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METHIONINE AND LYSINE SUPPLEMENTATIONS IN DIETS OR DRINKING WATER OF ONE-PHASE LOW DIETARY PROTEIN FEEDING SYSTEM

1- EFFECTS ON BODY WEIGHT, FEED UTILIZATION AND AGE AT SEXUAL MATURITY IN GROWING CHICKS

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This experiment was conducted to study the effect of methionine and lysine supplementation out to the level of 120% of requirements in feed or drinking water for one-phase low protein diet during growing period. A total number of 200 one-day old H and N brown nick female chicks were divided into three groups. Control group (C) fed according to the strain requirements on diets with 17, 15 and 14% CP during the periods of 0-5, 6-15 and 16-18 weeks of age. The other two groups were fed on one-phase low protein diet (14%CP) supplemented with methionine and lysine to the level of 120% of requirements either in feed (F) or drinking water (W).

Live weight has significantly ($P<0.05$) decreased at the first five weeks of age in groups F and W compared to group C. However, during the growing period (0-18 weeks), live body weight of group W (1522 gm) did not significantly differ than group C(1533 gm). Growth rate showed no significant differences in the experimental groups throughout the whole growing period.

Feed intake values (gm/bird/day) during 0-18 weeks of age were 55.05, 53.09 and 56.21 in C, F and W group, respectively. Through 0-18 weeks old, feed efficiency values were 0.213, 0.210 and 0.206 for the same groups, respectively. Birds in F and W groups consumed less protein than group C (9.38 gm/bird/day) during 0-18 weeks of age. Moreover, F and W groups recorded insignificantly better protein utilization value compared to C group. Age at sexual maturity was 130, 125 and 129 days for birds grown on C, F and W groups, respectively.

It could be recommended to use one-phase low protein diet (14% CP) supplemented with methionine and lysine to the level of 120% of requirements either in diet or drinking water for H and N female chicks during growing period.

Keywords: growing chicks, methionine, lysine, body weight, feed utilization, sexual maturity

The feeding costs of poultry production are generally the most expensive item, particularly the protein cost. Therefore, many workers tried to reduce feed costs by decreasing protein levels and supplementing diets with free amino acids especially methionine and lysine. For example, Chi (1985) and Keshavarz and Jackson (1992) reported no significant differences in body weight and feed intake of Leghorn chicks kept on 14.9% crude protein and supplemented by methionine and lysine when compared to those fed on 18.2% crude protein diet without supplementation. However, Douglas *et al.* (1985) found that birds receiving 14% crude protein plus supplemental methionine and lysine consumed less feed than birds fed 17% crude protein.

Sharma *et al.* (1990) and El-Khimsawy and El-Sharkawy (1991) reported that birds received low protein diet supplemented with methionine and lysine at 120% of suggested level of NRC gave better feed efficiency compared to the higher CP level.

Damron and Goodson-Williams (1987) and El-Khimsawy and El-Sharkawy (1991) found that the chicks received amino acids in drinking water gave slightly heavier live body weights than those received amino acids in the feed. In contrast, Boulos *et al.* (1987) and El-Khimsawy and El-Sharkawy (1991) found that amino acid supplementation in drinking water had no clear effect on feed consumption.

Chi (1984) and Mohamed (1994) reported that increasing protein level in the diet of growing chicks lead to an increase in the amount of protein intake and decrease the efficiency of protein utilization. However, Chi (1985) and El-Khimsawy (1992) reported that the lowest protein level gave the best efficiency of protein utilization. Proudfoot and Hulan (1986) reported that livability of growing birds was not influenced by dietary treatment.

Sexual maturity as judged by age at first egg was delayed for pullets fed on low protein diet supplemented with 2 gm DL- methionine/Kg (Chi, 1985). While, Maurice *et al.* (1982) and Okazaki *et al.* (1995) revealed that rearing regimens did not affect sexual maturity.

The aim of the present work is to study the effect of decreasing protein level and adding free amino acids either in diet or drinking water, on body weight, weight gain, feed utilization and age at sexual maturity in growing chicks.

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MATERIALS AND METHODS

The present work was carried out at the Poultry Experimental Station, Faculty of Agriculture, AL-Azhar University to study the effect of methionine and lysine supplementation either in diet or in drinking water for one-phase low protein diet on performance of growing chicks. Pure crystalline powder of DL-methionine and L-lysine were used in this experiment as they have a good solubility in water and easy to mix with diet.

A total number of 200 one-day old females H&N "Brown Neck" chicks hatched on October, 1997 were randomly distributed into three experimental groups; Control (C), Feed (F) and Water (W) treatments. 70 birds in control treatment (C), were divided into 3 replicates (23, 23 and 24 birds) and fed on 17% CP diet from first day to 5th weeks of age (stage I), 15% CP diet from 6-15 weeks of age (stage II) and 14% CP diet from 16-18 weeks of age (stage III), 65 birds in treatments (F) and also the same number in treatment (W), each divided into 3 replicates (22, 22 and 21 birds) and fed on one phase low protein diet (14% CP) supplemented by methionine and lysine either in feed or drinking water to the level of 120% of requirements, respectively. Formulation and chemical composition of the experimental growing diets are shown in table (1).

During rearing period, chicks were weighed weekly. Feed consumption, live body gain and mortality rate were recorded. Rate of growth was calculated as Rate of growth = 200 [We - Wo / d (We + Wo)] where: We = weight at any time, Wo = initial weight and d = days of period (El-khimsawy, 1983).

Feed efficiency was calculated as live body weight gain divided by feed consumed. Protein utilization was calculated as live body weight gain on protein consumed. Sexual maturity as judged by age at first age was also recorded.

Statistical Analysis

Analysis of variance was carried out according to Snedecor and Cochran (1967). Significant differences between means were made by Duncans multiple range test (SAS, 1988). The linear model for the experiment was as follows:

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

where: Y_{ij} = the j observation on the i th treatment

μ= Over all mean

T_i = Effect of the i^{th} treatment. (i = 1, 2 and 3)

e_{ij} = Random error treatment.

TABLE (1). Composition and analysis of growing diets during 0-18 weeks.

Ingredients	Control diets			Experimental diets		
	week 0-5	week 6-15	week 16-18	week 0-5	week 6-15	week 16-18
Yellow corn	67.5	70.5	71.0	71.0	71.0	71.0
Soybean meal (44% CP)	17.0	13.5	13.7	13.14	13.21	13.7
Concentrate [a]	4.5	2.5	1	1	1	1
Wheat bran	8.5	10.3	10.5	10.5	10.5	10.5
Calcium carbonate	0.9	1.25	1.43	1.43	1.43	1.43
Di calcium phosphate	0.6	0.95	1.37	1.37	1.37	1.37
DL-methionine	-	-	-	0.23	0.22	-
L-lysine	-	-	-	0.33	0.27	-
Vit. B complex [b]	0.25	0.25	0.25	0.25	0.25	0.25
Vit. AD3E [c]	0.25	0.25	0.25	0.25	0.25	0.25
Mineral mix. [d]	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**	**100**
Calculated values						
Crude protein %	17.04	15.03	14.01	14.01	14.01	14.01
ME (Kcal /kg)	2858	2856	2854	2854	2854	2854
Calcium %	0.9	0.9	0.9	0.9	0.9	0.9
Av. phosphorous %	0.41	0.41	0.4	0.4	0.4	0.4
Methionine + Cys. %	0.6	0.59	0.5	0.72	0.69	0.5
Lysine %	0.8	0.75	0.6	0.96	0.9	0.6
Analyzed values						
CP %	17.19	15.18	14.20	14.04	14.02	14.20
EE %	2.50	1.71	2.35	2.11	1.82	2.35
CF %	2.83	3.45	2.83	2.75	2.77	2.83
NFE %	62.28	66.34	67.42	66.33	66.74	67.42
OM %	84.80	86.68	86.80	85.23	85.35	86.80
Ash %	6.12	5.34	5.38	5.41	6.92	5.38
DM %	90.92	92.02	92.18	90.64	92.27	92.18
Moisture %	9.08	7.98	7.82	9.36	7.73	7.82
Total	**100**	**100**	**100**	**100**	**100**	**100**

[a] Contains CP 51%; ME 2400 Kcal /kg; Ca 8%; Av. p. 3.51%; Met. 1.69%; Lys 3.19%.
[b] Each kg contains: vit. B1 20 gm; vit. B2 4.5 gm; vit. B6 3 gm ; vit. B12 13 gm; choline chlorid 100 gm.
[c] Each kg contains: vit. A 20,000 IU; vit. D3 2000 IU; vit. E 400 IU.; K2 1 gm
[d] Each kg contains: Mn 40 gm ; Zn 45 gm ; Cu 3 gm ; Fe 30 gm ; I 0.3 gm ; Se o.1 gm.

RESULTS AND DISCUSSION

Effect of Dietary Methionine and Lysine Supplementation to Low Protein Diet on:

Body weight and rate of growth

Using one phase low protein diet supplemented with methionine and lysine either in feed or in drinking water (Table 2) significantly ($P<0.05$)

decreased live body weight at the first five weeks of age. This result agreed with Boulos *et al.* (1987) who reported that most of the differences between the live body weight of the chicks received amino acids either in feed or drinking water had occured in the second and third weeks of age. In the same way, Abdel-Hakim *et al.* (1992) added that live body weights of L.S.L chicks received 15% crude protein in the diet was 327 gm at the 6th week of age compared to 375 gm for that received 17% crude protein level in the diet.

Live body weight of H and N chicks at the 15-weeks old was not affected by the crude protein level in the diet as long as methionine and lysine requirements was added (Table 2). This result had been confirmed previously by Chi (1985), Abdel-Hakim *et al.* (1992) and El-Khimsawy (1992). At 18-weeks, averages of live body weight were 1533, 1565 and 1522 gm for C, F and W groups, respectively. Analysis of variance indicated that differences between C and F groups were significant ($p<0.05$), while the differences among W group and other groups were insignificant. These results illustrated that one-phase low protein diet supplemented with methionine and lysine at 120% of suggested level by NRC (1994) in drinking water for H and N layer strain chicks attained live body weight nearly equal to control regimen (step-down dietary protein regimen).

In the present study, average live body weights of H and N chicks throughout the experimental period (0-18 weeks) showed no significant differences among the different treatments. Similarly, Chi (1985) and Keshavarz and Jackson (1992) cleared that White Leghorn chicks kept on lower crude protein supplemented by methionine and lysine were similar in weight to pullets fed on high crude protein diet without supplementation.

It is worth to note that live body weights of chicks received the diet supplied with amino acids in drinking water were heavier particularly at the first five weeks ($P<0.05$) than that received the amino acids in feed. Similar findings were obtained by Damron and Goodson-Williams (1987), El-Kimsawy and El-Sharkawy (1991) and El-Khimsawy (1992). This might be due to that methionine and lysine providing in the drinking water are effectively assimilated by chicks and increased total amino acids intake and hence, improved live body weight feed was higher in W treatment.

The present study showed that the influence of the starter diets (0-5 weeks) on body weight disappeared with the increasing of age up to 18 weeks. This result indicates that the protein requirements of H and N layer-type chickens during growing period are less than 17% and gradually decreasing with advanced age up to 18 weeks. This mean that satisfactory growth with considerable savings of protein and adding lysine and methionine could be achieved during the growing period.

Observation of growth rate (Table 2) indicated that control group was significantly ($P<0.05$) better than other groups during 0-5 weeks old. While

during 6-15 weeks old, control group was lower than groups F and W. However, during 16-18 and 0-18 weeks old, there were no significant differences among treatment groups. This explained that birds of F and W groups became more adapted to the experimental diets after 5 weeks of age and showed sometimes higher significant values in growth rate compared to C group.

TABLE (2). Body weight and rate of growth of H and N chicks from 0-18 weeks of age as affected by dietary protein and amino acids programs.

Treatment-	initial weight (gm.)	Age (weeks)							
		0 – 5		6 - 15		16 – 18		0 – 18	
		Body weight (gm.)	Rate of Growth (%)	Body weight (gm.)	Rate of growth (%)	Body Weight (gm.)	Rate of Growth (%)	Body weight (gm.)	Rate of growth (%)
C	40	275A	4.262A	1242A	1.821B	1533A	1.001A	1533	1.507
F	39	237C	4.096B	1211A	1.923A	1465B	0.905A	1465	1.505
W	38	250B	4.209A	1251A	1.903A	1522AB	0.935A	1522	1.510

Means in same column with the same letter **A,B**,..are not significantly different ($p<0.05$).

Body weight gain, feed intake and feed efficiency

Body weight gain (gm/bird/day) did not significantly influenced by different treatments throughout the whole experiment (Table 3). Birds in group F showed insignificant decrease in feed intake compared to C or W groups during 0-5 weeks. This result support findings by Douglas *et al.* (1985), as birds receiving 14% CP plus added methionine and lysine consumed less feed than birds fed 17% CP. However, the present study revealed no difference between feed intake of C and W groups at 5 weeks of age. During 6-15 weeks old, analysis of variance showed that birds in group W consumed more feed ($P< 0.05$) compared to birds in group F, while differences among C and other groups were insignificant. These results indicate that supplementation of methionine and lysine in one-phase low protein diet decreased feed intake, while addition of the same amino acids in drinking water resulted in increasing feed intake. However, Chi (1985) and Douglas *et al.* (1985) reported that feed consumption of birds fed low protein diet supplemented with methionine and lysine was insignificantly less than that fed high protein diet without supplementation. In contrast, Damron and Goodson-Williams (1987) found that control chicks ate significantly less feed than chicks received liquid methionine in the drinking water. Generally, El-Khimsawy and El-Sharkawy (1991) cleared that amino acid supplementation in drinking water had no clear effect on feed consumption. Similar results were obtained by Boulos *et al.* (1987) and El-Khimsawy (1992).

During 0-5 weeks, control group attained feed efficiency better than that of groups F and W which nearly attained the same number of feed efficiency.

During 6-15 weeks, C group attained feed efficiency significantly ($P<0.05$) worse than that of F and W groups, also F group attained better feed efficiency than that of W group. During 16-18 weeks and during whole growing period, all differences among feed efficiency were insignificant. These results are in agreement with those reported by Chi (1984). Also, Sharma *et al.* (1990) and EL-Khimsawy and EL-Sharkawy (1991) reported that groups received low protein diet supplemented with methionine and lysine at 120% of suggested level of NRC gave better feed efficiency.

TABLE (3). Effect of dietary protein and amino acid programs on average body weight gain, feed intake and feed efficiency of H and N chicks during growing period.

Treatment	Measurements	Age (weeks)							
		0-5		6-15		16 - 18		0 - 18	
		(gm)	(%)	(gm)	(%)	(gm)	(%)	(gm)	(%)
C. group	Gain gm / bird / day	6.17	100	a 13.82	100	a 13.90	100	11.7	100
	Feed intake gm / bird /day	18.25	100	AB 59.27	100	A 87.62	100	55.05	100
	Feed efficiency	0.338	100	*C* 0.233	100	*A* 0.159	100	0.213	100
F. group	Gain gm / bird / day	4.99	80.9	a 13.92	100.7	a 12.13	87.3	11.13	95.1
	Feed intake gm / bird / day	16.67	91.3	B 56.03	94.5	A 86.58	98.8	53.09	96.4
	Feed efficiency	0.299	88.5	*A* 0.248	106.4	*A* 0.140	88.1	0.210	98.6
W. group	Gain gm / bird / day	5.42	87.8	a 14.29	103.4	a 12.98	93.4	11.60	99.2
	Feed intake gm / bird / day	18.20	99.7	A 59.59	100.5	A 90.85	103.7	56.21	102.1
	Feed efficiency	0.298	88.2	*B* 0.240	103	*A* 0.143	89.9	0.206	96.7

Means in column with the same letter (a,b,..), (A,B,..) or (*A*,*B*,..) are not significantly different ($p<0.05$)

Protein utilization

Birds in F and W groups ate less protein than control group at all experimental growing periods with slightly difference between them (Table 4). This is a logical result, as birds kept on low protein level consumed less feed than that kept on high protein level. In other words, birds received low protein level consumed equal or less feed compared to that received high protein level. This, however, confirmed by Proudfoot and Hulan (1986) who found that the amount of protein consumed during rearing period

differed significantly between low and high protein diet. Similar results also, obtained by Cheng *et al.* (1991).

During 0-5 weeks, protein utilization of group C was worse than that of group F or W, while groups F and W recorded equal protein values. These results were in agreement with those showed by Chi (1984) and Mohamed (1994) who reported that increasing protein level in the diet of growing chicks lead to an increase in amount of protein intake and decrease the efficiency of protein utilization.

During 6-15 weeks, protein utilization recorded by F group was significantly ($P < 0.05$) better than those of C or W group. Chicks of group W attained significantly ($P<0.05$) better protein utilization than the corresponding value of group C. These results were in agreement with finding obtained by Chi (1985) and EL-Khimsawy (1992) who reported that the lowest protein level gave the best efficiency of protein utilization.

During 16-18 weeks of age, protein utilization of control group was slightly worse than those of F and W group, which showed a close difference of protein. These results may be because the protein level in the diet during this period was similar in all experimental groups (14% CP), while the slight difference may be because diets received by F and W group were supplemented by methionine and lysine. However, Sharma *et al.* (1990) and EL-Khimsawy and EL-Sharkawy (1991) reported that groups received diet supplemented with methionine and lysine at 120% of suggested level of NRC (1994) gave better protein efficiency.

Generally, during the whole period of growing (0-18 weeks) it could be noticed that birds of group F and W recorded better protein efficiency than group C (about 120 and 117.6%, respectively). These results might be due to the fact that groups of F and W fed a diet which had two improving factors for protein utilization namely low protein level and supplementation with crystalline amino acids (El-Khimsawy, 1992 and Mohamed, 1994) and (Sharma *et al.*, 1990 and El-Khimsawy and El-Sharkawy, 1991).

The beneficial effect of amino acid supplementation may be due to the direction of the greatest part of the available protein to the production of meat. This is accompanied by the decrease of waste because none of amino acids can be limiting to the use of the other as all of them are available almost in the ratio needed to compose the protein produced (El-Khimsawy and El-Sharkawy, 1991).

Age at sexual maturity

Sexual maturity of H and N pullets as affected by feed treatment either fed on step-down dietary protein of 17, 15 and 14% CP as control (C) or one-phase low protein diet supplemented with methionine and lysine either in feed (F) or in drinking water (W) is shown in table (5).

Age at first egg was found to be 130, 125, and 129 days for chicks grown on C, F and W treatments, respectively. It could be clearly noticed

that birds grown on F treatment matured sexually early than birds in C and W groups. However, differences among the experimental groups were not significant.

TABLE (4). Effect of dietary protein and amino acids programs on protein utilization of H and N chicks during growing period.

Treatments	Measurements	Age (weeks)				
		0 - 5	6 - 15	16 – 18	0 - 18	%
C. group	Protein intake gm / bird / day	3.11	a 10.10	a 14.93	9.38	100
	Protein efficiency	1.98	C 1.37	A 0.93	1.25	100
F. group	Protein intake gm / bird / day	2.34	b 7.84	b 12.13	7.44	79.3
	Protein efficiency	2.13	A 1.78	A 1.00	1.50	120
W. group	Protein intake gm / bird / day	2.55	b 8.34	b 12.72	7.88	84.0
	Protein efficiency	2.13	B 1.71	A 1.03	1.47	117.6

Means in same column with the same letter (a,b,..) or (A,B,..) are not significantly different ($p<0.05$).

The previous results were in the contrary of those found by Chi (1985) who reported that sexual maturity as judged by age at first egg was delayed for pullets fed on low protein diet supplemented with 2 gm DL-methionine /Kg. On the other hand, Maurice *et al.* (1982) concluded that rearing regimens did not affect sexual maturity. Also, Okazaki *et al.* (1995) found that age at first egg was not affected by different treatment diets contained 100, 115 and 130% of NRC requirements of nutrients.

These results gave a proof that age at first egg was insufficient parameter for judgment the sexual maturity compared to age at 10% egg production because the first parameter was very changeable by the individual variation of chicks.

TABLE (5). Effect of dietary protein and amino acid programs during growing period on age at sexual maturity.

Measurements	Treatments		
	C	F	W
Number of birds	66	67	67
Body weight at 18 weeks kg	1.533a	1.465b	1.522ab
Age at first egg production day	130	125	129

Means in same column with the same letter are not significantly different

Mortality rate

Mortality rate of H and N laying-type grower chicks fed on step-down dietary protein regimen (C) or one phase low protein diet supplemented by methionine and lysine either in feed (F) or in drinking water (W) were found to be 3, 1 and 2 birds for groups C, F and W, respectively, during 0-2 weeks, after that no mortality were recorded (Table 6).

These results were in the contrary of findings by Carlson and Nelson (1981) who found that the livability was slightly higher for birds grown on the low protein diet. On the other hand, Proudfoot and Hulan (1986) and Keshavarz and Jackson (1992) reported that livability was not influenced by dietary treatments.

TABLE (6). Mortality rate of chicks in the different experimental groups

Measurements	C	F	W
No. of birds	66	67	67
Mortality number	3	1	2
Mortality rate%	4.55	1.49	2.99

Economical evaluation

Table (7) showed that birds grown on F treatment attained the lowest feed cost and also the lowest cost per Kg live body weight chicks followed by those grown on W treatment, while chicks grown on C diet recorded the highest value in this respect. However, this result agreed with those reported by Proudfoot and Hulan (1986).

TABLE (7). Economical evaluation as affected by dietary protein and amino acid supplementation during growing period.

Measurements	C	F	W
Total feed cost (L.E. /bird)	6.627	5.987	6.530
Relative feed cost/bird	100	90.30	98.5
Average body weight gain, Kg (0-18 wks)	1.467	1.466	1.472
Total cost (L.E./ Kg live body weight)	4.517	4.084	4.436
Relative cost	100	90.4	98.2

It could be recommended to use one-phase low protein diet (14% CP) supplemented with methionine and lysine to the level of 120% of requirements either in diet or drinking water for H&N female chicks during 0-18 weeks of growing period.

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التدعيم بالميثيونين والليسين فى العليقة أو ماء الشرب لنظام التغذية على مستوى واحد من البروتين المنخفض.

١- التأثير على وزن الجسم، الاستفادة من الغذاء والعمر عند النضج الجنسي في الدجاج النامي.

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أجريت هذه التجربة لدراسة تأثير الدعم بالميثيونين والليسين إلى مستوى ١٢٠% من الاحتياجات في العليقة أو ماء الشرب لنظام التغذية على مستوى واحد منخفض من البروتين وذلك في مرحلة النمو. تم تقسيم عدد ٢٠٠ كتكوت H and N إناث عمر يوم إلى ثلاث مجموعات. غذيت مجموعة المقارنة (C) على مستويات بروتين ١٧، ١٥، ١٤% في المراحل من ٠-٥، ٦-١٥، ١٦-١٨ أسبوع على الترتيب حسب احتياجات السلالة. حصلت مجموعة (F) على مستوى واحد من البروتين هو ١٤% مع الدعم بالميثيونين والليسين إلى مستوى ١٢٠% من الاحتياجات في العليقة، بينما حصلت مجموعة (W) على نفس العليقة السابقة ولكن كان الدعم في ماء الشرب.

لوحظ إنخفاضا معنويا في متوسط وزن الجسم في طيور المجاميع W ، F عند عمر ٥ أسابيع بالمقارنة بمجموعة المقارنة C وبوجه عام لم يكن هناك اختلاف حقيقي بين المجموعة W (١٥٢٢جم) ومجموعة المقارنة (١٥٣٣جم) أو بين المجموعة W والمجموعة F (١٤٦٥ جم). لم يكن هناك فارق معنوي في معدل النمو بين المجموعات خلال فترة النمو الكلية. إستهلكت طيور مجموعة F كمية غذاء أقل من باقي المجموعات (٥٣,٠٩ جم/طائر/يوم) بينما إستهلكت طيور المجموعة W أكبر كمية غذاء (٥٦,٢١ جم/طائر/يوم) وإستهلكت مجموعة المقارنة ٥٥,٠٥ جم/طائر/يوم.

حققت مجموعة المقارنة خلال فترة النمو الكلية (٠-١٨ أسبوع) كفاءة تحويل (٠,٢١٣) أفضل من مجموعتي F (٠,٢١) ، W (٠,٢٠٦) إلا أن الفروق لم تكن معنوية في هذا الصدد. إستهلكت طيور مجموعتي W، F كمية بروتين أقل من مجموعة المقارنة وذلك خلال فترة النمو. في الفترة من ٠-١٨ أسبوع كانت كفاءة البروتين لطيور مجموعتي W، F أفضل من مجموعة المقارنة. كان الفارق معنويا خلال الفترة من ٦-١٥ أسبوع بينما لم يكن هناك فارق معنوي خلال الفترة من ١٦-١٨ أسبوع. كان العمر عند النضج الجنسي هو ١٣٠، ١٢٥ و ١٢٩ يوم في كل من C ، F، W أسرع على التوالي.

خلصت هذه الدراسة إلى أنه يمكن التوصية بعمل عليقة منخفضة في نسبة البروتين (١٤%) للكتاكيت النامية من سلالة H and N Brown Neck مع إضافة الليسين والميثيونين حتى مستوى ١٢٠% من الاحتياجات الفعلية فى العليقة أو مياه الشرب للحصول على أداء إنتاجي جيد لهذه الطيور.