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PERFORMANCE OF LOCAL LAYING HENS AS AFFECTED BY LOW PROTEIN DIETS AND AMINO ACIDS SUPPLEMENTATION

By

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Abstract: *This experiment was conducted to study the effect of low crude protein diet (CP) levels and amino acids (AA) (methionine and lysine) supplementation on performance of local laying hens from 32 to 44 weeks of age. Matrouh hens of 32 weeks old were divided equally into five treatment groups. Each group contained five replicates with three Hens per each. Five test diet series were used: One, 16% CP diet plus additional (methionine amino acid)general control; Two, 14% CP diet; Three, 14% CP diet plus additional amino acids (methionine and lysine) identical to diet one; Four: 12% CP diet and Five ,12% CP diet plus additional amino acids (methionine and lysine) identical to diet one.*

Final body weight and body weight change were not significantly influenced by either crude protein (CP) levels or AA supplementation. The highest egg production, egg weight and egg mass values were for 16% CP (63.37%, 44.95g and 28.46 g/ hen/ day), respectively. Hens fed 14% CP diet supplemented with AA had recorded the lowest feed consumption (70.65 g/day). The best significant ($P<0.01$) values for feed conversion ratio were for16% CP diet (2.62 g feed/ g egg) and 14% CP diet supplemented with AA (2.62 g feed/ g egg).

The best value of egg shape index had been obtained by feeding 12 % CP diet with AA supplementation (80.24%). The best ($P<0.05$) yolk wt. values were for 14 % CP and 14% CP supplemented with AA (39.30 and 39.21%), respectively. Moreover, the best ($P<0.05$) yolk index value was for 14 % CP diet supplemented with AA (44.15). Hens fed 12 % CP diet with supplemented with AA recorded the highest ($P<0.05$) haugh unit (90.15).

The best economical efficiency and relative economical efficiency values had been recorded for hens fed 14 % CP diet supplemented with AA(0.81 and 117.39%), followed by hens fed 16% CP diet (0.69 and 100%), respectively.

It could be concluded that equal egg production and egg quality of Matrouh laying hens could be obtained with a 14% low-CP diet plus methionine and lysine supplementation to the same identical level of high crude protein diet (16%).Moreover, hens fed 14% low-CP diet plus methionine and lysine supplementation recorded the best economical efficiency and relative economical efficiency.

INTRODUCTION

Using low-protein diets has a great effect on reducing the rate of nitrogen emission into the environment. Also, it reduces feed cost which represents more than 70% of the total production costs. In addition, poultry can only utilize about 40% of the dietary protein. Therefore, it seems logic to decrease the level of protein in the diet (**Lopez and Leeson, 1995**). Thereby, low-protein diets are a way to reduce nitrogen excretion (**Blair *et al.*, 1999; Saitoh, 2001and Ayasan *et al.*, 2009**).

Methionine and lysine are generally the first and the next limiting amino acids in corn-soybean diets for laying hens. Moreover, methionine is considered the first limiting amino acid in low protein corn-soybean meal diet for laying hens. There is still controversy about this subject in the literature (**Abdel-Maksoud *et al.*, 2010**). Many studies have reported that the efficiency of protein utilization is increased by supplementation of methionine and lysine (**Schutte *et al.*, 1994 and Novak *et al.*, 2004**). Moreover, **Keshavarz and Austic (2004)** indicated that supplementing the negative control (13%CP) with methionine, lysine and tryptophan resulted in laying hen performance comparable to that obtained with the positive control (16%CP). A similar responses in egg production and egg mass had been obtained when low-protein diets (15 or 13%) were supplemented with Lys, Met, Trp, Arg, Thr,Val, and Ile compared with high-protein (17.6 or 15.5%) diets (**Harms and Russell,1993**). Other studies, **Leeson and Caston (1996)** reported that egg weight and egg mass was lower with diets containing 14.4% protein compared with 16.8% protein, although both diets had equal levels of Met and Lys. Moreover, **Summers *et al.*, (1991)** reported that hens fed a 10% protein diet supplemented with lysine, arginine, methionine, and tryptophan produced 11% lower egg mass than those fed 17% protein diet. Furthermore, performance of laying hens fed a 13 or 14% protein diet supplemented with adequate essential amino acids was not as satisfactory as the performance of a control group fed a 16% protein diet (**Jensen *et al.*, 1990**). In addition, **Zou and Wu (2005)** indicated that increasing dietary protein intake from 15.3 to 16.3 g/hen per day increased egg production.

The present research work was carried out to study the effect of using low crude protein (CP) diets with amino acids (AA) supplementation on productive performance of local laying hens.

MATERIALS AND METHODS

The present study was carried out at Siwa Oasis Research Station belonging to Desert Research Center (DRC), Egypt. A total of 75 *Matrouh* laying hens, 32 weeks of age were divided equally into five treatment groups. Each group contains five replicates with three hens each. Five test diet series were used: One, 16% CP diet plus additional (methionine amino acid); Two, 14% CP diet; Three, 14% CP diet plus additional amino acids (methionine and lysine) identical to diet one; Four: 12% CP diet and Five, 12% CP diet plus additional amino (methionine and lysine) identical to diet one. Diets were formulated to contain 16, 14, or 12% crude protein and to meet or exceed minimum amino acid standards suggested by **NRC (1994)** as shown in Table (1). Hens were housed in wire cages of triple deck batteries. Feed and water were provided *ad libitum*. Body weights were recorded at the beginning of the experimental (32 week of age) and monthly till the end of the experiment (44 week of age). Body weight changes were calculated as the difference between the initial and final body weights. Egg weight and egg number were recorded daily to calculate the egg mass (g/hen/day). Feed consumption was recorded biweekly, while feed conversion ratios (g feed /g eggs) were calculated as the amount of feed consumed divided by egg mass.

At the end of the experiment, egg quality parameters were measured using 25 eggs (5 eggs /each treatment group). These measurements involved yolk, albumen and shell weight percentage. Egg shell thickness was measured in µm using a micrometer. Egg shape index was computed as the ratio of egg width to the length (**Awosanya *et al.*, 1998**). Yolk index was calculated according to **Funk *et al.*, (1958)**, as yolk height divided by yolk diameter. Haugh unit was calculated according to **Eisen *et al.*, (1962)** using the calculation chart for rapid conversion of egg weight and albumen height.

Economical efficiency of egg production was calculated from the input-output analysis which was calculated according to the price of the experimental diets and egg production during the year of 2009.The values of economical efficiency were calculated as the net revenue per unit of total costs.

Statistical analysis:

Data were analyzed by the Computer Program, SAS **(2003)**, using the General Linear Model (GLM) procedure. All the data were subjected to one way analysis of variance model. The significant differences among treatments means were separated by Duncan's Multiple Range-Test **(Duncan, 1955)**.

RESULTS AND DISCUSSION

Results in (Table 2) showed that final body weight and body weight change were not significantly affected by either crude protein (CP) levels or AA supplementation. Egg production was significantly (P<0.01) affected by the treatments. The highest egg production values were for 16% CP (63.37%) followed by 14% CP supplemented with AA (61.68%) during the whole experimental period (32-44 weeks). There were significant effect on egg weight due to either crude protein levels or AA supplementation during different interval periods and total experimental period. The highest values for egg weight were for16% CP (44.95g) followed by 14 % CP (44.04g) and 14% CP supplemented with AA (43.94g) during the whole experimental period. Egg mass values were significantly (P<0.05) influenced by either crude protein levels or AA supplementation during the total experimental period. The highest values for egg mass was for16% CP followed by 14% CP supplemented with AA (28.46 and 27.13 g/ hen /day), respectively, while, the lowest value of egg mass had been recorded for 12% CP (19.74 g/ hen /day).

The effect of protein on body weight changes was in agreement with that of **Keshavarz and Nakajima (1995)**, **Grobas *et al.*,(1999)**, and **Sohail *et al.*, (2003)**, who reported no significant effect of reducing dietary protein levels on body weight. However, **Yakout (2010)** reported that dietary CP levels significant effect (P ≤ 0.001) body weight. **Zou and Wu (2005)** reported that reducing dietary protein intake from 16.3 to 15.3 g/ hen per day reduced egg production by 3.2%, while, **Keshavarz (1995)** indicated that egg production was only decreased by 1.9% with dietary protein intake reduction from 21.4 to 17.4 g/hen per day. On the other hand, **Keshavarz and Jackson (1992)** reported that egg production and egg weight for the period of the experiment (22 to 66 wk) were not significantly different when hens were fed a sequence of 14-13-12% protein supplemented with several essential amino acids for the age periods of 22 to 34, 34 to 50, and 50 to 66 wk, respectively, as compared with the control groups, which were fed a sequence of 18-16-15% protein for the same periods. **Sullivan (1989)** reported that 16% protein diet supplemented with 0.6% sulphur amino acids was adequate for higher egg mass. In the present study, reducing CP level from 16 to 12% decreased egg production. This may be attributed to three reasons; the ratio between methionine and lysine to total essential amino acids, the ratio of total essential amino acids supplementation, differences in amino acids requirements by different strains. Moreover, **Calderon and Jensen (1990)** and **Jensen *et al.*, (1990)** reported that performance of laying hens fed a 13 or 14% protein diet supplemented with adequate essential amino acids was not as satisfactory as the performance of a control group fed a 16% protein diet. The lowest egg mass obtained using 12% CP diet may be attributed to an inadequate level of total nitrogen **(Leeson and Caston, 1996)**.

Feed consumption and feed conversion ratios had significantly (P<0.01) influenced by either crude protein levels or AA supplementation during the total experimental period. The lowest feed consumption was for 14% CP diet supplemented with AA (70.65g/day). The best significant (P<0.01) values for feed conversion ratio were for 16% CP diet (2.62 g feed/ g egg) and 14% CP diet supplemented with AA (2.62 g feed / g egg). The improvement in feed conversion ratio for hens fed 16 % CP diet or 14 % CP diet with methionine and lysine supplementation are due to that such diets showed the highest egg mass and the lowest feed consumption (Table 2). These results are in agreement with data reported by **Novak *et al.*, (2007), Novak *et al.*, (2008)** and **Yakout (2010). Pour–Reza (1998)** reported that hens consuming 520 mg lysine per day at both 13 and 14% CP had better feed conversion ratio. Also, **Rys *et al.*, (1983)** found that the intake of feed /kg eggs increased with decreasing crude protein. **Balnave and Robinson (2000)** reported that increasing the dietary lysine concentration significantly reduced feed intake.

Results in (Table 3) revealed that shell weight, egg shell thickness and albumin weight did not significantly (P>0.05) affected by either crude protein levels or AA supplementation. Shape index (%) were significantly affected by either crude protein levels or AA supplementation, the best value was for 12 % CP diet with AA supplementation (80.24%). The best (P<0.05) yolk wt. values were in 14 % CP diet and 14% CP diet supplemented with AA (39.30 and 39.21%). The best (P<0.05) yolk index values were for 14 % CP diet supplemented with AA (44.15) followed by 12% CP diet supplemented with AA (43.99) and then by 14% CP diet (42.93). Hens fed diets 12 %CP diet with AA supplementation had recorded the best significant (P<0.05) haugh unit (90.15) compared with the other groups. In this connection, **Novak *et al.*, (2004)** reported that egg shell weight% was not affected by either lysine or TSAA intake. **Shafer *et al.*, (1996)** reported no effects of TSAA level on shell weight or percentage of shell by increasing the TSAA intake from 624 to 822 mg/hen/day. Moreover, **Scheideler and Elliot (1998)** and **Novak *et al.*, (2004)** reported no effect of increasing dietary TSAA from 520 to 800 mg/hen/day on percentage albumen or yolk.

Results in (Table 4) showed that , the best values for economical efficiency and relative economical efficiency were recorded by hens fed 14 % CP diet supplemented with AA, being (0.81 and 117.39%), respectively, followed by those fed 16% CP diet (0.69 and 100%), respectively . Moreover, hens fed 12% CP diet supplemented with AA had recorded better values than those having 14% CP. However, the 12 % CP diet gave the corresponding lowest values.

In conclusion, it could be suggested that equal egg production and egg quality could be obtained with a 14% low-CP diet with methionine and lysine supplementation to the same identical level of high protein diet (16%) CP. Moreover, hens fed 14% low-CP diet plus methionine and lysine supplementation recorded the best economical efficiency and relative economical efficiency.

Table 1: Composition and calculated analysis of the experimental basal diets.

Ingredients%	Treatments				
	1	2	3	4	5
Yellow Corn	59.87	63.60	63.60	66.40	66.50
Soybean meal , 44%	19.00	16.43	16.43	10.30	10.30
Corn Gluten meal , 60%	2.16	0.00	0.00	0.00	0.00
Wheat bran	7.74	8.76	8.73	12.06	11.75
Limestone	8.91	8.91	8.80	8.94	8.84
Dicalcium phosphate	1.75	1.75	1.75	1.75	1.75
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Vit&min premix*	0.30	0.30	0.30	0.30	0.30
L – Lysine HCl	0.00	0.00	0.08	0.00	0.22
DL-Methionine	0.02	0.00	0.06	0.00	0.09
Total	100	100	100	100	100
Calculated analysis					
ME, Kcal/kg	2610	2610	2610	2610	2610
CP%	16.00	14.00	14.00	12.00	12.00
CF%	3.53	3.51	3.51	3.51	3.48
EE%	2.71	2.81	2.81	2.97	2.96
Ca%	3.56	3.59	3.55	3.59	3.56
Total P%	0.72	0.72	0.72	0.72	0.72
Available P	0.45	0.45	0.45	0.44	0.44
Methionine + Cystine%	0.56	0.49	0.49	0.44	0.44
Methionine	0.30	0.24	0.30	0.21	0.30
Lysine%	0.74	0.66	0.74	0.52	0.74

* Vit. and Min. Premix per Kg of diet: 12000 IU. Vit. A, 2000 IU. Vit. D3, 10 mg Vit. E, 4 mg Niboflavin, 10mg Pantothenic acid, 0.01 mg Vit. B12, 500 mg Choline chloride, 2 mg Vit. K, 1 mg. Vit. B1, 1.5 mg Vit. B6 ‚1mg Folic acid, 30 mg Niacin, 0.05 mg Biotin, 10 mg Cu, 1 mg I, 30 mg Fe, 55 mg Mn, 55 mg Zn and 0.1 mg Se.

Table 2: Egg production and feed utilization as affected by CP level and AA supplementation.

Treatments / Parameter	16%	14%	14%+AA	12%	12%+AA	Sig.
Initial body wt., g	1374±23.13	1374±21.96	1354±22.56	1376±25.63	1369±25.63	NS
Final body wt., g	1616±53.52	1544±42.08	1614±53.36	1490±46.24	1509±23.85	NS
Body weight Changes	242±50.53	169±42.85	261±63.05	114±54.64	141±43.08	NS
Egg production %						
32-36 week	67.04^{a}±5.54	54.17^{bc}±1.21	63.93^{a}±2.08	47.80^{c}±1.81	59.34^{ab}±1.86	**
36-40	71.28^{a}±6.17	58.40^{b}±1.68	68.45^{a}±1.38	50.34^{b}±0.99	58.55^{b}±1.09	**
40-44	51.79±2.30	47.32±1.71	52.68±3.96	44.65±1.04	50.89±3.05	NS
32-44	63.37^{a} ±1.64	53.30^{b} ±0.71	61.68^{a} ±1.83	47.59^{b} ±0.40	56.26^{b} ±0.57	**
Egg wt. (g)						
32-36 week	44.79^{a} ±0.86	42.50^{ab}±1.77	42.38^{ab} ±1.03	36.23^{c}±0.38	39.52^{b}±0.94	**
36-40	43.95^{ab}±0.88	45.70^{a}±0.41	41.20^{c}±0.65	45.48^{a}±0.30	42.50^{bc}±1.09	*
40-44	46.10^{ab} ±0.81	43.93^{bc}±1.59	48.25^{a}±0.48	42.78^{bc}±1.62	40.85^{c}±1.61	*
32-44	44.95^{a}±0.58	44.04^{a}±0.80	43.94^{a}±0.57	41.49^{b}±0.59	40.96^{b}±1.12	*
Egg mass (g/hen/ day)						
32-36 week	29.98^{a}±2.37	23.05^{b}±1.29	27.23^{ab}±1.37	17.31^{c}±0.64	23.42^{b}±0.56	**
36-40	31.33^{a} ±2.78	26.69^{bc}±0.75	28.18^{ab} ±0.47	22.88^{c} ±0.35	24.87^{bc} ±0.59	**
40-44	23.91±1.39	20.80±1.10	25.44±2.01	19.09±0.80	20.92±2.02	NS
32-44	28.46^{a}±0.54	23.49^{b}±0.74	27.13^{a}±1.10	19.74^{c}±0.23	23.06^{b}±0.82	*
Feed consumption (g/ hen /day)						
32-36 week	71.60±1.51	78.60±3.76	71.95±5.51	81.80±2.02	77.10±2.72	NS
36-40	73.45^{b}±2.08	77.80^{ab}±2.65	72.90^{b}±4.88	85.60^{a}±1.25	74.45^{b}±1.14	*
40-44	78.18^{b} ±2.24	83.58^{ab} ±2.00	67.05^{c}±3.87	87.68^{a} ±0.88	80.68^{ab} ±3.29	**
32-44	74.40^{bc}±0.63	79.98^{ab} ±1.77	70.65^{c} ±3.92	85.03^{a} ±1.21	77.38^{b}±1.09	**
Feed conversion(g feed/g egg)						
32-36 week	2.43^{d}±0.16	3.46^{b}±0.32	2.67^{cd}±0.21	4.74^{a}±0.17	3.30^{bc}±0.18	**
36-40	2.40^{c}±0.20	2.92^{b}±0.11	2.59^{bc}±0.18	3.74^{a}±0.05±	2.99^{b}±0.04	**
40-44	3.31^{bc}±0.23	4.05^{ab} ±0.21	2.71^{c} ±0.34	4.61^{a} ±0.19	3.96^{ab}±0.41	**
32-44	2.62^{c} ±0.05	3.42^{b} ±0.14	2.62^{c}±0.21	4.31^{a} ±0.03	3.37^{b} ±0.10	**

a, b ....= Means in the same row in each classification bearing different letters differ significantly ($P \leq 0.05$)
NS = not significant *= ($P \leq 0.05$) **= $P \leq 0.01$)

Table 3: Egg quality as affected by CP level and AA supplementation .

Parameter	Treatments					
	16%	14%	14%+AA	12%	12%+AA	Sig.
Egg wt. (g)	44.31ᵃ±0.92	44.41ᵃ±0.93	39.71ᵇ±1.45	43.30ᵃ±0.68	44.08ᵃ±0.81	*
Shell wt.%	10.87±0.50	11.95±1.11	12.48±0.67	12.48±0.27	11.21±0.48	NS
Shape index	79.02ᵃᵇ±1.10	76.88ᵃᵇ±0.80	76.37ᵇᶜ±0.45	74.80ᶜ±0.79	80.24ᵃ±1.88	*
Shell thickness (mm)	0.444±0.02	0.434±0.01	0.456±0.01	0.464±0.02	0.440±0.01	NS
Albumen wt.%	53.82±0.87	50.94±2.40	51.05±0.85	51.98±0.49	55.54±1.27	NS
Yolk wt.%	37.09ᵃᵇ±1.80	39.30ᵃ±1.21	39.21ᵃ±1.67	33.50ᵇ±0.50	36.19ᵃᵇ±1.57	*
Yolk index	40.05ᵃᵇ±2.33	42.93ᵃ±0.99	44.15ᵃ± 1.21	38.23ᵇ±0.72	43.99ᵃ±0.42	*
Haugh unit	83.05ᵇ±2.67	86.41ᵃᵇ±1.57	89.94ᵃ±0.99	88.07ᵃ±0.74	90.15ᵃ±1.21	*

a, b ....= Means in the same row in each classification bearing different letters differ significantly ($P \leq 0.05$)
NS = not significant *= ($P \leq 0.05$)

Table 4: Input and output analysis and economical efficiency of different treatments during the whole experimental period.

Items	Treatments				
	16%	14%	14%+AA	12%	12%+AA
Price/kg feed (L.E.)	1.695	1.565	1.588	1.450	1.507
Total feed intake / hen (kg)	6.250	6.718	5.935	7.143	6.499
Total feed cost / hen (L.E.)	10.59	10.51	9.42	10.35	9.79
Egg mass, Kg/hen	2.39	1.97	2.28	1.66	1.94
Total revenue	17.93	14.78	17.10	12.45	14.55
Net revenue/hen (L.E.)	7.34	4.27	7.68	2.10	4.76
Economical efficiency (E.E.)	0.69	0.40	0.81	0.20	0.48
Relative EE (%)	100	57.97	117.39	28.98	69.56

-Price of 1.oKg Egg was 7.50 LE. At the time of the experimental period. -Net revenue per unit of total feed cost. -Relative economical efficiency% of the control, assuming that relative EE of the control = 100.

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الملخص العربي

الأداء الإنتاجي لدجاج البيض المحلى وتأثره بالعلائق المنخفضة فى البروتين الخام والمدعمة بالأحماض الأمينية

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أجريت هذه الدراسة لبحث تأثير العلائق المنخفضة فى البروتين الخام والمدعمة بالأحماض الأمينية(المثيونين والليسين)على معدل أداء دجاج البيض المحلى. إستخدم في هذه التجربة دجاج مطروح عمر ٣٢ أسبوع وزعت على خمسة مجاميع تجريبية لكل معاملة خمس مكررات بكل مكررة ثلاث دجاجات. إستخدم خمس علائق مختبرة (الأولى) تحتوى على ١٦% بروتين خام - (الثانية) تحتوى على ١٤% بروتين خام - (الثالثة) تحتوى على ١٤% بروتين خام مع الإمداد بالمثيونين و الليسين بما يكافىء محتواهما فى العليقة الأولى أما (الرابعة) فتحتوى على ١٢% بروتين خام و(الخامسة) تحتوى على ١٢% بروتين خام مع الإمداد بالمثيونين والليسين بما يكافىء محتواهما فى العليقة الأولى .أشارت النتائج الى الآتى:

لم يتأثر كل من وزن الجسم النهائى والتغير فى وزن الجسم معنويا بمستوى البروتين الخام أو الإمداد بالأحماض الأمينية. بينما لوحظت أعلى قيم معنوية فى إنتاج البيض ، وزن البيض وكتلة وزن البيض فى العلائق المحتوية على ١٦%بروتين خام (٦٣,٣٦%،٤٤,٩٥ جم ،٢٨,٤٦جم على الترتيب) . كانت أقل قيمة للغذاء المستهلك للعلائق المحتوية على ١٤% بروتين خام مع الإمداد بالأحماض الأمينية (٧٠,٦٥ جم/دجاجة/ يوم). بينما كانت أحسن قيمة لمعامل التحويل الغذائى للعلائق المحتوية على ١٦% بروتين خام (٢,٦٢ جم علف / جم كتلة بيض) والعلائق المحتوية على ١٤% بروتين خام مع الإمداد بالأحماض الأمينية (٢,٦٢ جم علف / جم كتلة بيض).

سجلت العلائق المحتوية على ١٢% بروتين خام مع الإمداد بالأحماض الأمينية أحسن قيمة معنوية لدليل شكل البيضة (٨٠,٢٤%). كانت أحسن قيمة لوزن الصفار للعلائق المحتوية على ١٤% بروتين خام و١٤% بروتين خام مع الإمداد بالأحماض الأمينية (٣٩,٣٠ و٣٩,٢١%) على التوالى، بينما كانت أحسن قيمة معنوية لدليل الصفار للعلائق المحتوية على ١٤% بروتين خام مع الإمداد بالأحماض الأمينية (٤٤,١٥). سجل الدجاج المغذى على ١٢% بروتين خام مع الإمداد بالأحماض الأمينية أحسن قيمة لوحدات هاو(٩٠,١٥).

سجلت العلائق المحتوية على ١٤% بروتين خام مع الإمداد بالأحماض الأمينية أحسن قيم للكفاءة الأقتصادية و الكفاءة الإقتصادية النسبية (٠,٨١ ، ١١٧,٣٩ %) يليها الدجاج المغذى على ١٦% بروتين خام (٠,٦٩ ، ١٠٠ %).

وعموما تشير النتائج السابقة الى انه يمكن الحصول على إنتاج بيض وجودة بيض لدجاج مطروح المحلى بالتغذية على علائق تحتوى على ١٤% بروتين خام مع الإمداد بالأحماض الأمينية المثيونين والليسين بصورة مكافئة للعلائق المحتوية على ١٦% بروتين خام. أضافة الى ذلك الدجاج المغذى على ١٤% بروتين خام مع الإمداد بالاحماض الأمينية المثيونين والليسين سجل أفضل كفاءة إقتصادية و كفاءة أقتصادية نسبية.