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Effect of Low Protein Diets Supplemented with Glycine on Growth Performance Carcass Traits, Blood Parameters and Antioxidant Status of Mandarah Chicks During Starter and Grower Periods

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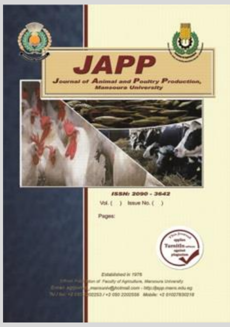

ABSTRACT

The objective of this study was to evaluate the effect of low protein diet fortified with 0.2% glycine (gly) on Mandarah a native Egyptian strain chick's growth performance, carcass, small intestinal morphology, shank and keel bone length, blood parameters, growth hormone and blood antioxidant status during starter and growing periods (from 1 day to 12 weeks of age). A total number of 135 one day old Mandarah chicks were randomly divided into 3 equal groups with 3 equal replicates each. Control group (C) was fed normal crude protein diets (19% CP as starter and 17% CP for grower), group 2 (LP1) and 3 (LP2) fed 1.5 and 3% less crude protein respectively, than control supplemented with 0.2% glycine. Results indicated that LP1diet supplementation with glycine led to significant improvement in body weight (BW) during the starter period, and in feed conversion ratio (FCR) during the first 4 weeks of age. However, LP2+gly group recorded the lowest BW at 12 weeks of age, while recorded significantly better relative weights of carcass, liver, gizzard and spleen. Results also showed no significant differences in shank and keel length, goblet cell number, villi height, crypt depth, blood total antioxidant capacity, glutathione and all blood biochemical parameters. Glycine supplemented groups recorded significantly higher growth hormone values and lower litter moisture and litter nitrogen values. In conclusion adding glycine 0.2% to low protein diet (1.5% reduction) improve growth performance and litter quality of Mandarah local Egyptian strain during starter and grower periods.

***Keywords*:** Mandara chicks, glycine, protein, performance, carcass, blood, litter

INTRODUCTION

Feed accounts for about 70% of the total cost of poultry production (Willems *et al.,* 2013). Whereas, a large part of that cost involves meeting the crude protein and amino acid requirements (Adabi *et al* 2019). Decreasing dietary crude protein in poultry diets is of attention to improve sustainability of poultry industry (Hilliar *et al.,* 2019). Using low protein diets in poultry feed have been recognized to potentially decrease feeding costs, enhance health and welfare concerns, and improves feed efficiency (Hilliar and Swick, 2018), also has environmental impact by decreasing pollution as a result of nitrogen emission and reduce water consumption, which lead to low volume of water excreted and enhance quality of the litter and related health and welfare results and decrease foot pad dermatitis (Alleman and Leclercq, 1997; Powers and Angel, 2008; Shepherd and Fairchild, 2010; Belloir *et al.,* 2017). However, reducing litter nitrogen and NH3 gas concentration enhance the quality of housing air and contributes to reduce heating costs related to high ventilation rates especially during winter (Ferguson *et al.,* 1998). However, decreasing dietary crude protein with adding essential amino acids have failed to achieve the expected growth as the recommended crude protein diets. Nonessential amino acid glycine supplementation in low crude protein diets can improve poultry growth performance (Corzo *et al.*, 2005; Dean *et al.,* 2006; Ospina-Rojas *et al.,* 2013). Since 1912 amino acids have been classified as essential and nonessential amino acids, rising suggestions shows that a sufficient providing of non-essential amino acids like glutamine, glycine, or proline is required for the ideal chickens growth and health. Moreover, Plant-based diets are not sufficient in glycine and prolin and does not provide birds with an adequate amount of both nonessential amino acids related to protein synthesis in chickens (Hou *et al.*, 2019; Li *et al.*, 2011; Li and Wu 2020). He *et al* (2021) Showed that in broiler chickens corn soybean meal based diets offer 30.8% and 28.2% of the gly. needed for optimum growth and production process of uric acid during the second and sixth weeks of age respectively. Baker, (2009) also indicated that chickens are not able to synthesize sufficiently glycine for their nutritional and physiological demands. Glycine necessary for glutathione syntheses, heme, bilirubin (Nakashima *et al.*, 2008). Namroud *et al.* (2008) reported that glycine and glutamic fortification of low crude protein diets significantly decreased liver percentage. Glycine is a functional amino acid with anti-inflammatory and anti-apoptotic properties (Xu *et al.,* 2018). Glycine supplementation during the laying period promoted the productive performance and had beneficial effects on quality of poultry litter (Abd El-Atty *et al.,* 2020). Hofmann *et al.* (2020) found that glycine significantly improved the body weight and FCR of broilers. Moreover, Awad *et al.* (2018) showed that feeding birds with low protein diet fortified with glycine 0.8 – 1% of diets resulted in feed consumption, weight gain and feed conversion ratio equivalent to the broiler chicks fed normal protein diets, as well as improved protein

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efficiency. In addition, Powel *et al.* (2009) indicated that glycine addition to broiler chick diets increased feed efficiency in diets with 1.35% lysine and excess total sulphur amino acids. Chrystal *et al.* (2020) indicated that inclusions of glycine and threonine in the 16.5% protein diet resulted in 6.18% increase in ileal protein digestibility coefficients and 10.1% increase in ileal protein disappearance rates. Supplementation with glycine 2% enhance the intestinal immunological barrier role and the microbial component, therefore, improve the growth of weaned piglets (Ji *et al.,* 2021). Moreover, in pigs 3% less in crude protein as moderate reduction did not affect mucosal barrier function of intestinal tract and morphology (Li *et al.,* 2019). Also, Barekatain *et al.* (2021) indicate that glycine supplementation 1 and 2% could improve energy status and protein synthesis in piglets. On the other hand, Star *et al.* (2021) indicated that glycine was not limiting for growth at low crude protein diets unless threonine was deficient in broiler chicks. However, there were many studies about the effect of low protein and glycine supplementation on growth hormone, Decuypere *et al., (*1991) indicated that broiler chickens reared on a diet with low protein content have a more obvious growth hormone release. Also, Eklund *et al. (*2005) and Dean *et al.* (2006) suggested that glycine has a significant role in growth hormone releasing and growth hormone levels increasing response are typically an improve efficiency of protein synthesis.

Hence, Local Egyptian chicken strains are known to own favorite properties such as disease resistance, good meat savor and taste, and preferable eggs for consumers and it has superior survival under local production conditions than the commercial hybrid strain (Abd El-Atty *et al.,* 2020). Whereas, Hassan *et al.* (2004) observed that Native Egyption breed (Mandarah) has genetic resistance to very virulent infectious bursal disease virus and Newcastle disease virus Thus, enhancing productive efficiency and health of our local breeds is very important.

The objective of this study was to investigate the effect of feeding low protein diets fortified with glycine on growth performance, carcass, small intestine morphology, blood antioxidant status, growth hormone and litter quality of Native Egyption breed (Mandarah) chicks during starter and grower periods.

MATERIALS AND METHODS

This study was carried out at Sakha Animal Production Research Station, Animal Production Research Institute, Agricultural Research Center, Egypt. A total number of 135 one day old Native Mandarah chicks were used. The chicks were assigned randomly into 3 treatments (each of 45 chicks) and each treatment was subdivided into three replicates, 15 chicks each. Chicks were housed from day of hatch, on a deep wheat-straw-litter floor system at an experimental chamber-partitioned-house. All chamber partitions, feeders, drinkers and heaters were cleaned and disinfected a week before starting the study. Environmental temperature was adjusted according to the age using fine-tuned gas heaters. Thereafter, chicks fed 3 experimental diets during starter period (1 day to 8 weeks of age); control chicks were fed standard protein (SP) (19% CP) without supplementation, LP1 (T2) (17.5% CP + 0.2% gly.) and LP2 (T3) (16% CP + 0.2% gly.). During grower period (8-12 weeks) chicks fed with; control diet T1 (17% CP), T2 (15.5% CP + 0.2% gly.) and T3 (14% CP + 0.2% gly.) Metabolizable energy was 2800 Kcal/kg diet in all experimental. Diets and water was provided ad libitum. Control experimental diet was formulated to meet the nutritional requirements of Mandarah chicks during starter and grower periods according to Agriculture Ministry Decree (1996). Feed calculated analysis according to Feed Composition Tables for Animal and Poultry Feed Stuffs Used in Egypt (2001), the composition and calculated analysis of the composition the starter and grower diets are as shown in Table (1).

Starting from 1st week to 12th weeks of age, every two weeks live body weight and as well as per replicate feed intake were recoded and body weight gain and feed conversion ratio were calculated and livability rate were determined.

Table 1. Composition and calculated analysis of the experimental diets

Ingredients (%)	Starter diets			Grower diets		
	Control	LP1	LP2	Control	LP1	LP2
Yellow corn (7.7%CP)	61.3	63.7	65.8	64.1	66.3	68.5
Soybean meal (44%CP)	31.2	25.86	21.00	24.86	19.3	14.3
Wheat bran (15% CP)	3.7	6.4	9.0	7.6	10.6	13.3
Limestone	1.40	1.40	1.40	1.30	1.30	1.30
Di calcium phosphate	1.70	1.70	1.70	1.50	1.50	1.50
Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30
Salt	0.30	0.30	0.30	0.30	0.30	0.30
DL– Methionine	0.10	0.14	0.15	0.04	0.07	0.10
Lysine-HCL	-	-	0.15	-	0.13	0.20
Glycine	-	0.20	0.20	-	0.20	0.20
Total	100	100	100	100	100	100
Calculated analysis2:						
CP (%)	19	17.5	16	17	15.5	14
ME (kcal/kg)	2800	2800	2803	2801	2800	2800
Calcium (%)	1.0	1.0	1.0	0.91	0.91	0.90
Available phos. (%)	0.47	0.47	0.47	0.43	0.43	0.43
Dl-Methionine (%)	0.43	0.44	0.44	0.34	0.35	0.36
Meth.+cyc. (%)	0.75	0.74	0.72	0.64	0.63	0.61
L- lysine-Hcl (%)	1.10	1.0	0.95	0.93	.90	0.83
Glycine (%)	0.80	0.93	0.86	0.72	0.84	0.78
Serine (%)	0.95	0.85	0.76	0.83	0.73	0.65

[1]Vitamin and mineral premix provides per 3kg: Vitamin A 12000 IU; Vitamin D3 2000 IU; Vitamin E. 10mg; Vitamin k3 2mg; VitaminB1 1mg; Vitamin B2 5mg; Vitamin B6 1.5 mg; Pantothenic acid 10mg; VitaminB12 0.01mg; Folic acid 1mg; Niacin 30mg; Biotin 0.05mg; Choline chloride (60% choline) 500 mg; Zn 55mg; Fe 30mg; cu 4mg I 1mg; Se 0.1mg; Mn 60mg;.

[2]According to Feed Composition Tables for Animal and Poultry Feedstuffs Used in Egypt (2001).

Slaughtering and carcass traits

At the end of experiment (12 weeks of age) three birds from each treatment were slaughtered then scalded, de-feathered and carcasses were eviscerated. The gizzard, heart, liver, spleen, kidney and abdominal fat were excised and weighted, and expressed as percentage of live body weights. Also intestine length was recorded and shank and keel bone length were measured.

Intestinal Sample Collection, morphometric and Goblet Cell Count

Two birds from each replicate were selected by weight at 12 weeks of age based on the average weight in each replicate pen, and slaughtered and exsanguinations. After that 3 cm from the length of section of the small intestine was collected: duodenum (from the pylorus to the distal duodenal loop), after that collected samples were washed in saline solution and fixed in 10% buffered formalin, then dehydrated in ascending alcohol concentrations, diaphanized in xylene, and embedded in paraffin for morphometric examinations (Luna, 1968).

Blood collection and serum metabolites analysis:

Three birds from each replicate were taken randomly at 12 weeks of age then slaughtered and blood samples (3 mL/tube) were collected. Later, the blood samples were centrifuged at 4000 roll per minute (rpm) at 4 C for 20 min. Hemolysis-free serum samples were transferred to 1.5 mL micro centrifuge tubes and stored at -20ºC. Albumin, alanine aminotransferase (ALT), aspartate amino transferase (AST), uric acid, blood urea, creatinine, total cholesterol, LDL- and HDL-cholesterol, triglycerides (TG), plasma glutathione (GSH), total antioxidant capacity (T-AOC) and growth hormone (GH) were measured using commercial kits. All blood examinations were done by using analytical kits produced by Bio-diagnostic Cairo, Egypt, www.bio-diagnostic.com).

Litter sampling

Litter samples were collected at 12 weeks of age as described by Atapattu *et al.* (2008). From each replicate 3 samples were randomly taken away from the feeders and drinkers area. litter pH (LpH, degree) using comparative pH paper were taken at two weeks intervals. The three samples from a replicate were pooled and kept in the refrigerator for twenty four hours. Samples were then analyzed for their content of moisture and nitrogen .

Statistical analysis:

Data were analyzed by the least square analysis of variance using the General Linear Model Procedure (SAS, 2004). The design was one way analysis and the model. Significant differences of P<0.05 among means were determined using Duncan's Multiple Range Test (Duncan, 1955).

The following model was used:

$$Y_{ik} = \mu + T_i + e_{ik}$$

Where: Y_{ik} **= an observation,** μ **= overall mean,** T_i **= effect due to experimental diets (i =1, 2 and 3)**
e_{ik} **= residual error.**

RESULTS AND DISCUSSION

Productive performance

The effect of low crude protein diets supplemented with glycine on body weight and body weight gain are presented in Table 2. Results showed that LP1 with gly 0.2% groups recorded significantly superior live body weight at 4 and 8 weeks of age, while at the end of the experiment (12 weeks of age) there were no significant differences between control and low protein diet groups with gly, however LP2+gly. recorded the lowest live body weight compared to control at 12 weeks of age. the results of body weight gain showed that LP1+gly. had significantly the highest body weight gain during the first 4 weeks of age, while there were no significant differences among groups during 4-8 weeks, 8-12 weeks and during the overall period. Results of feed intake FI and FCR are shown in Table 3.

Glycine supplementations of low protein diets increased significantly feed intake during 0-4 weeks (LP2+gly) and during 4-8weeks (LP1+gly.) while during the last 4 weeks control group recorded significantly the highest feed intake. Moreover, LP1+gly group recorded significantly the best FCR during the first 4 weeks of age, while there were no significant differences in FCR during 4-8, 8-12 and 0-12 weeks of age among groups, however, LP1+gly. was the best FCR during the overall period. These results are in agreement with the finding of Wang *et al.* (2020) who found that adding glycine to broiler chicks diet to 2.32% total glycine and Serine with a 3% reduction of crude protein level normalized the growth performance of broiler chicks and significantly improved feed conversion ratio during starter and the overall periods as standard protein diet chicks. Supplementation of glycine to the diet with a 4.5% CP reduction restored to the standard levels both of feed conversion ratio (starter period), final Body weight and overall average daily weight gain. In addition, Hilliar *et al.* (2020) observed that no significant difference due to feeding 20% crude protein in BWG, feed intake, or feed conversion ratio compared to the standard protein (22.5%) treatment. However, further reducing protein significantly reduced body weight gain, feed intake and impair FCR while, 0.713% Glycine supplementation improved this items.

Table 2. The effect of low crude protein diets supplemented with 0.2% glycine on body weight and body weight gain

Items	Protein levels			SEM	p-value
	Control	LP1+ 02% gly.	LP2+0.2% gly.		
		body weight (g)			
1-day	33.18	33.05	33.78	0.279	0.1450
4wks	259.33[c]	289.89[a]	274.11[b]	3.668	0.0001
8wks	665.11[b]	706.44[a]	671.22[b]	10.606	0.0138
12wks	1117.22	1141.67	110٤.00	13.490	0.1387
		Daily weight gain (g/bird/day)			
0-4wks	8.08[c]	9.17[a]	8.58[b]	0.132	0.0001
4-8wks	14.49	14.88	14.18	0.359	0.3955
8-12wks	16.15	15.54	15.45	0.283	0.1753
0-12wks	12.91	13.20	12.74	0.161	0.1305

a, b Means bearing different superscripts within the same row are significantly different (P<0.05). LP1: 17.5% CP starter and 15.5% CP grower diets. LP2 : 16% CP starter and 14% CP grower diets. SEM: Standard Error of the mean

Table 3. The effect of low crude protein diets supplemented with 0.2% glycine on FI and FCR

Items	Protein levels			SEM	p-value
	Control	LP1+ 02% gly.	LP2+0.2% gly.		
		Daily feed intake (g/bird/d)			
0-4wks	34.27[c]	35.23[b]	35.97[a]	0.088	0.0001
4-8wks	59.73[b]	60.43[a]	58.93[c]	0.116	0.0001
8-12wks	71.23[a]	68.60[b]	67.90[c]	0.112	0.0001
0-12wks	55.08[a]	54.76[b]	54.26[c]	0.055	0.0001
		Feed conversion ratio			
0-4wks	4.30[a]	3.89[b]	4.20[a]	0.061	0.0001
4-8wks	4.29	4.19	4.23	0.119	0.8476
8-12wks	4.47	4.50	4.44	0.084	0.8745
0-12wks	4.30	4.18	4.28	0.054	0.2414

a, b, c Means bearing different superscripts within the same row are significantly different (P<0.05);). LP1: 17.5% CP starter and 15.5% CP grower diets, LP2 : 16% CP starter and 14% CP grower diets. SEM: Standard Error of the mean

Moreover, Hofmann *et al.* (2020) found that glycine significantly improved the body weight and FCR of broilers. Moreover, Awad *et al.* (2018) showed that feeding birds with low protein diet fortified with glycine 0.8 – 1% of diets resulted in feed consumption, weight Gain and FCR equivalent to the broiler chicks fed normal protein diets, as well as improved protein efficiency. Also, Powel *et al.* (2009) indicated that glycine addition to broiler chick diets increased feed efficiency in diets with 1.35% lysine and excess total sulphur amino acids. On the other hand, Star *et al.* (2021) indicated that glycine was not limiting growth of broiler chicks at low crude protein diets unless threonine was deficient. In addition, Barekatain *et al.* (2019) showed that low protein diet of broiler chickens supplemented with 10 g/kg Gly had no effect on BWG or FCR. Barekatain *et al.* (2021) also indicate that glycine supplementation 1 and 2% could improve energy status and protein synthesis in piglets. In another kinds of animals Ji *et al* (2021) showed that feeding diet with 2% glycine instead of 0.5% or 1% glycine, presented elevated BWG and FCR in Piglets as compared with the control and 2% glycine improved the mucin in the jejunum and ileum during the first week after weaning. While, Zhong *et al.* (2021) found that no significant difference was noticed in final weight, average daily gain, average daily feed intake and FCR among treatment groups due to glycine supplementation (0.16%) of pigs diets. However, BW was higher and FCR was better in glycine supplementation group. Also, these results are in agreement with He *et al.* (2021) who showed that the typical corn soybean meal-based diets for 7 to 42-day-old broiler chickens offer only about 28.2% of the glycine which wanted for weight gain and uric acid formation, so chicks need free glycine supplementation diets to support growth during starter period.

Carcass traits

The results of relative weight for dressing and internal organs weight as influenced by low protein diets supplemented with 0.2% gly. are illustrated in Table (4).

There was significant positive effect of LP1 and LP2 + gly. On carcass, liver, gizzard spleen and intestinal length while, there were no effect due treatment on dressing weight, abdominal fat, heart, kidney, shank and keel bones length. However, low protein diets groups with gly. Decreased abdominal fat and increased keel bone length. This results are in agreement with the finding of Wang *et al.* (2020) who found that there were no significant effects due to 1.5% of dietary CP reduction on carcass traits of broilers at 21 and 42 day of age. Lowering dietary CP level by 3% significantly increased abdominal fat percentage of birds on d 42. Glycine supplementation in the diet with a 4.5% CP reduction supported a similar resulted in abdominal fat pad of birds at 21and 42 day compared to control, while there were no significant differences in the relative weight of thymus, spleen of birds among groups. These results are in agreement with those of (Yuan *et al.,* 2012, Awad, *et al.,* 2017, Xie, *et al.,* 2017) who found that relative weights of the liver, heart, and gizzard were not significantly affected by dietary glycine added at levels of 0.02, 0.12, 0.13, 0.29, 0.35, and 0.49%, However, Namroud *et al.* (2008) reported that glycine and glutamic fortification of low crude protein diets significantly decreased liver percentage weight .

Small intestinal morphology and Goblet Cell Count

As shown in Table 6, the effect of low crude protein diet supplemented with gly. 0.2% on Intestinal goblet cell number and Small intestinal morphology. The results showed no significant differences in Goblet cell number, villi height and crypt depth among groups due to glycine supplemented low protein diets. This results are in agreement with the finding of Awad *et al.* (2018) demonstrated that Feeding broiler chicks low protein diet (5% reduction) supplemented with glycine 0.8 – 1% resulted in feed intake, body weight gain, feed conversion ratio, morphology parameters equal to the birds fed standard protein diets, as well as enhanced protein efficiency ratio, while villus height and crypt depth were not affected. In earlier studies by Zaghari *et al.* (2011) and Laudadio *et al.* (2012), they found that villus height significantly reduced due to feeding broilers with low protein diets and these differences could be related to the glycine supplementation to the low protein diet in the present study. Moreover, in pigs 3% less in crude protein as moderate reduction did not affect mucosal barrier function of intestinal tract and morphology (Li *et al* 2019). However, the improvement of body weight of chicks fed low protein diet supplemented with glycine may due to the role of glycine in mucin formation in intestinal tract. Chrystal *et al.* (2020) indicated that inclusions of glycine and threonine in the 16.5% protein diet resulted in 6.18% increase in ileal protein digestibility coefficients and 10.1% increase in ileal protein disappearance rates. Also, Ospina-Rojas *et al.* (2013) observed that glycine can affect the appropriate function of the intestinal mucosa and enhance dietary energy utilization. Also they noticed that intestinal mucin secretion significantly increased. However, goblet cells numbers in the different parts of the intestine were not affected by glycine fortification. Therefore, glycine could help only as a substrate for synthesis of mucin and exert slight effect on the number of goblet cells expression. In addition, several studies reported increased in secretion of crude mucin after glycine supplementation. (Faure *et al.*, 2005; Hamard *et al.*, 2007; Horn *et al.*, 2009 and Moghaddam *et al.,* 2011), Whereas, mucin plays an important role in maintaining and protecting the intestine from acidity effects, digestive enzymes, and pathogens also, filtering nutrients in the gastrointestinal tract, thereby affecting nutrients digestion and absorption (Horn *et al.*, 2009).

Blood metabolites and antioxidant status.

Low crude protein diets supplemented with glycine of Mandarah native growing chicks on blood constituents are presented in Table 5. There were no significant effect due experimental treatments on blood constituents (total protein, albumin, globulin, liver and kidney functions (AST, ALT, creatinine, urea and uric acid) and lipid profile (Total cholesterol, TG, HDL and LDL cholesterol). However, LP1+0.2% gly recorded the lowest level of creatinine, total cholesterol and the highest level of HDL cholesterol, (TAC) and GSH while LP2 with 0.2% gly. recorded the lowest level of uric acid and LDL cholesterol. Therefore, results of this study showed that there are no adverse effects of low protein diets supplemented with glycine on growing Mandarah chicks. This results are in agreement with many researches, Zhong *et al.* (2021) found that Diet supplemented with glycine did not affect the concentrations of ALT, AST, total protein, albumin, urea nitrogen, creatinine in pigs. In addition, Wang *et al.* (2020) who found that lowering dietary CP level did not affect serum total protein, albumin, uric acid and creatinine contents of broilers on. Adding glycine decrease significantly serum uric acid and serum urea content. Hilliar *et al.* (2019) showed that reducing crude protein significantly decreased serum uric acid by 26.9%. Moreover, Powel *et al.* (2009) observed that glycine addition to broiler chick diets decreased serum uric acid and serum urea N concentrations.

Growth hormone

The results of growth hormone level as affected by low protein diet supplemented with glycine are shown in Table 7. Results showed that plasma growth hormone concentration increased significantly ($p<0.0003$) linearly with decreasing crude protein fortified with glycine. These results are in agreement with Buyse *et al* (1992) showed that growth hormone secretion was significantly affected by dietary crude protein. Broiler chickens fed on the low protein diet (15%) had higher overall mean of growth hormone level than the high protein (20%). Furthermore, Lauterio and Scanes (1988) observed that the higher plasma growth hormone concentrations of protein restricted birds resulted from increasing the rate of its secretion. Also, (Johnson *et al.*, 1986 ; Decuypere *et al.*, 1991) who indicated that broiler chickens reared on a diet with low protein content have a more obvious growth hormone release. Researches in humans have suggested that glycine has a significant role in growth hormone releasing (Eklund *et al.*, 2005). Growth hormone levels increasing response are typically an improve efficiency of protein synthesis (Dean *et al.*, 2006).

Table 4. The effect of low crude protein diets supplemented with 0.2% glycine on carcass and internal organs

Items	Protein levels			SEM	p-value
	Control	LP1+0.2% gly.	LP2+0.2% gly.		
Live body weight (g)	972.22^b	1061.11^{ab}	1090.00^a	20.023	0.037
Carcass (%)	63.23^b	66.03^{ab}	67.81^a	1.170	0.023
Abdominal fat (%)	2.09	1.93	1.78	0.056	0.085
Liver (%)	3.006a^b	2.85^b	3.22^a	0.060	0.034
Gizzard (%)	3.27^b	3.51^{ab}	3.94^a	0.105	0.025
Heart (%)	0.679	0.602	0.663	0.018	0.198
Spleen (%)	0.317^b	0.342^b	0.430^a	0.015	0.004
Kidney (%)	0.571	0.521	0.520	0.017	0.395
Intestine length (cm)	150.11^b	159.33^a	165.77^a	2.129	0.006
Shank length (cm)	9.088	9.089	9.092	0.0758	0.991
Keel length (cm)	13.400	13.481	13.519	0.0813	0.842

a, b Means bearing different superscripts within the same row are significantly different (P<0.05). LP1: 17.5% CP starter and 15.5% CP grower diets, LP2 : 16% CP starter and 14% CP grower diets, SEM: Standard Error of the mean

Table 5. The effect of low crude protein diets supplemented with 0.2% glycine on Intestinal goblet cell number and Small intestinal morphology.

Items	Protein levels			SEM	p-value
	Control	LP1+ 0.2% gly.	LP2+0.2% gly.		
Goblet cell number*(cell/vill)	125.6	121.8	119.5	10.45	0.98
Villi height (μm)**	880	870	865	0.73	0.65
Crypt depth(μm)**	155	152	149	0.93	0.06

a, b Means bearing different superscripts within the same row are significantly different (P<0.05);). LP1: 17.5% CP starter and 15.5% CP grower diets. LP2 : 16% CP starter and 14% CP grower diets. SEM: Standard Error of the mean

***Average goblet cell number (2 bird/replicate cage) was determined from 5 villi on each of 3 tissue pieces/bird.**

****Average villus length and crypt depth (2 bird/replicate cage) were determined from 20 villi on each of 3 tissue pieces/bird.**

Table 6. The effect of low crude protein diets supplemented with glycine on blood constituents

Items	Protein levels			SEM	p-value
	Control	LP1+ 0.2% gly.	LP2+0.2% gly.		
Total Protein (g/dl)	5.42	5.24	5.14	0.14	0.730
Albumin (g/dl)	1.86	1.9	2.02	0.067	0.562
Globulin (g/dl)	3.55	3.34	3.12	0.173	0.617
AST (U/L)	84.2	80.8	83.94	1	0.345
ALT (U/L)	12.49	8.95	10.82	0.94	0.327
Creatinine (mg/dl)	0.80	0.41	0.51	0.071	0.059
Urea (mg/dl)	16.62	19.44	17.82	0.998	0.539
Uric acid (mg/dl)	4.18	3.62	3.45	0.198	0.314
Total cholesterol (mg/dl)	131.11	129.2	132.77	4.67	0.958
Triglycerides (mg/dl)	70.42	78.27	98.27	11.68	0.633
HDL (mg/dl)	46.58	54.38	54.06	1.906	0.17
LDL (mg/dl)	70.44	59.16	59.05	5.79	0.68
T-AOC (mm/l)	0.476	0.501	0.45	0.016	0.482
GSH (mu/ml)	0.24	0.64	0.24	0.106	0.213

a, b Means bearing different superscripts within the same row are significantly different (P<0.05); LP1: 17.5% CP starter and 15.5% CP grower diets. LP2 : 16% CP starter and 14% CP grower diets. SEM: Standard Error of the mean AST: aspartate amino transferase , ALT: alanine aminotransferase, HDL: high-density lipoprotein, LDL: low-density lipoprotein, T-AOC: total antioxidant capacity GSH: Glutathione

Table 7. The effect of low crude protein diets supplemented with glycine on Growth hormone (GH)

Items	Protein levels			SEM	p-value
	Control	LP1+ 0.2% gly.	LP2+0.2% gly.		
GH (ng/ml)	1.52^c	2.55^b	3.75^a	0.294	0.0003

a, b, c Means bearing different superscripts within the same row are significantly different (P<0.05); LP1: 17.5% CP starter and 15.5% CP grower diets. LP2 : 16% CP starter and 14% CP grower diets. SEM: Standard Error of the mean

Moreover, Arwert *et al.* (2003) indicated that an oral mixture of glycine, glutamine and niacin can improve growth hormone releasing in healthy middle-aged and elderly subjects. Therefore, growth hormone increasing may also help to explain the improvement in body weight and feed conversion ratio that observed due to glycine supplementation of low protein diets.

Litter quality

The results of litter quality as affected with low protein diet fortified with glycine 0.2% are shown in table 8. Results showed that low crude protein groups LP1 and LP2 with 0.2% glycine significantly decreased litter moisture at 4, 8 and 12 weeks of age and significant decreasing in pH in LP1 and LP2 with glycine at 12 weeks of age. Moreover, the results showed that by decreasing protein level litter nitrogen% decreased significantly at 12 weeks of age and non-significantly at 4 and 8 weeks of age. This result is in agreement with Hilliar *et al.* (2020) who observed that low crude protein diets improved nitrogen retention efficiency in both grower and finisher and water intake decreased with decreasing crude protein intake in broiler chicks. Moreover, Alfonso-Avila *et al.* (2019) showed that nitrogen efficiency can be increased and litter moisture can be reduced by 2.3% and 4% respectively for each percent in crude protein reduction in broiler diets. In addition, Awad, *et al.* (2017) reported that glycine fortified low protein diets obviously decreased litter moisture and nitrogen contents compared to control diet. Ferguson *et al.* (1998) observed that reduction of litter nitrogen and NH3 gas concentration enhance the quality of housing air and contributes to reduce heating costs related to high ventilation rates. Therefore, low crud protein diets have positive effect in sustainability improvement of poultry production by efficiently decreasing environmental load linked with nitrogen emission (Belloir *et al.*, 2017 and Hilliar *et al.*, 2019).

However, reducing litter nitrogen and NH3 gas concentration enhance the quality of housing air and contributes to reduce heating costs related to high ventilation rates especially during winter (Ferguson *et al*., 1998)

Table 8. The effect of low crude protein diets supplemented with 0.2% glycine on litter quality

Items	Protein level			SEM	p-value
	Control	LP1+ 0.2% gly.	LP2+0.2% gly.		
Litter moisture %					
4wk	18.05[a]	17.70[b]	17.43[c]	0.096	0.003
8wk	20.66[a]	19.56[b]	19.06[b]	0.256	0.003
12wk	22.15[a]	21.93[a]	21.50[b]	0.112	0.021
Litter pH					
4wk	6.50	6.40	6.30	0.040	0.125
8wk	6.80	6.60	6.50	0.060	0.098
12wk	7.50[a]	6.78[b]	6.60[b]	0.165	0.031
Litter nitrogen %					
4wk	2.221	2.200	2.188	0.006	0.055
8wk	2.325	2.306	2.278	0.009	0.091
12wk	2.433[a]	2.400[a]	2.358[b]	0.012	0.009

a, b, c Means bearing different superscripts within the same row are significantly different (P<0.05): LP1: 17.5% CP starter and 15.5% CP grower diets. LP2 : 16% CP starter and 14% CP grower diets. SEM: Standard Error of the mean

In conclusion, the results indicate that feeding low protein diets (1.5% reduction) fortified with glycine 0.2% can support growth performance higher than chicks fed with a standard protein diet during starter period and improve carcass, growth hormone concentration, maintain intestinal tract morphology health, and improve litter quality. Further research is required to clearly the role of glycine in increasing growth hormone in native breeds.

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تأثير بروتين العليقة المنخفض مع اضافة الجليسين علي النمو, صفات الذبيحة, معاملات الدم و السعة التاكسدية لدجاج المندرة خلال فترة البادي و النامي

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تهدف هذه الدراسة إلي دراسة تأثير تقليل مستوي البروتين مع إضافة الحامض الاميني الجليسين في علائق السلالة المحلية المندرة خلال مرحلة التربية (البادي والنامي) علي النمو، مواصفات الذبيحة، مورفولوجي الأمعاء الدقيقة، عدد خلايا جوبالت، قياسات الدم، السعة التاكسدية للدم، هرمون النمو وجودة الفرشة حيث أجريت هذه الدراسة بمحطة بحوث الانتاج الحيواني بسخا. تم استخدام عدد ١٣٥ كتكوت عمر يوم من سلالة المندرة حتي عمر ١٢ أسبوع تم تقسيمهم إلي ٣ مجموعات (٤٥ كتكوت في كل مجموعة) وكل مجموعة بها ثلاث مكرارات (١٥ كتوت/ مكررة) - قد تم استخدام المجموعة الأولي للمقارنة وتم تغذيتها على العليقة الأساسية التى تحتوى على ١٩ و١٧% بروتين خام خلال مرحلتى البادى والنامى على التوالى - والمجموعة الثانية غذيت على عليقة مستوي البروتين بها أقل من الكنترول ب ١,٥% (LP_1) مع إضافة جليسين ٠,٢% أما المجموعة الثالثة كان مستوي البروتين بها أقل من الكنترول ب ٣% (LP_2) مع إضافة ٠,٢% جليسين خلال مرحلتى البادي والنامي و أشارت النتائج إلى: سجلت الطيور المغذاة على مستوي البروتين المنخفض مع إضافة الجليسين (LP1) زيادة معنوية في وزن الجسم مقارنة بمجموعة المقارنة عند عمر ٤، ٨ أسبوع بينما لم يكن هناك فروق معنوية في وزن الجسم عند عمر ١٢. بينما سجل مستوي البروتين الثاني مع الجليسين اقل وزن جسم عند عمر ١٢ اسبوع. سجلت المجموعة الثانية تحسن معنوي في معامل التحويل الغذائي مقارنة بمجموعة الكنترول خلال الاربع اسابيع الاولي من عمر الكتاكيت بينما لم يكن هناك اي فروق معنوية في معامل التحويل الغذائي خلال باقي المراحل وكان أفضل معامل تحويل فى المجموعة الثانية خلال الفترة الكلية للتجربة. سجلت الأوزان النسبية لكل من وزن الذبيحة، الكبد، القونصة، الطحال وطول الأمعاء زيادة معنوية في المجموعة الثالثة (مستوي البروتين LP_2 المضاف إليها الجليسين) مقارنة بالكنترول. لم يلاحظ أي فروق معنوية بين المعاملات في عدد خلايا جوبلت أو ارتفاع الخملات ولكن سجلت مجموعة المقارنة أعلي نسبة. لم يكن هناك أي فروق منعوية في معاملات الدم المختلفة أو السعة التأكسدية الكلية في الدم أو الجلوتاثيون نتيجة المعاملات التجريبية. سجلت المعاملات ذات مستوي البروتين المنخفض المضاف إليها الجليسين الجليسين زيادة معنوية في تركيز هرمون النمو بالمقارنة بالكنترول. لوحظ انخفاض معنوي في نسبة رطوبة الفرشة ونسبة النيتروجين فى مجموعات البروتين المنخفض المضاف إليها الجليسين.ومن تلك الدراسة نستنتج أنه يمكن خفض نسبة البروتين في علائق كتاكيت المندرة خلال فترة البادي والنامي حوالي ١,٥% مع إضافة ٠,٢% حامض أميني جليسين حيث أدي إلي زيادة الوزن مع تحسين معامل التحويل الغذائي وارتفاع جودة الفرشة مما ينعكس علي صحة الطيور وتقليل مشاكل الأرجل – بالضافة الي الاحتياج إلى مزيد من الدراسات حول تأثير الحامض الأميني الجليسين في حالة انخفاض مستوى البروتين علي تركيز هرمون النمو في الدم.