±.24	.85 ±.03	1.27 ±.06	1.01 ±.09	1.29 ±.37
Bursa%	.15 ±.004^{bc}	.12 ±.01^{c}	.17 ±.01^{abc}	.14 ±.004^{bc}	.21 ±.02^{ab}	.22 ±.02^{a}

$^{a, b, c}$ Means on the same row with different superscripts are statistically different at P<0.05, according to Tukey's Honesty significant difference test.

TABLE 6. Blood biochemical parameters of broilers fed experimental diets (mean ± SE).

Traits	Treatments + diets					
	(T1)	**(T2)**	**(T3)**	**(T4)**	**(T5)**	**(T6)**
Total cholesterol (mg/dl)	109.75 ±5.63^{a}	111 ±1.15^{a}	108.5 ±6.35^{a}	106.5 ±3.18^{ab}	89.25 ±0.43^{b}	104.75 ±0.72^{ab}
Triglyceride (mg/dl)	67.33 ±25.5	89 ±21.36	105 ±19.63	70.5 ±4.91	60 ±3.18	119 ±5.2
HDL-C (mg/dl)*	44.5 ±6.06^{b}	68.5 ±2.6^{a}	50.5 ±9.53^{ab}	57 ±1.15^{ab}	61.5 ±.3^{ab}	62 ±2.31^{ab}
LDL-C (mg/dl)*	87.5 ±8.83	59.05 ±1.24	69.47 ±17.8	46.35 ±.61	55.25 ±1.07	70.3 ±9.7
Total protein (g/dl)	4.42 ±.14	4.39 ±.05	4.41 ±.14	4.12 ±.01	4.62 ±.1	4.28 ±.17
Albumin (g/dl)	2.33 ±.04^{b}	2.39 ±.01^{ab}	2.52 ±.11^{ab}	2.42 ±.11^{ab}	2.7 ±.04^{a}	2.39 ±..02^{ab}
Globulin (g/dl)	2.09 ±.1	2 ±.06	1.89 ±.03	1.7 ±.12	1.92 ±.06	1.89 ±.15
ALT (u/l)*	58 ±21.36	53 ±13.86	43.5 ±18.76	73 ±4.62	29.5 ±4.91	67 ±.0
AST (u/l)*	343 ±25.4^{a}	284 ±37.53^{ab}	339 ±15.01^{ab}	305.5 ±.87^{ab}	276.5 ±6.64^{ab}	248 ±6.93^{b}
Creatinine (mg/dl)	.67 ±.11	.76 ±.01	.8 ±.06	.67 ±.04	.7 ±.1	.72 ±.08
Uric acid (mg/dl)	1.99 ±.03^{a}	1.93 ±.04^{a}	1.9 ±.01^{ab}	1.8 ±.03^{c}	1.78 ±.06^{c}	1.81 ±.02^{bc}
Urea (mg/dl)	45.5 ±.46^{a}	7.31 ±.17^{b}	7.31 ±.86^{b}	5.9 ±.16^{bc}	6.76 ±.15^{bc}	5.05 ±.05^{c}

$^{a, b, c}$ Means on the same row with different superscripts are statistically different at P<0.05, according to Tukey's Honesty significant difference test.

Table 7. Histomorphology of broilers fed experimental diets (mean ± SE).

Traits	Treatments + diets					
	(T1)	(T2)	(T3)	(T4)	(T5)	(T6)
Duodenum						
VL (µm)	854.33 ±46.12^{c}	950.67 ±38.15^{bc}	1162 ±123.31 ^{abc}	1248 ±113.19^{ab}	1485 ±16.37^{a}	1479.67 ±31.47^{a}
VW (µm)	106.67 ±12.99^{c}	117.33 ±8.19^{bc}	134 ±11.50^{abc}	175 ±9.54^{ab}	189.33 ±21.73^{a}	191.33 ±10.68^{a}
CD (µm)	157.33 ±12.81^{b}	272.33 ±25.21^{a}	258.67 ±19.06^{ab}	310 ±8.02^{a}	314.67 ±25.21^{a}	343.67 ±35.41^{a}
VL/CD (µm)	5.53 ±.69	3.55 ±.35	4.54 ±.6	4.05 ±.47	4.79 ±.43	4.38 ±.38
Jejunum						
VL (µm)	818.33 ±93.12^{c}	917.33 ±55.23^{bc}	987.67 ±37.36^{bc}	1013.67 ±6.98^{bc}	1105.67 ±36.88^{ab}	1299.33 ±25.13^{a}
VW (µm)	108.67 ±7.69	135 ±27.62	153.67 ±22.48	190.33 ±22.28	189.33 ±22.84	190.67 ±13.38
CD (µm)	180.33 ±22.81	196 ±17.1	236 ±19.66	247 ±11.06	268.33 ±9.13	255.67 ±38.56
VL/CD (µm)	4.64 ±.62	4.76 ±.51	4.22 ±.22	4.12 ±.2	4.14 ±.27	5.32 ±.77
Ileum						
VL (µm)	680.67 ±8.41^{b}	699.33 ±30.53^{ab}	744.33 ±12.44^{ab}	790 ±43.21^{ab}	823.33 ±61.51^{ab}	851.67 ±27.82^{a}
VW (µm)	122.67 ±7.54^{b}	148 ±31.97^{ab}	164.67 ±35.22^{ab}	218 ±15.10^{ab}	256 ±38.31^{ab}	281 ±28.35^{a}
CD (µm)	228.67 ±16.38	235.33 ±2.96	214.33 ±12.99	257 ±23.71	250.33 ±10.68	267 ±14.98
VL/CD (µm)	3.01 ±.23	2.97 ±.15	3.5 ±.25	3.12 ±.33	3.32 ±.38	3.21 ±.2

$^{a, b, c}$ Means on the same row with different superscripts are statistically different at P<0.05, according to Tukey's Honesty significant difference test.Villous length (VL) µm, villous width (VW) µm, Crypt depth (CD) µm,

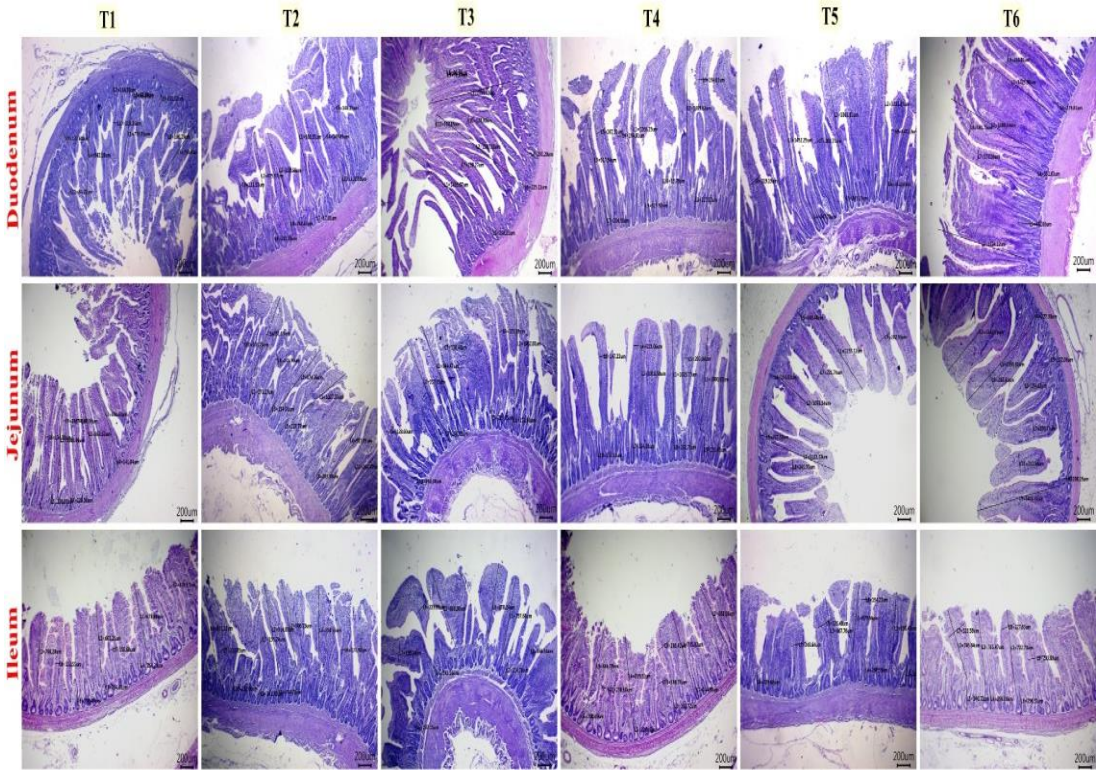

Fig.1. Duodenum, jejunum, and ileum sections stained with H&E are shown in a photomicrograph (scale bar 200µm). VL "villous length", VW "villous width", and CD "crypt depth"

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تأثير وجبة منخفضة البروتين مدعمة بملف الأحماض الأمينية عالية الليسين على الأداء وصفات الذبيحة والتشريح النسيجي ومعاملات الدم في دجاج التسمين

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الملخص

هذه الدراسة تناولت تأثيرات تعديل النظام الغذائي من خلال تقليل البروتين الخام بنسبة 1.5%، دمج ملف أحماض أمينية غني باللايسين، وإضافة 5% من وجبة عباد الشمس على أداء النمو، وخصائص الذبيحة، والمعايير البيوكيميائية في الدم، وتشريح النسيج المعوي للدجاج اللاحم. تم تقسيم 360 كتكوتا من سلالة ROSS 308 في عمر يوم واحد إلى ست معاملات تجريبية (T1 – T6) بتصميم عشوائي كامل، مع ست مكررات لكل معاملة تحتوي كل مكررة على عشرة كتاكيت. تم تضمين وجبة عباد الشمس بنسبة 5% في جميع المعاملات باستثناء المجموعة الضابطة (T1) . تم إعداد الوجبات لتوفير مستوى الليسين الموصى به (100%) للمعاملتين الاولى والثانية ، وزيادة مستويات الليسين (105%، 110%، 115%، و120%) للمعاملات من الثالثة الى السادسة مع تعديل ملف الأحماض الأمينية وفقًا لذلك. لم تُلاحظ النتائج فروق معنوية في الوزن النهائي، وزيادة الوزن، واستهلاك العلف، ومعدل تحويل العلف بين المعاملات، مما يشير إلى أن التعديلات الغذائية لم تؤثر سلبًا على أداء النمو. لم تتأثر نسب الأعضاء مثل الكبد، والمعدة، والأمعاء، والطحال، والقلب بالتعديلات الغذائية. ومع ذلك، تم ملاحظة زيادة معنوية في الوزن النسبي للجراب في المعاملة السادسة .بالنسبة للمعاملات البيوكيميائية في الدم، كانت مستويات الكوليسترول الكلي أقل بشكل معنوي في المعاملة الخامسة مقارنةً بالمعاملات الأخرى، وكانت مستويات الكوليسترول مرتفع الكثافة (HDL-C) أعلى في المعاملة الثانية. كانت مستويات الألبومين أعلى في المعاملة الخامسة. كانت مستويات (AST) أعلى في المعاملة الاولى وأدنى في المعاملة السادسة. أظهرت مستويات حمض اليوريك واليوريا فروقًا معنوية، حيث كانت أعلى في المعاملة الاولى. أما بالنسبة للتشريح النسيجى للامعاء، أظهرت المعاملات الخامسة والسادسة تحسينًا في صحة الأمعاء، مع أطول وأعرض زغابات وأعمق تجويفات في الاثني عشر. ومع ذلك، لم تكن هناك فروق معنوية في نسبة طول الزغابات إلى عمق التجويف. بشكل عام، لم تؤثر العلاجات الغذائية سلبًا على أداء دجاج التسمين، والمعايير البيوكيميائية في مصل الدم، وصحة الأمعاء.

الكلمات الرئيسية: دجاج التسمين، وصفات الذبيحة، الليسين، التشريح النسيجي ومعاملات الدم.