PROTEIN AND TOTAL SULFUR AMINO ACIDS RELATIONSHIP EFFECT ON PERFORMANCE AND SOME BLOOD PARAMETERS OF LAYING HENS.

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(Received 21/10/2011, Accepted 30/12/2011)

SUMMARY

A total number of 180 Lohmann hens 18-wks-old were randomly divided into 9 experimental groups of 5 replicates each. A 3×3 factorial design containing three levels of crude protein (16,18 and 20%) and three levels of total sulfur amino acids (0.67, 0.72 and 0.77%) to study the effect of dietary crude protein and total sulfur amino acids (TSAA) on egg production and some blood constituents during the period from 18-34 wks of age. Egg number and egg mass were increased (P<0.01) for hens fed diets of 20 and 18% CP versus that of 16% protein through the period from 26-30 wks of age. There were no significant effects of dietary protein levels on globulin, uric acid and creatine, while total protein, albumen and urea of hens fed the high and moderate protein diet were significantly greater than those of hens fed the low-protein diet from 30-34 wks. Feed and protein efficiency values were improved with 0.67 and 0.72% TSAA during 26- 30 wks of age. Whilst, feed intake and feed and protein efficiency at the other studied ages were not significantly affected by TSAA levels. Economical efficiency was affected with different levels of TSAA, whereas, 0.72% TSAA recorded the highest value versus 0.67 or 0.77% TSAA diet at all ages. Interaction between dietary protein and TSAA levels did not reach to significant level, except for egg number at 26-30 and 30-34 wks of age that differed significantly (P<0.01). It could be conducted that dietary level of 18% crude protein with 0.72% TSAA is recommended for improving laying hens performance through 18-34 wks of age.

***Keywords:** Lohmann performance; blood constituent; economics; protein; TSAA.*

INTRODUCTION

Maximizing of egg production profits is depending on flock performance, egg and feed prices, and farm management. Many factors have some effects on productive performance of laying birds. Factors Such as nutrient levels of the diet must be optimized not maximized to optimize profits. For example, depending on egg and feed prices, the maximum performance may or may not result in maximum profits. Consuming 14 % crude protein caused a significantly reduction in egg performance for hens at 21-33 wk of age comparing with that of hens consumed 16 or 18 % crude protein (Chaiyapoom *et al.* 2005). Baiao *et al.* (1999), Liu *et al.* (2005) and Wu *et al.* (2005[a]) reported that increasing TSAA had positive effect on fed efficiency and performance of laying hens.

Novak *et al.* (2004) reported that dietary TSAA level for maximum egg production and feed efficiency were 811 and 699 mg per hen daily, respectively. Silva *et al.* (2005) reported that increasing of TSAA from 0.484 to 0.734% had an effect on egg production, egg weight, feed intake, feed conversion and body weight. They also indicated that TSAA requirements for maximizing egg production, egg weight, egg mass and body weight gain and minimizing feed conversion were 0.658, 0.681, 0.664, 0.683, and 0.6665%, respectively. On contrary, Ahmad and Roland (2003) found little or no effect on egg production, feed consumption when various levels of TSAA were fed to laying hens. Methionine + cystine levels (0.517, 0.569, 0.624, 0.679, and 0.734%) did not significantly affect feed intake, while feed conversion and egg production were positive influenced by methionine + cystine level in laying hen diets (Sá *et al.* 2007).

The objectives of this study will be, quantitively describe the effect of increasing and decreasing dietary levels of protein and TSAA on productive performance, some blood parameters and economic evaluation of Lohmann laying hens.

MATERIALS AND METHODS

The present work was conducted in Poultry research Farm, Department of Poultry, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. A total number of 180 "Lohmann" hens of 18-wks-old were randomly divided into 9 experimental groups of 5 replicates each. Hens were housed in conventional type cage 25×40×50 cm provided with feed and water for *ad-libitum*. Hens were maintained on a 16L: 8D throughout the trial.

A 3×3 factorial design containing three levels of crude protein (16, 18 and 20%) and three levels of TSAA (0.67, 0.72 and 0.77%) to study the effect of dietary crude protein and TSAA on egg production and blood constituents during the period from 18-34 wks of age. The experimental diets were formulated to be isocaloric and supplemented with DL-methionine to meet the required of TSAA. The composition and chemical analysis of the experimental diets are presented in Tables (1 and 2).

Eggs were collected daily, while feed consumption and egg production were calculated biweekly intervals. Egg weight was recorded two times weekly. Egg mass (egg weight x egg production), feed efficiency (g of egg /g of feed) and protein efficiency ratio (g of egg /g of protein consumed) were determined every 4 wk interval.

At the end of the experimental period (34 wks of age,), blood samples were randomly collected from three birds per each treatment from wing vein into sterilized tubes that closed with rubber stoppers and gently shacked to dissolve the anticoagulant heparin. Blood samples were centrifuged at 4000 rpm for ten minutes and plasma was separated for analyzing process for total proteins "TP" (g/dl), albumin "Alb" (g/dl), globulin (g/dl), AST (U/L) and ALT (U/L), urea (mg/dl), uric acid (mg/dl), creatine (mg/dl) were determined using available commercial kits as described by the manufacture companies (spectrum, diagnostics, Egypt, Co. for biotechnology, S. A. E.) were determined by RIA technique as described by Akiba *et al.* (1982).

Economic evaluation for all experimental diets was calculated as the net revenue per unit feed cost that calculated from input-output analysis as described by (Zeweil *et al.* 1996). Data were statistically analyzed on a 3×3 factorial design basis according to Snedecor and Cochran, (1982) using the following model:

$$Y_{ijk} = \mu + A_i + S_j + AS_{ij} + e_{ijk}$$

Where: Y_{ijk} = an observation, μ = the overall mean, A_i = effect of protein level (i=1 to 3), S_j = effect of TSAA level (j =1 to 3), AS_{ij} =the interaction between two variables and e_{ijk}= Experimental random error. Duncan's New Multiple Range test (Duncan, 1955).

Table (1). Ingredient composition of the experimental diets.

Protein levels %	16			18			20		
TSAA levels %	0.67	0.72	0.77	0.67	0.72	0.77	0.67	0.72	0.77
Ingredients:									
Yellow corn	67.34	67.34	67.34	62.14	62.14	62.13	53.00	53.00	53.00
Soybean meal 44%	15.50	15.50	15.50	22.00	22.00	22.00	31.05	31.05	31.05
Corn gluten meal 62%	4.43	4.38	4.33	4.41	4.36	4.31	2.70	2.64	2.59
Wheat bran%	1.80	1.80	1.80	-	-	-	-	-	-
Cotton seed oil	-	-	-	0.70	0.70	0.70	2.75	2.75	2.75
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Vitamin premix [1]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Mineral premix [2]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Dicalcium phosphate	1.86	1.86	1.86	1.80	1.80	1.80	1.70	1.70	1.70
Limestone	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20
L-lysine	0.17	0.17	0.17	0.11	0.11	0.11	-	-	-
Dl-Methionine	0.10	0.15	0.20	0.04	0.09	0.15	-	0.06	0.11
Total	100	100	100	100	100	100	100	100	100

[1]*Layer vitamin Premix: Each 1.5 Kg consists of : Vit. A 12000.000 IU; Vit. D3, 2000.000 ICU, Vit.E 10g; Vit. K 328 ; Vit. B1, 1000 Mg; Vit. B2, 5000 Mg; Vit. B6, 1500 Mg, Vit. B12,10 Mg ; Biotin 50 Mg; Pantothenic acid , 10 g; Niacin, 30 g; Folic acid, 1000 Mg;*

[2]*Layer Mineral Premix: Each 1.5 Kg consists of Mn. 60 g; Zn. 50 g; Cu; 10g; I. 1000Mg; Si. 100Mg; Co.1000Mg.*

Table (2). Calculated and analyzed composition of experimental diets.

Protein levels %	16			18			20		
TSAA levels %	0.67	0.72	0.77	0.67	0.72	0.77	0.67	0.72	0.77
ME, Kcal /Kg[1]	2800	2800	2800	2801	2801	2801	2800	2800	2800
Crude protein %[1]	16.01	16.01	16.01	18.03	18.03	18.02	19.98	19.98	19.98
Crude protein% "analyzed"[2]	15.65	17.23	17.23	17.28	19.66	19.71	20.13	22.28	21.30
Calcium%[1]	3.64	3.64	3.64	3.64	3.64	3.64	3.62	3.62	3.62
Nonphytate P %[1]	0.45	0.45	0.45	0.45	0.45	0.45	0.43	0.43	0.43
Lysine%[1]	0.84	0.84	0.84	0.94	0.94	0.94	1.04	1.04	1.04
Methionine%[1]	0.41	0.46	0.51	0.39	0.44	0.49	0.37	0.42	0.47
Cystine%[1]	0.26	0.26	0.26	0.28	0.28	0.28	0.30	0.30	0.30
TSAA %[1]	0.67	0.72	0.77	0.67	0.72	0.77	0.67	0.72	0.77
Crude fat % analyzed"[2]	4.47	4.83	4.88	4.20	5.00	5.20	4.00	5.11	5.20
Ash % "analyzed"[2]	12.85	14.00	7.14	10.00	11.12	10.63	10.99	11.11	13.11
Moisture "analyzed"[2]	9.45	10.90	9.85	9.99	10.00	10.37	10.00	9.98	10.22
TSAA of % CP[1]	4.18	4.50	4.81	3.72	4.00	4.27	3.35	3.60	3.85
Lysine of % CP[1]	2.25	5.25	5.25	2.25	5.25	5.25	2.25	5.25	5.25
Choline mg / Kg[1]	855	855	855	1000	1000	1000	1180	1180	1180
Price / ton diet, L.E[3]	2389	2404	2419	2465	2480	2498	2602	2620	2635

[1]*Calculated according to NRC (1984).*
[2]*Analyzed according to (A.O.A.C. 1990)*
[3]*Caculated according to the price of feed ingredients when the experiment was started.*

RESULTS AND DISCUSSION

Feed utilization

Results shown in Tables (3 and 4) indicated that feed intake during 20-30 wk of age and feed efficiency ratio during 22-34 wk of age of laying hens fed the 20% crude protein diet were improved (P<0.05 or 0.01) comparing with those obtained from hens fed 16 and 18 % crude protein diet. Protein efficiency values for 16 and 18 % protein diet were significantly higher (P<0.01) than those of 20% protein diet during almost the experimental period (Table 5). These results agreed with that of Si *et al.* (2004[a,b]) and Dean *et al.* (2006) reported similar results with reduced gain: feed ratio when CP levels were reduced below 22%.

Only feed efficiency at 26-30 or 18-34 wks of age (Table 4) and protein efficiency values at 26-30 wks of age (Table 5) were improved significantly (P<0.05) with 0.67 and 0.72% TSAA in the diets. Whilst, feed intake, feed efficiency and protein efficiency at the other studied ages were not significantly affected by TSAA levels as shown in Tables (3, 4 and 5). The obtained results coincided with those found by Novak *et al.* (2004) who reported that feed efficiency was not significantly improved with increasing of TSAA intake during the first phase of feeding (20 to 40 wks of age).

It is evident from the obtained results that diet of 18% CP with 0.67 TSAA at 26-30 wks of age recorded the highest value of feed efficiency and protein efficiency ratio meanwhile the worst ones were recorded by using 18% protein diet with 0.77% TSAA diet and 20% protein diet with 0.67% TSAA diet for feed efficiency ratio and protein efficiency, respectively at 26-30 wks of age. While during the other studied phases, the difference in feed utilization had insignificant effect. These results are in harmony with those stated by Novak *et al.* (2006) who found that there is no significant difference for interaction between protein diet and TSAA on feed intake and feed conversion for laying hens at the early period of production. Baratov (1979) reported an increase in feed intake for chicken fed low protein diets.

Egg number and egg mass

Data presented in Tables (6 and 7) reveal that egg number at 26- 30 wks old and egg mass during the experimental period from 22- 34 wks old for laying hens were significantly increased (P<0.01) by feeding diets of 20 and 18% CP comparing with those of 16% crude protein. Similar results were reported by Novak *et al.* (2006) concluded that egg production was reduced by 2% in response to feeding low protein diet, whereas hens fed the high and medium protein diets recorded similar values of the same traits.

Egg number and egg mass did not differ significantly due to TSAA levels except those of whole trail period (22-34 wks of age) that differed significantly (P<0.05). Birds received 0.72% of TSAA recorded the highest values for the two traits. Liu *et al.* (2005) and Wu *et al.* (2005[a]) reported that increasing dietary levels of TSAA from 0.67 to 0.77% improved egg production and egg mass. The low egg production of hens fed the low level of TSAA can partially attributed to amino acid imbalance which causes the decrease of protein synthesis, inhibits absorption and increase catabolism of the essential amino acids (Harper 1956). Ahmad and Roland (2003) found little or no effect on egg production when various levels of TSAA were fed to laying hens.

Interaction due to dietary protein and TSAA levels in the diets had a significant effect (P<0.01) on egg number of laying hens during trail period from 26-34 wks of age only. The highest values of egg number were recorded by hens received 20% protein and 0.72% TSAA. Egg number and egg mass did differ significantly though the others periods of the trail. Harms and Russell (1993) fed hens a low protein diet (13%) and reported similar egg production when compared with feeding a diet with 17% protein.

Table (3). Feed intake ($\overline{X}$ ±SE) for Lohmann laying hens as affected by protein, total sulfur amino acids levels and their interaction.

Items		Feed intake				
		18-22 wks	22-26 wks	26-30 wks	30-34 wks	18-34 wks
Protein		ns	ns	**	*	ns
	16	94.38±3.33	108.64±2.02	102.79±2.08^{b}	100.91±1.58^{b}	100.75±1.66
	18	96.01±3.33	109.48±2.02	102.47±2.08^{b}	103.53±1.58^{ab}	102.55±1.13
	20	87.60±3.33	110.11±2.02	111.63±2.08^{a}	106.92±1.58^{a}	102.25±1.33
TSSA		ns	ns	Ns	Ns	ns
	0.67	94.53±3..33	112.48±2.02	103.78±2.08	105.04±1.58	103.99±1.11
	0.72	93.18±3.33	107.74±2.02	107.04±2.08	103.31±1.58	101.37±1.60
	0.77	90.28±3.33	108.00±2.02	106.07±2.08	103.02±1.58	100.19±1.33
Interaction		ns	ns	Ns	Ns	ns
	0.67	99.20±6.06	114.19±3.51	98.46±3.61	101.78±2.74	104.81±1.21
16	0.72	93.24±6.06	103.59±3.51	107.87±3.61	106.55±2.74	102.68±1.83
	0.77	90.71±6.06	108.14±3.51	102.04±3.61	94.40±2.74	94.74±1.41
	0.67	93.38±6.06	112.28±3.51	97.60±3.61	100.18±2.74	100.80±0.89
18	0.72	97.48±6.06	107.98±3.51	102.33±3.61	102.93±2.74	102.09±1.50
	0.77	97.19±6.06	108.18±3.51	107.49±3.61	107.50±2.74	104.76±1.04
	0.67	91.01±6.06	110.98±3.51	115.28±3.61	113.15±2.74	106.35±1.11
20	0.72	88.85±6.06	111.65±3.51	110.93±3.61	100.44±2.74	99.33±1.74
	0.77	82.94±6.06	107.69±3.51	108.67±3.61	107.16±2.74	101.06±0.78

Means in the same column within each classification bearing different letters are significantly different (P<0.05 or 0.01).
** = significant (P<0.05), ** = significant (P<0.01) and ns = not significant.*

Table (4). Feed efficiency ($\bar{X}$ ±SE) for Lohmann laying hens as affected by protein, total sulfur amino acids levels and their interaction.

Items		Feed efficiency (g egg /g feed)				
		18-22 wks	22-26 wks	26-30 wks	30-34 wks	18-34 wks
Protein		ns	*	**	**	**
	16	0.33±0.01	0.47±0.01[b]	0.50±0.01[b]	0.44±0.01[b]	0.42±0.00[b]
	18	0.37±0.01	0.53±0.01[a]	0.58±0.01[a]	0.44±0.01[b]	0.46±0.00[a]
	20	0.33±0.01	0.53±0.01[a]	0.56±0.01[a]	0.51±0.01[a]	0.46±0.00[a]
TSSA		ns	ns	*	ns	*
	0.67	0.33±0.01	0.48±0.01	0.56±0.01[a]	0.44±0.01	0.43±0.00[b]
	0.72	0.36±0.01	0.54±0.01	0.56±0.01[a]	0.48±0.01	0.47±0.00[a]
	0.77	0.35±0.01	0.51±0.01	0.52±0.01[b]	0.46±0.01	0.44±0.00[b]
Interaction		ns	ns	*	ns	ns
	0.67	0.32±0.03	0.43±0.03	0.52±0.02[c]	0.43±0.02	0.39±0.00
16	0.72	0.34±0.03	0.52±0.03	0.52±0.02[c]	0.44±0.02	0.45±0.00
	0.77	0.33±0.03	0.46±0.03	0.47±0.02[d]	0.45±0.02	0.41±0.00
	0.67	0.37±0.03	0.52±0.03	0.64±0.02[a]	0.40±0.02	0.46±0.00
18	0.72	0.35±0.03	0.56±0.03	0.59±0.02[b]	0.45±0.02	0.47±0.00
	0.77	0.40±0.03	0.52±0.03	0.51±0.02[c]	0.47±0.02	0.45±0.00
	0.67	0.29±0.03	0.49±0.03	0.54±0.02[c]	0.48±0.02	0.44±0.00
20	0.72	0.37±0.03	0.54±0.03	0.57±0.02[b]	0.56±0.02	0.49±0.00
	0.77	0.33±0.03	0.55±0.03	0.58±0.02[b]	0.47±0.02	0.45±0.00

Means in the same column within each classification bearing different letters are significantly different (P<0.05 or 0.01).
** = significant (P<0.05). ** = significant (P<0.01) and ns = not significant.*

Table (5). Protein efficiency ($\bar{X}$ ±SE) for Lohmann laying hens as affected by protein, total sulfur amino acids levels and their interaction.

Items		Protein efficiency (g egg /g protein)				
		18-22 wks	22-26 wks	26-30 wks	30-34 wks	18-34 wks
Protein		**	**	**	ns	**
	16	2.05±0.09[a]	2.96±0.09[a]	3.15±0.07[a]	2.76±0.08	2.67±0.06[a]
	18	2.09±0.09[a]	2.99±0.09[a]	3.22±0.07[a]	2.50±0.08	2.62±0.03[a]
	20	1.67±0.09[b]	2.64±0.09[b]	2.83±0.07[b]	2.55±0.08	2.31±0.04[b]
TSSA		ns	ns	*	ns	ns
	0.67	1.85±0.09	2.70±0.09	3.17±0.07[a]	2.50±0.08	2.44±0.06
	0.72	2.00±0.09	3.03±0.09	3.13±0.07[a]	2.70±0.08	2.65±0.05
	0.77	1.96±0.09	2.86±0.09	2.91±0.07[b]	2.61±0.08	2.51±0.04
Interaction		ns	ns	*	ns	ns
	0.67	2.01±0.17	2.71±0.16	3.24±0.12[a]	2.66±0.14	2.55 ±0.07
16	0.72	2.14±0.17	3.27±0.16	3.25±0.12[a]	2.79±0.14	2.84±0.06
	0.77	2.01±0.17	2.91±0.16	2.97±0.12[b]	2.85±0.14	2.61±0.05
	0.67	2.07±0.17	2.93±0.16	3.55±0.12[a]	2.40±0.14	2.62±0.00
18	0.72	1.97±0.17	3.12±0.16	3.29±0.12[a]	2.50±0.14	2.61±0.03
	0.77	2.23±0.17	2.93±0.16	2.84±0.12[b]	2.61±0.14	2.62±0.05
	0.67	1.48±0.17	2.47±0.16	2.71±0.12[b]	2.43±0.14	2.14±0.06
20	0.72	1.89±0.17	2.71±0.16	2.87±0.12[b]	2.82±0.14	2.49±0.02
	0.77	1.64±0.17	2.75±0.16	2.92±0.12[b]	2.39±0.14	2.29±0.02

Means in the same column within each classification bearing different letters are significantly different (P<0.05 or 0.01).
** = significant (P<0.05). ** = significant (P<0.01) and ns = not significant.*

Table (6). Egg number ($\overline{X}$ ±SE) for Lohmann laying hens as affected by protein, total sulfur amino acids levels and their interaction.

items		Egg number				
		18-22 wks	22-26 wks	26-30 wks	30-34 wks	18-34 wks
Protein		ns	ns	**	ns	ns
	16	13.75±0. 43	25.73±0.25	25.30±0.30^{b}	23.70±0.32	87.96±2.05
	18	13.51±0.43	26.38±0.25	26.35±0.30^{a}	25.54±0.32	91.77±1.41
	20	12.52±0.43	25.81±0.25	26.41±0.30^{a}	25.76±0.32	90.10±1.37
TSSA		ns	ns	Ns	ns	*
	0.67	12.39±0.43	25.58±0.46	25.77±0.30	24.74±0.32	88.41±1.66^{b}
	0.72	15.19±0.43	26.85±0.47	26.88±0.30	26.34±0.32	94.81±0.56^{a}
	0.77	12.19±0.43	25.75±0.46	24.42±0.30	23.91±0.32	86.60±1.93^{b}
Interaction		ns	ns	**	**	ns
	0.67	13.35±0.75	25.35±0.43	24.80±0.52^{b}	23.30±0.57^{bc}	86.50±2.42
16	0.72	15.60±0.75	26.75±0.43	26.75±0.52^{a}	25.90±0.57^{ab}	95.25±0.38
	0.77	12.30±0.75	25.15±0.43	24.30±0.52^{b}	21.90±0.57^{cd}	82.15±2.05
	0.67	12.55±0.75	26.95±0.43	26.55±0.52^{a}	24.95±0.57^{b}	90.70±0.60
18	0.72	14.20±0.75	27.00±0.43	26.65±0.52^{a}	26.05±0.57^{a}	93.65±0.48
	0.77	13.80±0.75	25.21±0.43	25.88±0.52^{ab}	25.64±0.57^{ab}	90.97±2.46
	0.67	11.30±0.75	24.45±0.43	26.00±0.52^{a}	26.00±0.57^{a}	88.05±1.71
20	0.72	15.77±0.75	26.80±0.43	27.15±0.52^{a}	27.10±0.57^{a}	95.55±0.78
	0.77	10.50±0.75	6.20±0.43	26.05±0.52^{a}	24.20±0.57^{b}	86.70±0.88

Means in the same column within each classification bearing different letters are significantly different (P<0.05 or 0.01).
** = significant (P<0.05). ** = significant (P<0.01) and ns = not significant.*

Table (7). Egg mass ($\overline{X}$ ±SE) for Lohmann laying hens as affected by protein, total sulfur amino acids levels and their interaction.

Items		Egg mass				
		18-22 wks	22-26 wks	26-30 wks	30-34 wks	18-34 wks
protein		ns	**	**	**	**
	16	667.45±44.39	1406.07±34.50^{b}	1412.80±33.12^{b}	1338.09±41.10^{c}	4824.42±113.55^{b}
	18	675.79±44.39	1598.67±34.50^{a}	1636.76±33.12^{a}	1505.48±41.10^{b}	5418.57±72.61^{a}
	20	647.00±44.39	1548.78±34.50^{a}	1658.10±33.12^{a}	1651.91±41.10^{a}	5556.25±91.19^{a}
TSSA		ns	ns	Ns	ns	*
	0.67	649.79±44.39	1483.08±34.50	1583.64±33.12	1473.39±41.10	5194.81±117.40^{b}
	0.72	751.49±44.39	1568.34±34.50	1584.56±33.12	1557.15±41.10	5507.01±56.43^{a}
	0.77	588.98±44.39	1502.10±34.50	1539.47±33.12	1465.00±41.10	5097.41±136.21^{b}
Interaction		ns	ns	Ns	ns	ns
	0.67	652.6±76.90	1370.31±59.77	1386.90±57.37	1320.00±71.20	4729.93±107.93
16	0.72	758.69±76.90	1495.54±59.77	1549.57±57.37	1476.33±71.20	5280.18±48.20
	0.77	590.98±76.90	1352.33±59.77	1301.89±57.37	1217.95±71.20	4463.16±117.45
	0.67	590.98±76.90	1352.33±59.77	1301.89±57.37	1217.95±71.20	4463.16±117.45
18	0.72	676.29±76.90	1629.91±59.77	1677.41±57.37	1430.10±71.20	5413.74±30.50
	0.77	714.91±76.90	1601.61±59.77	1620.29±57.37	1508.85±71.20	5445.68±15.83
	0.67	620.37±76.90	1564.40±59.77	1612.57±57.37	1577.55±71.20	5396.28±131.19
20	0.72	780.86±76.90	1449.03±59.77	1701.28±57.37	1670.08±71.20	5440.77±139.41
	0.77	539.7±76.907	1607.84±59.77	1737.74±57.37	1686.28±71.20	5795.17±40.76

Means in the same column within each classification bearing different letters are significantly different (P<0.05 or 0.01).
** = significant (P<0.05). ** = significant (P<0.01) and ns = not significant.*

Blood constituents

There were no significant effects of dietary protein levels on globulin, uric acid and creatine, while total protein, albumen and urea of hens fed the high and moderate protein diet were significantly higher (P<0.05) than those of hens fed the low-protein diet. Values of ALT and AST were increased significantly (P<0.05) for hens fed low-protein diet compared with those of hens fed high-protein diet

(Table 8). These results agreed with Chaiyapoom *et al.* (2005) showed that alpha-globulin and ratio of albumin: globulin tended to decline, meanwhile all serum protein fractions and serum total protein tended to increase as protein levels increased from 14 to 18% CP. In the same line Donsbough *et al.* (2010) indicated that plasma uric acid and uric acid excreta were increased as dietary N intake increased; however, inconsistent results have been reported using plasma uric acid as a response variable to assess amino acid utilization. Also, plasma uric acid and uric acid excreta should be viable response variables to determine amino acid requirements of broilers or the efficiency of amino acid utilization. Results obtained by Zeweil *et al.* (2011) showed that total protein and globulin were significantly increased by increasing the protein levels from 12 to 16% CP in Baheij layer hen diets. While, plasma albumen was insignificantly affected by different protein levels.

There were no significant differences due to the effect of TSAA levels on albumen, urea, uric acid and creatine of blood plasma, while total protein, globulin, ALT and AST were increased as TSAA increased. Xie *et al.* (2004) reported that both increases and decreases in plasma uric acid concentrations depend on increases or decreases of methionine level in the diet. Also, results obtained by Zeweil *et al.* (2011) mentioned that total protein and globulin were significantly increased by increasing methionine levels from 1.673 to 2.754% of crude protein in Baheij layer hen diets. Whereas, plasma albumen was did not significantly affected by different methionine levels.

Results of this study showed that interaction effect on total protein, albumin and liver enzymes (AST and ALT) were significant (P<0.05 o 0.01), however there is no a significantly differences for this effect on other blood parameters (Table 8). Hsu *et al.* (1998) reported that the concentration of plasma uric acid and excreta nitrogen in birds group fed high protein diets (170 g kg diet) was significantly (P<0.05) higher than those two others diet (140 g/kg diet) crude protein or 140 g/ kg diet crude protein supplemented with methionine (1.4 g/kg diet).

Zeweil *et al.* (2011) revealed that all blood biochemical parameters were significantly affected by the interaction between protein and methionine levels. Since, the highest plasma total protein and globulin concentrations (7.93 and 6.14 g/dl, respectively) were recorded for the layers fed diet of the highest level of crude protein (16%) and Meth (2.327 % of CP).

Economic evaluation (EE)

Data presented in Table (9) showed that, the level of 18% crude protein affected EE value compared with that of 16 and 20 % crude protein diet at the whole period. Economic efficiency was affected with different levels of TSAA, whereas, 0.72% TSAA recorded the highest value versus 0.67 or 0.77% TSAA. These results agreed with the requirement of laying hens in NRC (1994). The results of EE indicated that the best EE was recorded by laying hens fed 18% crude protein with 0.72% TSAA, then that of those fed the diet contained 20% crude protein with 0.72% TSAA. In the same trend, Abd El-Maksoud *et al.* (2011) showed that, the best values for economic efficiency and relative economic efficiency were recorded by hens fed 16% CP diet versus to those fed 12 or 14% CP. While, Zeweil *et al.* (2011) reported that the diet contained 12 % CP recorded the most relative economic efficiency as compared to those of the other diets (14 and 16% CP).

Table (8). Means of some blood parameters (±SE) for Lohmann laying hens fed diets of different levels of protein and total sulfur amino acids.

Items		Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Urea (mg/dl)	Uric acid (mg/dl)	Creatine (mg/dl)	ALT (U/L)	AST (U/L)
Protein		*	*	ns	**	ns	ns	*	*
	16	7.01±0.22[b]	3.19±0.13[ab]	3.81±0.26	34.83±4.04[b]	4.60±0.32	0.47±0.07	54.78±2.35[a]	265.36±0.55[a]
	18	7.60±0.22[a]	3.01±0.13[b]	4.60±0.26	51.50±4.04[a]	3.77±0.32	0.31±0.07	35.76±2.35[b]	230.71±0.55[c]
	20	7.96±0.22[a]	3.43±0.13[a]	4.52±.26	38.60±4.04[b]	4.14±0.32	0.45±0.07	30.46±2.35[b]	245.10±0.55[b]
TSAA		*	ns	*	ns	ns	ns	*	*
	0.67	7.83±0.22[a]	3.11±0.13	4.73±0.26[a]	44.68±4.04	4.69±0.32	0.50±0.07	33.28±2.35[b]	249.80±0.55[a]
	0.72	6.97±0.22[b]	3.11±0.13	3.85±0.26[b]	36.35±4.04	4.07±0.32	0.33±0.07	43.71±2.35[a]	255.65±0.55[a]
	0.77	7.76±0.22[a]	3.41±0.13	4.35±0.26[ab]	43.91±4.04	3.77±0.32	0.40±0.07	44.02±2.35[a]	235.73±0.55[b]
Interaction		*	*	ns	ns	ns	ns	*	**
	0.67	7.66±0.38[ab]	3.60±0.23[a]	4.06±0.46	38.63±7.00	5.07±0.56	0.81±0.12	43.00±4.08[c]	282.00±0.95[a]
16	0.72	6.73±0.38[b]	2.89±0.23[b]	3.84±0.46	36.34±7.00	4.84±0.56	0.21±0.12	66.23±4.08[a]	273.45±0.95[b]
	0.77	6.63±0.38[b]	3.10±0.23[a]	3.53±0.46	29.54±7.00	3.91±0.56	0.40±0.12	55.13±4.08[b]	240.65±0.95[e]
	0.67	7.03±0.38[ab]	2.55±0.23[b]	4.55±0.46	52.26±7.00	3.47±0.56	0.40±0.12	34.30±4.08[d]	249.40±0.95[d]
18	0.72	7.36±0.38[ab]	3.20±0.23[a]	4.16±0.46	40.90±7.00	3.45±0.56	0.25±0.12	34.00±4.08[d]	233.55±0.95[f]
	0.77	8.40±0.38[a]	3.30±0.23[a]	5.10±0.46	61.36±7.00	4.40±0.56	0.30±0.12	39.00±4.08[cd]	209.20±0.95[h]
	0.67	8.80±0.38[a]	3.20±0.23[a]	5.60±0.46	43.17±7.00	5.52±0.56	0.31±0.12	22.55±4.08[e]	218.00±0.95[g]
20	0.72	6.83±0.38[b]	3.26±0.23[a]	3.56±0.46	31.81±7.00	3.92±0.56	0.53±0.12	30.90±4.08[d]	259.95±0.95[c]
	0.77	8.26±0.38[a]	3.85±0.23[a]	4.41±0.46	40.83±7.00	2.99±0.56	0.50±0.12	37.95±4.08[d]	257.35±0.95[c]

Means in the same column within each classification bearing different letters are significantly different ($P<0.01$ or 0.05).

** = significant ($p<0.05$), ** = significant ($p<0.01$) and ns = not significant.*

Table (9). Economic evaluation for Lohmann laying hens as affected by protein, total sulfur amino acids levels and their interaction during whole period 18-34 wks of age.

Items		Total feed intake (kg)	Cost of kg feed (LE)	Total feed cost (LE)[A]	Total egg mass (kg)	Egg market price (LE)[B]	Net return (LE)[C]	Economic efficiency (%)[D]	Relative economic efficiency[E]
protein	16	11.280	2.404	27.11	4.824	48.28	21.13	77.94	86.43
	18	11.485	2.481	28.49	5.418	54.18	25.69	90.17	100.00
	20	11.452	2.619	29.99	5.556	55.56	25.57	85.26	94.55
TSAA	0.67	11.640	2.485	28.92	5.194	51.94	23.02	79.59	84.63
	0.72	11.350	2.501	28.38	5.507	55.07	26.69	94.04	100.00
	0.77	11.220	2.517	28.24	5.097	50.97	22.73	80.48	85.58
Interaction									
	0.67	11.730	2.389	28.02	4.729	47.29	19.27	68.77	74.64
16	0.72	11.500	2.404	27.646	5.280	52.80	25.16	91.02	98.79
	0.77	10.610	2.419	25.66	4.463	44.63	18.98	74.28	80.62
	0.67	11.280	2.465	27.80	5.413	54.13	26.33	94.71	102.8
18	0.72	11.430	2.480	28.34	5.445	54.45	26.11	92.13	100.00
	0.77	11.730	2.498	29.30	5.396	53.96	24.66	84.16	91.34
	0.67	11.910	2.602	30.98	5.440	54.40	23.42	75.59	82.04
20	0.72	11.120	2.620	29.13	5.795	57.95	28.82	98.93	107.38
	0.77	11.310	2.635	29.80	5.432	54.32	24.52	82.28	89.30

A: Total feed cost= feed intake cost of kg.*
*B: Egg market price= total egg mass*cost of kg egg (10 LE).*
C: Net return =difference between egg market price and total feed cost.
*D: Economic efficiency= (net return/ total cost)*100.*
E: Relative economic efficiency % of the treatment (18 %CP with 0.72%TSAA) assuming that the relative economical efficiency.

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تأثير العلاقة بين البروتين والأحماض الأمينية الكبريتية الكلية على آداء وبعض صفات الدم للدجاج البياض

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تم تصميم تجربة عاملية (3×3) لدراسة تأثير ثلاث مستويات من البروتين (16، 18، 20%) وثلاث مستويات من الأحماض الأمينية الكبريتية الكلية (0.67، 0.72، 0.77%) على الأداء الإنتاجي وصفات جودة البيضة وبعض قياسات الدم لدجاج اللوهمان البياض أثناء 18- 34 إسبوع ، حيث تم إستخدام 180 دجاجة عمر 18 اسبوع و قسمت هذه الطيور عشوائيا إلى 9 مجاميع تجريبية بكل مجموعة تجريبية 20 طائر، قسمت كل مجموعة إلى خمس مكرارات بكل مكرر 4 طيور. وتم توزيع الطيور فى البطاريات بشكل متجانس وأيضا تم تغذية الدجاج بشكل حر مع توفر الماء أمام الطيور بإستمرار.

وكانت أهم النتائج المتحصل عليها كالآتى:

- سجلت المجاميع المغذاه على 18 و 20 % بروتين زياده معنوية (P<0.01) فى كل من عدد وكتلة البيض مقارنة بالمجاميع المغذاه على 16% بروتين فى الفترة من 26- 30 إسبوع.
- لايوجد تأثير معنوي لبروتين العليقة على الجلوبيولين وحامض اليوريك و الكيراتين، بينما البروتين الكلى والألبيومين واليوريا تأثروا معنويا بالعلائق المرتفعة والمتوسطة مقارنة بالعلائق المحتوية على بروتين منخفض خلال الفترة من 26-30 إسبوع.
- تأثرا كل من الكفاءة الغذائية وكفاءة البروتين بإختلاف مستويات الأحماض الأمينية الكبريتية الكلية.
- الطيور التى تغذت على مستوى بروتين 20 % أعلى وزن للدجاج فى نهاية الفترة التجريبية وذلك مقارنة بالطيور المغذاه على المستويات الاخرى من البروتين 16 و 18 %.
- التداخل بين البروتين و الأحماض الأمينية الكبريتية الكلية أثر معنويا عل إنتاج البيض أثناء الفترة 26-34 إسبوع، بينما الفترة من 18-26 إسبوع لم يحدث اى تأثير معنوى على هذه الصفة.
- أيضا تأثرت الكفاءة الاقتصادية باستخدام مستويات مختلفة الأحماض الأمينية الكبريتية الكلية.
- من خلال هذه الدراسة يمكن التوصية باستخدام عليقة تحتوى على 18 % بروتين خام مع 0.72 % أحماض أمينية كبريتية كلية للدجاج البياض فى الفترة الإنتاجية من 18 – 34 إسبوع من العمر.