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EFFECT OF DIETARY PROTEIN LEVELS, LYSINE SUPPLEMENTATION AND STOCKING DENSITIES ON LAYING HENS PERFORMANCE.

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SUMMARY

A total number of 280 Bovans Brown Laying hens aged 24 weeks were randomely distributed into 8 groups in 2x2x2 factorial arrangement of treatments. Two dietary crude protein levels 16.55. & 18.11% with two dietary supplemental lysine levels 0.00 & 0.1% the total dietary lysine become (0.83 & 0.93%) and (0.96 & 1.06%) for either dietary protein levels, respectively. Two stocking densities, 4 & 3 birds / cage (450 & 600 cm^2/bird) were used. Feed was given in all mash form and offered with water ad – libitum under a total of 16 hours light daily. Results indicated that dietary protein levels showed no significant differences on egg production, egg quality, feed intake feed conversion, final body weight, body weight gain. The 16.55% dietary crude protein showed significant (P≤0.05) effect on protein intake, and protein utilization than 18.11% CP. Dietary Lysine levels had no effect on egg number, egg mass, egg quality, feed conversion, protein intake. The best final body weight, body weight gain and protein utilization showed significance (P≤0.05) with high dietary lysine supplementation level 0.1% than 0.00%. Stocking density showed significant (P ≤0.05) increas in egg number, egg mass, final body weight, body weight gain when three birds were housed in cage. Yolk weight at 39 weeks of age as stocking density increased (600 cm^2/bird), while stoking density showed no significant difference in shell weight and shell thickness at 43 weeks of age, similar with decreasing stocking affect on (450 cm2/bird). Feed consumption was decreased significantly, while, feed conversion, protein intake and protein utilization were significantly (P≤0.05) improved by stocking density at 600 cm2/hen as compared with 450 cm2/hen, while egg weight and egg quality were not significantly affected by different stocking density. The interaction effect of protein, lysine & stocking density showed no significant effect on egg number, egg mass, albumin weight, egg shape index at 39 wks of age, shell thickness and shape index at 43 wks of age. While, final body weight and body weight gain were significantly (P≤0.05) increased by 18.11% CP & 0.1% lysine (1.06% Lysine in the diet) & 600 cm2/hen stocking density interaction. However, treatments which fed diet at 18.11% CP with (0.96% lysine in the diet) lysine and 450 cm2/hen stocking density improved feed intake and feed conversion significantly (P≤0.05) compared with other treatments. Egg mass were significantly (P≤0.05) improved by protein level (16.55%), lysine

(0.1%) stocking density (600 cm2/hen) interaction compared with other treatments. Protein intake and protein utilization were significantly($P \leq 0.05$) improved for hens received diet containing 16.55% CP with 0.1% lysine and stocking density at 600 cm2/hen. The economic parameters were affected by dietary protein or lysine supplementation and stocking density wherease decreasing protein level, increasing lysine supplementation and decreasing stocking density increase economic efficiency. It may be concluded that diets containing 16.55% CP and 0.1% Lysine supplementation (0.93% Lysine in the diet) with 600 cm2/bird would be ideal for the achievement of optimum revenue cost ratio for laying hens under Egyptian conditions.

Keywords: *Protein level, lysine level, cage, stocking density, laying hens.*

INTRODUCTION

Nutritional requirements of laying hens especially protein requirement needs are the most expensive ingredients in poultry diets. Investigations concerning the essential amino acids of laying hens have placed little emphasis on the influence of dietary protein concentration of the requirement of these nutrients. Feeding costs is the most expensive item, especially dietary protein sources in laying diets. Poultry investigators continue to look for methods of producing an economical poultry production through increasing returns, over the cost of feed, especially consumption of energy and protein, (El-Sheikh, 2002).

Poultry managers are interested in increasing the number of birds per space area and reducing housing and labor costs per cage. However, increasing bird number per space area causes a decline in egg production and increased hen mortality (Lowe and Heywang, 1964, Cook and Dembnicki, 1966 and Wilson *et al.*, 1967). North (1978) found that caged layers produced more eggs than floor ones.

Reduced floor space resulted in lower performance of laying hens (Adams at al., 1978 and Hill and Hunt, 1978). Cunningham and Ostrander (1981), Christmas *et al.*, (1982), Lesson and Summers (1984) and Davami *et al.*, (1987) recorded a marked reduction in productive and reproductive traits with increasing birds densities.

Stocking density of birds can be defind by the number of the weight of birds in a given area. Increasing the number of hens in a given space is a management technique used to reduce cost associated with labor, housing, fuel and equipment. Crowding of broilers (Shannawany, 1988), Laying hens (Roush, 1986) can lead to reduction in performance.

Simsek, *et al.* (2006) and Pavan *et al.* (2005) reported that a significant effect of cage density on egg weight and feed intake were detected. Decrease in cage space per bird resulted in the decrease of egg production, water intake and feed intake (Ezieshi, *et al.*, 2003).

Brake, and Peebles (1992) reported as dietary protein, lysine and TSAA increased, hen day egg production, egg weight and feed conversion improved, feed intake and feed per dozen eggs were not consistently affected by diet, cages density had no constant effect on any of the production parameters, no interactions were detected between dietry treatments and cage density (3, 2 or 1 bird per cage). Increasing the plane of nutrition can to some extent alleviate the decreased egg production resulting from increased hen density (Jackson, and Waldroup, 1988).

Cantor (1980) studied the effect of dietary Lysine and cage density on performance of turkey breeder hens. It is concluded that 0.65% lysine (0.90 g/day) was sufficient to maintain reproductive performance, increasing the density from 1 to 2 birds/ cage had no adverse effect on reproduction.

MATERIALS AND METHODS

The present work was carried out at poultry Breeding Farm, Faculty of Agriculture, Zagazig University, Zagazig, Egypt. The experiment was conductied in a 2x2x2 factorial design. Two levels of crude protein 16.55 and 18.11% with two dietary supplemented lysine levels (0.00 and 0.1%). The total dietary lysine become (0.83&0.93%) for low and (0.96&1.06%) for high respectively. two stoking densities (4 birds/cage and 3 birds /cage). The experimental diets formulated according to NRC (1994) are shown in Table (1).

Table (1): The basal experimental diets.

Ingredients %	Protein	
	Low	High
Yellow corn	66.25	64.03
Soybean meal (44%)	14.00	19.00
Wheat bran	4.25	1.50
Fish meal (72%)	2.00	2.00
Meat meal (60%)	4.00	4.00
Bone meal	1.30	1.30
Limestone	7.50	7.50
Premix	0.30	0.30
Salt	0.30	0.30
DL-methionine	0.10	0.07
Total	**100**	**100**
Calculated analysis %		
Crude protein	16.55	18.11
ME (kcal Me/kg)	2751	2751
Lysine	0.83	0.96
Calcium	3.63	3.63
A. phosphorus	0.46	0.45

Each kg vitamin and mineral premix contains: vit. A 4000000 IU, Vit. D3 400000 mg, vit. E 4000 mg, vit. K3 400 mg, vit. B2 2000 mg, Niacin 12000 mg, pantothenic acid 4000 mg, vit. B6 600 mg, Vit. B12 4000 mg, choline chloride 40000 mg, manganese 24000 mg, Copper 500 mg, zinc 8000, cobalt 10 mg, iodine 120 mg, selenium 40 mg.

Two hundreds and eighty Bovans Brown laying hens of twenty four weeks of age are nearly similar in initial live body weigh and egg prodction percenctage at the beginging of the experiment. Hens were randomly distributed into eight groups of thirty five each hens ten replicates. Hens were kept in cleaned and fumigated cages of wire batteries in open system house. Feed and water were offered ad – libitum all over the experimental period (20 weeks) from 24 to 43 weeks of age, under a total of 16 hours light daily.

Hens were weighted at the beginning (initial live body weight) and at the end of the experimented period (final live body weight). Body weigh (BW), body weight gain

(BWG), feed intake (FI), hen day egg production were calculated every four weeks intervals during the experimental periods (20 weeks). Feed conversion ratio (FCR) was calculated by deviding feed intake (g) per hen egg weight (g). Egg mass (egg weight x egg number) protein intake (feed intake (g) x protein% in the diet) and protein utilization (egg weight, g/protein intake, g were calculated.

Egg quality measurement at 39 and 43 weeks of age were studied by using four hundreds and eighty freshly collected eggs, (60 eggs for each treatments) in treams of some exterior and interior parameters, (egg components) and the exterior parameters included egg shape index (Harms *et al.*, 1990). Egg shell thickness (mmx100) was determined using a dial pipe gauge digital. Egg components were detemined according to the procedure described by Keshavar and Nakajima (1995). To determine the economic efficiency of egg production, the amount of feed consumed through the entire experimental period and the total eggs preduced per treatment were considered. The price of experimental diets was calculated according to the local market price of lysine as well as the price of the ingredients at the time of the experiment

Statistical analysis:

Data were statistically analyzed by using the General Linear Model procedures (GLM) described by SAS Institute (2004). Differences among laying hens performance of treatment means were tested using Duncan's multiple range test (Duncan, 1955) and differences were significant at ($P \leq 0.05$).

RESULTS AND DISCUSSION

Laying hen performance:

Egg number and production:

Egg number and production as hen – day (H. D., %) are summarized in Table (2). The differences in egg number or egg production were not significant ($P \leq 0.05$) due to either crude protein or lysine levels. The increased hen density per cage (600 cm2/bird) significantly increased ($P \leq 0.05$) egg number and egg production when compared to the decreased hen density per cage (450 cm2/bird). Moreover, the effect of interaction among protein x lysine x stocking density on egg number or egg production were not significant ($P \leq 0.05$). The highest egg number or egg production (126.29 or 90.21%, respectively,) were recorded by T4, while T1 were the least egg number and percentage (119.17 g and 85.12%). These results may be attributed to the supplementation of lysine to low protein diet (16.55%) and decreased stocking density (600 cm2/bird) that improved egg number and egg production%. These results agreed with the findings of Silva *et al.* (2006) who reported that decreasing the dietary crude protein from 16.5 to 15.25 or 14% did not affect the Lohmann LSL strain laying hens performance, where as the lysine supplementation of the lower protein diet to these levels of lysine and methionine+ systhine similar to control (0.80 and 0.70%, respectively) decreased the egg production in relation to control. Balnave *et al.* (2000) found that egg production were similar for Isa Brown laying hens fed both dietary protein levels (160 or 180 g crude protein /kg diet) during lay. The daily lysine requirement for maximum egg production approximated 940 mg for hens in single cages and 975 mg for hens in multiple bird cages. Pour-Reza (1998) indicated that no significant differences in egg production values were observed due to the different levels of protein

(13 or 14% CP) in laying hens diets. Hens consuming lysine 520 mg daily at both protein level had better egg production. Peterson (1995) reported that there was no significant difference in egg production due to dietary lysine levels from 6.7 to 7.5 or 8.1 g/kig diet) Kout El-Kloub *et al.* (2005) suggested that egg production was not affected by dietary protein levels (14 and 15% CP) of Mamoura local strain chickens. It was concluded that maximum requirements of laying hens for lysine do not exceed 6.7g/kg feed. Bustany and ElWinger (1987) found that egg out put was estimated to determine the lysine requirement, being 820-1023 mg per females (Hisex or LSL or Shaver). While, results obtained herein disagreed with those obtained by Vogt and Krieg (1986) who reported a significant increase in egg production with increasing dietary protein levels from 15.53 to 17.40% in the laying hens diet. Zanaty (2006) showed that increasing dietary protein levels from14.16 to 18% significantly ($P<0.05$) improved egg number and egg production or Norfa hens. On the other hand, Nahashon *et al.* (2006) reported that means hen-day egg production decreased significantly ($P<0.05$) with increase in cage density. Such that 1.394> 697 cm2/bird. Simsek *et al.* (2006) Ezieshi et al (2003) and Hashemi and Pourreza (1998) observed that hens at higher cage density level had lower percentage hen- day egg production than hens at lower density level ($P<0.05$). Altan *et al.* (2002) reported that housing at 3 or 4 hens/cage (640 and 480 cm2/hen, respectively) did not affect egg production, while increasing the cage density to 5 hens /cage (384 cm2) in white layers decreased egg production. Carey (1987) found that hen-day egg production at 62-75 wk of age was significantly higher in birds housed at 239 cm superscript 2 per bird than in other birds (311 or 259 cm superscript 2 per bird) in the 1st experiment. In the 2nd experiment birds housed at 222 cm superscript 2 per bird, hen – day egg production at 20-23 wk at age was significantly lower than in other birds (311 or 259 cm superscript 2 per bird). While, results obtained disagreed with those of Brake and Peebles (1992) who reported that caging density had no consistent effects on any of the production parameters. Gharib (2006) indicated that housing hens at low cage density and concomitant increased floor area per hen resulted in significant increase in hen- day egg production of Lohman Selected Leghorn hens.

These results indicated that under heat stress conditions, housing hens at low cage densities is a good management practice. This leads to less competition for feed and water, and consequently reduces the depression in egg production.

Egg weight and egg mass:

Egg weight and egg mass data are shown in Table (2). The differences in egg weights were not significant due to either protein, lysine levels, stocking density or protein x lysine x stocking density interactions. Moreover, the effect of protein and lysine levels on egg mass were not significant ($P \leq 0.05$). While, a significant effect on egg mass due to stocking density was significant. Moreover, the effect of interactions among protein lysine x stocking density on egg mass were significant. The highest value of egg mass (7.43 Kg.) was obtained by T4, while T1 gave the least value (6.91kg). Generally, increasing protein levels from 16.55 to 18.11% or decreasing stocking density from 450 cm2 to 600 cm2/bird increased egg weight and egg mass.

Table (2): Effect of experimental treatments on egg number, production, weight, mass, feed intake and conversion during the period from 24 to 43 weeks of age.

Item	Egg number	Egg production%	Egg weight (g)	Egg mass (kg)	Feed intake (g)	Feed conversion
Protein levels %:						
16.55 (P1)	122.46 ±1.10	87.47±0.78	58.45±0.37	7.16±0.07	125.44±0.52	2.15±0.01
18.11 (P2)	122.41±1.11	87.34±0.79	59.17±0.30	7.24±0.08	126.51±0.63	2.,14±0.01
supplementation Lysine %:						
0.00 (L1)	122.37±2.42	87.32±0.86	58.91±0.37	7.21±0.08	125.24±0.55^{b}	2.13±0.02
0.10 (L2)	122.50±1.00	87.50±0.71	58.71±0.32	7.19±0.07	126.71±0.59^{a}	2.16±0.01
Stocking density:						
4 birds/cage (d1)	120.56±1.01^{b}	86.02±0.71b	58.62±0.36	7.-07±0.07^{b}	124.45±0.44^{b}	2.13±0.01^{b}
3 birds/cage (d2)	124.31±1.12^{a}	88.80±0.80a	59.00±0.32	7.33±0.08^{a}	127.50±0.60^{a}	2.16±0.01^{a}
Interaction effect:						
T_1 P_1 L_1 d_1	119.17±2.75	85.12±1.96	57.96±0.98	6.91±0.17^{c}	124.08±0.59^{c}	2.15±0.03^{b}
T_2 P_1 L_1 d_2	123.92±1.71	88.52±1.22	58.74±0.62	7.28±0.13^{b}	126.54±1.32^{b}	2.16±0.03^{ab}
T_3 P_1 L_2 d_1	120.48±2.25	86.05±1.60	58.27±0.60	7.02±0.11^{c}	124.07±0.82^{c}	2.13±0.02^{b}
T_4 P_1 L_2 d_2	126.29±1.45	90.21±1.03	58.84±0.78	7.43±0.12^{a}	127.06±0.32^{b}	2.16±0.03a^{b}
T_5 P_2 L_1 d_1	122.30±1.73	86.99±1.14	59.75±0.55	7.31±0.13^{ab}	123.14±0.90^{c}	2.07±0.03^{c}
T_6 P_2 L_1 d_2	124.10±3.18	88.65±2.27	59.20±0.68	7.35±0.19^{ab}	127.18±1.06^{b}	2.15±0.02^{b}
T_7 P_2 L_2 d_1	120.29±1.16	85.92±0.83	58.52±0.66	7.04±0.13^{c}	126.51±0.93^{b}	2.16±0.03a^{b}
T_8 P_2 L_2 d_2	122.94±2.47	87.81±1.76	59.22±0.56	7.28±0.19^{b}	129.21±1.38^{a}	2.18±0.02^{a}

a, b and c Means in same column, within each factor with different superscripts are significantly ($P \leq 0.05$) different.

These results were confirmed by Pour – Reza (1998) who repoted that egg weight and egg out put were not affected by dietary lysine levels up to 0.79%, while hens consuming lysine 520 mg daily at both protein levels (13 or 14% cp) had better egg weight. Peterson (1993) reported that the levels of dietary lysine (6.7, 7.5 or 8.1 g/kg diet) with 15.4 % crude protein did not affect the egg weight of Lohmann LsL laying hens. Vogt and Krieg (1986) observed that dialy egg mass per hen (51.3 and 52.7g) increase with increasing dietary protein (15.35 and 17.4%) and Lysine (0.65-0.81 and 0.75-0.91%) levels, respectively. Results obtained disagreed with those obtained by Silva *et al.* (2006) who reported that decreasing the dietary crude protein from 16.5 to 14% did not affect the Lohmann LSL strain laying hens performance, whereas the lysine supplementation of the lower protein diet decreased the egg mass compared to the control. Diets were supplemented with amino acids at 15.25 and 14% of crude protein to show levels of lysine or methionine + cystine similar to control (0.80% lysine or 0.70 methionine cystine). Balnave *et al.* (2000) found that egg mass out put was greater for Isa Brown Laying hens fed the diet containing 180 g CP/Kg diet compared with the diet containing 160 g CP/Kg. Zanaty (2006) reported that egg weight and egg mass increased with increasing dietary protein levels (18 or 14%) of Norfa hens. Nahashon *et al.* (2006) found that egg mass was higher (P<0.05) for guinea fowls reared in cages at 1.394 cm2/bird than those reared in cages at 697 and 465 cm2/bird (24.8, 17.4 and 14 g/hen per day, respectively). Pavan *et al.* (2005) indicated that significant effect of cage density (562.15, 450.0 and 375.0 cm2 per hen) on egg weight were detected for Isa Brown laying hens. Hashemi and Purreza (1998) reported that egg weight decreased significantly (P<0.05) with increasing cage density (3, 4 and 5 birds/cage) for white Leghorn hens from 25-37 weeks of age. Gharib (2006) showed that the significantly lowest egg weight and egg mass were produced by hens caged at high density compared with low density.

These results indicated that the positive effect on egg weight and egg mass may be alleviated by decreasing the number of birds per cage and increasing floor space per bird. This may be due to increasing amount of feeder space per bird and reducing the competition for feed and water. Roland *et al.* (1991) stated that increasing the consumed feed and calcium resulted in a significant increase in egg weight Altan *et al.* (2002) observed that egg weight were not significantly affected by higher cage density (640, 480 and 384 cm2/hen) for White and Brown Hybrid layers.

Feed consumption and conversion:

Feed consumption and conversion (calculated as a mount of feed (g) required to produce 1g of egg) are presented in Table (3). No significant differences in feed intake or feed conversion due to increasing dietary protein. There was a significant effect ($P \leq 0.05$) on the amount of feed cosumed (g/hen/day) due to lysine levels while, no significant differences in feed conversion. There were significant differences ($P \leq 0.05$) among stocking density where (600 cm2/bird) recorded the highest feed intake and the poorest feed conversion ratio. Intractions effects were significant ($P \leq 0.05$) . The best feed intake or feed conversion ratio (123.14 or 2.07) were recorded by T_5, while the worst feed intake or feed conversion ratio were obtained by T_8. these results may be attributed to the different egg production and egg weights. These results agreed with those supported by Silva *et al.* (2006) who observed that lysine supplementaiton of the lower protein (15.25 or 14%% cp) diet decreased the feed: egg mass ratio and feed: egg dozen ratio in relation to control (16.5% CP and 0.80% lysine) of Lohmann LsL strain. Balnave *et al.* (2000) found that feed intake was similar for Isa Brown Laying hens fed both dietary protein levels (160 or/180g/kg diet) during lay Kout El-Kloub *et al.* (2005) reported that no significant differences in feed intake or feed conversion due to protein levels (14 or 15%) of Mamoura local strain chickers. Pour – Reza (1998) reported that feed intake was not influenced by dietary protein (13 or 14%CP). Feed conversion ratio (FCR) improved ($P<0.05$) with increasing dietary protein. Hens consuming Lysine 520mg daily at both protein levels had better FCR. While, results obtained disagreed with those obtained by Vogt and Krieg (1986) who indicated that increasing the dietary protein levels (15.35 and 17.4%) decreased feed intake per g egg (2.31 and 2.22 g diet). Zanaty (2006) showed that increasing dietary protein form 14.16 to18% levels improved feed conversion and decreased feed intake of Norfa hens during laying period (22-42 weeks of age). Nahashon *et al.*, (2006) observed that mean feed conversion ratio of the laying guinea fowl (Numida meleagris) was lower in birds reared in cages at 1.394 cm2/bird than in other treatment groups (697 and 465 cm2/bird). Pavan *et al.* (2005) reported that significant effects of cage density (562.15, 450.0 and 375.0 cm2 per hen) on feed intake was detected during the laying period. Ezieshi *et al.* (2003) indicated that decrease in cage space per bird of laying hens resulted in the decrease of feed intake. Hashemi and Pourreza (1998) observed that feed conversion ratio reduced ($P<0.05$) due to increased cage density (3, 4 and 5 birds) for White Leghorn hens, from 25 to 47 weeks of age. Carey (1987) noticed that laying hens housed in 222 cm superscript 2 per bird, feed consumption at 20-33 wks of age were significantly lower than in other birds (311 or 259 cm superscript 2 per bird). \

Gharib (2006) found that decreasing birds density and consequently increased floor space per bird resulted in a significant increase in feed consumption. These results indicated that hens housed at low cage densities reacted less adversely to heat stress. This may be due to their ability to dissipate more heat, thus providing an opportunity for increased feed intake and greater layer performance.

Protein intake and utilization:

Protein intake and utilization are presented in Table (3). There were significant difference in average protein intake and utilization among hens fed the two different crude protein levels, while hens receiving the low protein diet gained the best. Lysine levels did not affect protein intake, while there was a significant effect on the protein utilization due to lysine levels. Significant differences were observed in the protein intake and protein utilization due to stocking density.

Interactions were significant among protein x lysine x stocking density on protein intake or protein utilization. The best protein intake and protein utilization was recorded by T3, while T8 was the worst protein intake and protein utilization Generally, the best protein intake or protein utilization were noticed with all diets containing 16.55% CP with stocking density 3 birds/cage compared with other treatments. These results supported the findings of Rys *et al.* (1983) who reported that intake of feed/kg eggs increased with decreasing CP from 17.2 to 14 or 11% and intake of protein decreased of Leghorn laying hens.

Table (3): Effect of experimental treatments on Initial body weight, final body weight , body weight gain, protein intake and protein untilization during the period from 24 to 43 weeks of age.

Item	Initial body weight (g) 24 wk of age	Final body weight (g) 43 wk of age	Body weight gain (g)	Protein intake (g)	Protein utilization
Protein levels %:					
16.55 (P1)	1623.25±4.46	1819.25±14.09	196.13±14.05	20.76±0.09b	2.81±0.02a
18.11 (P2)	1629.00±4.19	1851.37±17.78	226.38±15.87	22.91±0.11a	2.58±0.02b
Lysine levels %:					
0.96 (L1)	1622.13±5.41	1814.00±10.95b	192.00±11.05b	21.68±0.18	2.72±0.03a
1.06 (L2)	1630.25±2.79	1856.50±19.62a	230.50±17.89a	21.95±0.22	2.68±0.03b
Stocking density:					
4 birds/cage d1	1629.38±3.91	1807.75±13.47b	179.88±13.38b	21.58±0.19b	2.72±0.03a
3 birds/cage d2	1623.00±4.70	1862.88±17.55a	242.63±15.22a	22.08±0.21a	2.67±0.03b
Interaction effect:					
T1 P1 L1 d1	1620.00±9.46	1801.00±26.73b	181.00±31.41d	20.54±0.10e	2.83±0.05a
T2 P1 L1 d2	1611.00±12.95	1787.00±24.51b	176.00±21.29d	20.94±0.22d	2.81±0.04ab
T3 P1 L2 d1	1630.00±6.01	1886.00±23.68b	157.00±24.71d	20.53±0.14e	2.84±0.02a
T4 P1 L2 d2	1632.50±4.43	1903.00±22.73a	270.50±22.71b	21.02±0.17d	2.78±0.05b
T5 P2 L1 d1	1641.50±67.60	1828.50±13.46ab	187.00±12.68d	22.30±0.16c	2.68±0.04c
T6 P2 L1 d2	1616.00±11.47	1840.00±19.56ab	224.0±18.9ac	23.03±0.14a	2.57±0.03d
T7 P2 L2 d1	1626.00±7.33	1815.50±39.75b	194.50±35.47cd	22.91±0.17b	2.55±003d
T8 P2 L2 d2	1632.50±4.73	1921.50±50.82a	300.00±41.26a	23.40±0.25a	2.53±0.03d

a,b and *c* Means in same column, within each factor with different superscripts are significantly ($P \leq 0.05$) different.

Live body weight and live body weight gain:

The effect of treatment on live body weight and body weight gain are presented in Table (3). The average initial live body weight values at the beginning of the experiment (23 weeks of age) were not significant. There was no significant difference between the average values of live body weigh or body weight gain due to protein level. There was a significant difference in average live body weight or body weight gain among hens fed the two different lysine levels or stocking density, while hens receiving the high lysine diets or decreasing hen density per cage (600 cm2/bird) gained the best, however those receiving the low lysine diets or increasing hen density per cage (450 cm2/bird) gained the least weight. Interaction effects showed a significant difference in the average live body weight or body weight gain due to protein x lysine x stocking density interactions. The best live body weight or body weight gain (1921.50 or 300 g, respectively) was recorded by T8, while T2 showed the lowest live body weight or body weight gain. (1777 or 1760 g, respectively). Generally, the average live body weight or body weight gain increased gradually with increasing the protein level from 16.55 to 18.11 CP%, lysine supplementation from 0.00 to 0.1% or decreased stocking density from 600 to 450 cm2/bird. These results supported by Harms and Ivey findings (1992) (who reported that body weight increased as the dialy intake of protein and lysine increased of Arbor Acres broiler breeder hens). Kout El-Kloub *et al.* (2005) found that body weight did not differ among treatments which containing 14 or 15% rude protein for Mamoura local strain chickens.

Carey (1987) indicated that laying hens at 222 cm superscript 2 per bird, body weight at 147 and 499 days of age (1297 g and 1779g) were significantly lower than in other birds (311 or 259 cm superscript 2 per bird). These results indicated that increased live body weight and weight gain may be due to increasing intake of feed, protein and lysine.

Egg Quality:

Albumin weight:

Albumin weight is tabulated in Table (4). The protein, lysine levels, stocking density and protein x lysine stocking density interactions did not affect albumin weight values at 39 weeks of age. Moreover, the differences between either two protein or lysine levels or stocking density were not significant at 42 weeks of age. The interaction effect of protein x lysire x stocking density was significant ($p \leq 0.05$) at 42 weeks of age. These results agreed with the findings of Simsek *et al.* (2006) who reported that effect of cage density on characteristics of egg quality were non-significant for Isa Brown hens when placed in 40 x 50 x 40 cm cages at the rate of four or five hens per cage. Kout El-Kloub (2005) showed no significant difference in albumin weight % due to protein levels (14 or 15%) of Mamoura local strain chickens. However, the present results disagreed with those reported by Zanaty (2006) who showed that increasing dietary protein levels (14, 16 or 18%) were significantly increased albumen percentage of Norfa hens.

Yolk weight:

Egg yolk weight % is presented in Table (4). Protein or lysine levels did not affect average yolk weight% values, while the differences between two stocking density or protein x lysine x stocking density intractions were significant ($P \leq 0.05$) at 39 weeks of age. Protein, lysine levels or stocking density did not affect average yolk weight % values, while the interaction effect of protein x lysine levels x stocking density was significant ($p \leq 0.05$) at 42 weeks of age. Yolk weight % at 39 and 42 weeks of age ranged from 27.21 to 29.62% for T_1 and T_4 and 26.55 to 28.95% for T_6 and T_2, respectively. These results agreed with those suppoted by Kout El-kloub (2005) who indicated that no significant differences in yolk weight % values were observed due to the different levels of protein (14 or 15%) in Mamoura local strain chickens. While, results obtained herein disagreed with those obtained by Zanaty (2006) who reported that yolk percentage decreased with increasing protein levels (14, 16 or 18%) of Norfa hens.

Shell weight:

Egg shell weight were calculated as a percentage of the egg weight and listed in Table (4). No significant differences were observed in shell weight% due to protein, lysine levels or stocking density, while the effect of interaction among protein x lysine x stocking density were significant at ($P \leq 0.05$) at 39 weeks of age. The values ranged between 11.8 and 12.43% for T_1 and T_7 respectively. Protein and lysine levels did not affect egg weight of on, while the interaction effect of protein x lysine x stocking density was significant ($P \leq 0.05$) at 42 weeks of age. The highest value (12.68%) was for T4, while the least (11.69%) was for T_5. These results were confirmed by Kout E–Kloub (2005) who reported that shell weight % was not affected by dietary protein levels (14 or 15%) for Mamoura local strain chickens. The results disagreed with those of Hashemi and Pourreza (1998) who indicated that no significant differences in shell weight values were observed due to the different stocking density (3, 4 and 5 bird/cage) of laying hens.

Shell thickness:

The averages shell thickness (100 xmm) were not influenced significantly by protein, lysine levels or stocking density, and influenced by the interaction among protein x lysine x stocking density at 39 weeks of age, the values varied from 31.90 and 33.00 for T5 to T1, respectively, at 39 weeks of age. Protein or lysine levels did not affect average shell thickness values, while the difference between two stocking density was significant ($P \leq 0.05$). No significant differences were observed due to protein x lysine x stocking density interaction and the values of shell thickness ranged from 31.10 to 32.70 (mmx100) for T3 and T6, respectively. Generally, all diets which formulated to contain 18.11% CP or decreased stocking density (600 cm2/bird) improved egg shell thickness compared to 16.55 CP or 450 cm2/bird at 42 weeks of age. These results were confirmed by Kout El kloub (2005) who reported that egg shell thickness did not significantly influenced by dietary protein levels. Altan *et al.* (2002) observed that shell quality was not significantly affected by higher cage density (640, 480 or 384 cm2/hen) of White Hybrid layers or (640 and 480 cm2/hen) of Brown Hybrid layers. Hashemi and Pourreza (1998) reported that cage density (3, 4 and 5 laying hen/ cage) had no effect on shell thickness. Gharib (2006) found that the differences between all the cage density groups (750, 600, 500, 428, 375 and 333 cm2/bird), in egg shell thickness, were not significant.

Table (4): Effect of experimental treatments on some interior and exterior egg quality during the period from 24 to 43 weeks of age.

Item	39 wks of age					42 wks of age				
	Albumin wt.%	Yolk wt.%	Shell wt.%	Shell thickness(mm).	Shap index	Albumin wt.%	Yolk wt.%	Shell wt.%	Shell thickness(mm).	Shap index
Protein levels %										
(16.55) (P1)	59.66±0.42	28.31±0.34	12.02±0.13	32.58±0.25	75.86±0.45	59.47±0.37	28.17±0.31	12.36±0.12	31.68±0.20	75.84±0.37
(18.11) P2)	59.55±0.33	28.37±0.29	12.08±0.11	32.58±0.20	76.67±0.44	60.23±0.36	27.70±0.34	12.07±0.15	32.10±0.22	76.55±0.53
Lysine levels %										
(0.96) (L1)	59.89±0.41	28.13±0.36	11.98±0.11	32.40±0.16	76.13±0.47	60.06±0.40	27.78±0.36	12.16±0.14	32.10±0.19	76.39±0.49
(1.06) L2)	59.32±0.34	28.56±0.27	12.12±0.12	32.55±0.20	76.40±0.43	59.64±0.34	28.08±0.29	12.28±0.14	31.68±0.23	75.95±0.42
Stocking density										
4 birds/cage d1	60.04±0.42	27.85±0.33b	12.12±0.12	32.43±0.55	76.06±0.48	60.01±0.34	27.96±0.30	12.03±0.14b	31.58±0.23b	75.71±0.41
3 birds/cage d2	59.17±0.31	28.85±0.28a	11.98±0.11	32.53±0.19	76.47±0.43	59.69±0.38	27.90±0.36	12.41±0.31a	32.20±0.18a	76.62±0.49
Interaction effect										
T1 P1 L1 d1	61.01±0.96	27.20±0.77d	11.80±0.24*b	33.00±0.39a	74.53±1.25	60.40±0.75*ab	27.19±0.65*b	12.41±0.28*ab	31.40±0.40	75.47±0.82
T2 P1 L1 d2	59.53±0.74	28.30±0.65c	12.17±0.22ab	32.00±0.49c	76.53±0.76	58.91±0.92c	28.95±0.81a	12.14±0.16ab	32.20±0.25	76.63±0.77
T3 P1 L2 d1	59.63±0.84	28.14±0.58c	12.23±0.31ab	32.30±0.60bc	76.06±0.65	59.95±0.63b	27.82±0.50b	12.23±0.21ab	31.10±0.48	75.72±0.74
T4 P1 L2 d2	58.48±0.71	29.62±0.61a	11.90±0.25b	33.00±0.30a	76.33±0.86	58.60±0.55c	28.72±0.37a	12.68±0.27a	a32.00±0.37	75.53±0.71
T5 P2 L1 d1	59.88±0.92	28.10±0.83c	12.02±0.19b	31.90±0.59c	77.15±0.87	59.88±0.67b	28.43±0.62ab	11.69±0.30b	32.10±0.43	76.28±0.86
T6 P2 L1 d2	59.14±0.59	28.91±0.57b	11.95±0.22b	32.70±0.40ab	76.32±0.76	61.06±0.77a	26.55±0.62c	12.39±0.30ab	32.70±0.30	77.14±1.42
T7 P2 L2 d1	59.64±0.67	27.93±0.49c	12.43±0.20a	32.50±0.378b	76.50±0.89	59.82±0.71b	28.39±0.59ab	11.79±0.32ab	31.70±0.52	75.36±0.98
T8 P2 L2 d2	59.52±0.44	28.57±0.32bc	11.91±0.22b	32.40±0.22bc	76.70±1.12	60.19±0.79b	27.40±077b	12.41±0.28ab	31.90±0-.46	77.18±0.93

a, b, c and *d* Means in same column, within each factor with different superscripts are significantly (P ≤ 0,05) different.

Table (5): Effects of dietary protein, Lysine, levels and stocking density on economic efficiency during the period from 24-43 weeks of age.

Item	Protein levels %		Lysine levels%		Stoking density		Interaction Effect							
	(16.55)p1	18 11p2	(0.96)l1	(1.06)l2	4birds d1	3 birds d2	P1L1	P1l1d2	P1 L2d1	P1 L2d2	P2 L1d1	P2 L1d2	P2 L2d1	P2 L2d2
Total feed intake/hen	17.56	17.71	17.53	17.74	17.42	17.85	17.37	17.72	17.37	17.79	17.24	17.81	17.71	18.09
Price/kg/feed (LE)(1)	9.02	92.82	91.41	91.43	91.42	91.42	90.01	90.01	90.03	90.03	92.81	92.81	92.83	92.83
Total feed cost/hen (L.E)	15.81	16.44	16.02	16.22	15.93	16.32	15.63	15.95	15.64	16.02	16.00	16.53	16.44	16.79
Total number of eggs/hen	122.46	122.41	122.37	122.50	120.56	124.31	119.17	123.92	120.48	126.29	122.30	124.10	120.19	122.94
Price of total eggs produced /hen (L.E)	24.49	24.48	24.47	24.50	24.11	24.86	23.83	24.78	24.10	25.26	24.46	24.82	24.06	24.59
Net Revenue / hen (L.E)(2)	8.68	8.04	8.45	8.28	8.18	8.54	8.20	8.83	8.46	9.24	8.46	8.47	7.62	7.80
Eonomic Efficiency (E.E (3)	0.46	0.49	0.53	0.51	0.51	0.52	0.52	0.55	0.54	0.58	0.53	0.51	0.46	0.46
Retative Economic Efficiency (4)	100	107	100	0.96	100	102	100	107	104	112	102	98	88	88

(1) L.E = 1 pound Egyptian currency = 100 piasters.

Price of total egg production /hen (L.E.) = Total number of eggs / hen price of one egg (0.20 LE).

(2) Net revenue / hen (L.E) = price of total egg production/hen (L.E) – total feed cost / hen (LE).

(3) Economic Efficiency = Net revenue / price of total feed intake.

(4) Assuming that the group number 1 from each group represent the control=100.

Shape index:

Values of shape index are listed in Table (4). Both ages (39 or 42 weeks of age) had no significant differences in shape index due to protein, lysine levels, stocking density or the interaction effect among protein x lysine x stocking density. At 39 weeks of age T5 recorded the highest value of shape index (77.15), while T1 gave the least value (74.53). however, the values of the different experimental treatments at 42 weeks of age ranged between 75.36 to 77.18 for T7 and T8, respectively. Generally, the shape index insignificantly increased with increasing the protein or lysine levels with decreased stocking density. Similarly Kout El – Kloub (2005) reported by that, crude protein levels had no effect on shape index.

Econmic efficiency:

The economic efficiency and money return per hen fed the different formulated diets are summarized in Table (5). The net revenue and economic efficiency values ranged between 7.62-9.24 and 0.46 – 0.58, respectively. The lowest values were recorded for T7 or T8, while the highest values were listed for T4, this may due to the better egg mass obtained for those birds fed this experimental diet compared with other diets.

It may be concluded that diets containing 16.55% CP and 0.1% Lysine supplementation (0.93% Lysine in the diet) with housing area 600 cm2/bird would be suitable to some extent for the achievement of optimum revenue cost ratio for laying hens under Egyptian conditions.

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تأثير مستويات بروتين العليقة وإضافة الليسين وكثافة التسكين علي المظاهر الإنتاجية للدجاج البياض

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استخدمت في هذه الدراسة ٢٨٠ دجاجة بياضة بوفانز بني عمر ٢٤ أسبوع وزعت عشوائياً إلى ٨ مجموعات نظام عاملي factorial ٢×٢×٢ حيث استخدمن مستويان من البروتين ١٦,٥٥ ، ١٨,١١٪ الليسين المضاف ٠,٠، ٠,١٪ والتسكين لكثافة ٤، ٣ طائر لكل قفص (٤٥٠، ٦٠٠سم٢/طائر) وتم تغذية الدجاج البياض على علف ناعم وقدم العلف ومياة الشرب حتى الشبع مع ١٦ ساعة إضاءة يومياً.

لم يظهر مستوى البروتين أي معنوية في إنتاج أو خواص البيضة أو الغذاء المأكول او معدل التحويل الغذائي ووزن الجسم النهائي والزيادة المكتسبة في وزن الجسم بينما أظهرت العليقة المحتوية ١٦,٥٥٪ بروتين معنوية في البروتين المأكول والإستفادة من البروتين عنه في العليقة المحتوية على ١٨,١١٪ بروتين. لم يلاحظ أي تأثير لإضافة الليسين على عدد البيض المنتج أو كتلة أو خواص البيضة أو معدل التحويل الغذائي أوالبروتين المأخوذ بينما افضل وزن نهائي للجسم أو زيادة مكتسبة للجسم أو الاستفادة من البروتين أظهرت معنوية عند المستوى الأعلى لإضافة الليسين عنه في المستوى الأقل.

وأظهرت الكثافة زيادة معنوية في عدد وكتلة البيضة والوزن النهائي للجسم ووزن الصفار عند عمر ٣٩ أسبوع كلما قلت كثافة الطيور في القفص ومن الناحية الاقتصادية نجد أنها تتأثر ببروتين العليقة ومستوى الليسين والكثافة بينما نقص مستوى البروتين وزيادة الليسين وتقليل الكثافة يزيد من الكفاءة الاقتصادية.

لا توجد اختلافات معنوية نتيجة لاختلاف مستوى البروتين على إنتاج البيض أو جودة البيض أو استهلاك العلف أو معامل التحويل الغذائي أو الوزن النهائي للجسم أو الزيادة المكتسبة في وزن الجسم. بينما حدث تحسن معنوي للبروتين المستهلك أو الاستفادة من البروتين مع مستوى ١٦,٥٥٪ بروتين خام في العليقة بالمقارنة مع ١٨,١١٪ بروتين خام.

لم يؤثر معنوياً مستوى ليسين الغذاء على عدد أو كتلة أو جودة البيض أو معامل التحويل الغذائي أو البروتين المستهلك . بينما أظهر تحسناً معنوياً للوزن النهائي للجسم والاستفادة

والبروتين والزيادة المكتسبة في وزن الجسم مع إضافة ٠.١٪ ليسين إلى الغذاء بالمقارنة مع عدم الإضافة (صفر٪).

تحسن معنوياً كل من عدد البيض وكتلة البيض والوزن النهائي للجسم والزيادة في وزن الجسم ووزن الصفار (عند ٣٩ أسبوع) واستهلاك العلف ومعامل التحويل الغذائي والاستفادة من البروتين مع قلة كثافة التسكين (٣ طائر/قفص) وزيادة المسافة المخصصة للطائر (٦٠٠ سم٢/طائر) بالمقارنة مع ٤ طائر/ قفص (٤٥٠سم٢/طائر) بينما لم يتأثر معنوياً كل من وزن البيض أو جودة البيض.

بالنسبة للتداخل بين البروتين والليسين وكثافة التسكين لم يحدث تأثير معنوي على كل من عدد البيض وكتلة البيض ووزن البيض

Egg shape index عند ٣٩ اسبوع أو shell thickness, shape index عند ٤٣ اسبوع. بينما زاد معنوياً الوزن النهائي للجسم والزيادة في وزن الجسم نتيجة المعاملة ١٨.١١٪ بروتين خام وإضافة ٠.١٪ ليسين و٦٠٠سم٢ مساحة في القفص/طائر. وقل استهلاك الغذاء وتحسن معامل التحويل الغذائي مع المعاملة ١٨.١١٪ بروتين خام إضافة و٠.١٪ ليسين و٤٥٠سم٢ مساحة في القفص/طائر. كتله البيض زادت مع المعاملة ١٦.٥٥٪ بروتين خام وإضافة ٠.١٪ ليسين و٦٠٠سم٢ مساحة في القفص/طائر.

تحسن استهلاك البروتين والاستفادة من البروتين معنوياً مع المعاملة ١٦.٥٥٪ بروتين خام وإضافة ٠.١٪ ليسين ,٦٠٠ سم٢/طائر في القفص.

كانت أحسن كفاءة اقتصادية نتيجة لخفض مستوى البروتين ١٦.٥٥٪ وإضافة ٠.١٪ ليسين وزيادة مساحة التسكين ٦٠٠سم٢/طائر في القفص.

ونوصى بأن تحتوى علائق الدجاج البياض على نسبة بروتين ١٦.٥٥٪ بروتين خام و٠.١٪ ليسين مضاف، على أن يكون إجمالي الليسين بالعليقة ٠.٩٣٪ وأن تكون كثافة الأقفاص ٦٠٠سم٢ لكل طائر وذلك لتحقيق أحسن عائد اقتصادي تحت الظروف المصرية.