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# EFFECT OF DIETARY ENERGY AND TOTAL SULFUR AMINO ACIDS CONTENT ON PRODUCTIVE PERFORMANCE AND EGG QUALITY TRAITS OF LOHMAN LIGHT LAYING HENS

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## ABSTRACT

A 3 X 3 factorial experimental design which contain 3 dietary energy levels (2750 , 2850 and 2950 Kcal ME/Kg) and 3 dietary total sulfur amino acids level [TSAA] (0.67 , 0.72 and 0.77%) was conducted to evaluate the effect of dietary energy and TSAA levels on production performance, egg quality and economical feed efficiency of Lohman light laying hens. In this experiment, a total of 180 Lohman light laying hens in first phase of production cycle (20 wk of age) were randomly assigned into 9 treatments (5 replicates of 4 birds/ treatment), the experiment lasted 20 wk. The obtained results showed that when dietary energy increased from 2750 to 2950 Kcal ME/Kg, hens adjusted feed intake from 96.7 to 90.40 g/hen/day to achieve a constant energy intake so that the same amount of dietary energy (4.9Kcal) was used to produce 1 g of egg. Increasing dietary energy significantly ($p \leq 0.05$) increased egg weight, egg mass, shell thickness and significantly improved feed conversion and decreased Haugh unit. Increasing dietary TSAA from 0.67 to 0.77% significantly improved feed intake, egg production, egg weight, egg mass, feed conversion, but had no effect on egg quality traits. The maximum profits were obtained by feeding hens diets containing 2950 Kcal ME/Kg and 0.72% TSAA. From the nutritional and economical point of view, it could be concluded that Lohman light laying hens required 2950 Kcal ME/Kg and 0.72% TSAA in the diet or 277 Kcal ME/Kg and 676 mg TSAA per hen daily from 21 to 40 wk of age under Egyptian conditions.

**Keywords:** Energy, TSAA, laying hens, performance, egg quality.

## INTRODUCTION

There is a wide range of dietary energy levels (2,684 to 2992 Kcal ME/kg) currently being used by the egg industry. Part of the reason for this is that information is not available that would allow egg producers to know the ideal dietary energy level required for optimal performance and profits during phase1 of production. Feed intake and egg weight can significantly affect cost of production and profits. Many researchers have reported that increasing energy level decreased feed intake by 3-8.5% (Grobas *et al.*, 1999 and Harms *et al.*, 2000) and increased early egg weight (Keshavarz, 1995, Harms *et al.*, 2000, Bohnsak *et al.*, 2002, Sohail *et al.*, 2003 and Wu *et al.*, 2005b). However, Summers and Leason (1993) reported that egg weight was not changed by increasing dietary energy.

Efficiency of dietary protein utilization depends on the amount, composition and digestibility of the amino acids that contained in the diet. Methionine + Cystine (TSAA) perform a number of functions in enzyme reactions and protein synthesis. Methionine is the first limiting amino acid in corn soybean meal diets in laying hens (Schutte *et al.*, 1978). Cystine can supply no more than 52% of the TSAA in chicks (Baker *et al.*, 1996). Based on the ideal protein concept, a protein supplies amino acids in exactly the amount and proportions required by animals and can be 100% utilized under appropriate circumstances (Emmert and Barker, 1997 and Barker, 2003).

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It is important to know the TSAA and methionine requirements of laying hens. There are contradicting results in methionine and TSAA requirements of laying hens. Reports of NRC (1994) idicated that laying hens with 100g daily feed consumption required 0.30% methionine and 0.58% TSAA in the diets. Also, Ahmed *et al.* (1997) reported that TSAA ranging form 580 to 660 mg per hen daily. However, Schutte *et al.* (1994) reported that the requirement of TSAA was about 740 mg/hen daily, of which about 440 mg was methionine. In this connection, Novak *et al.* (2004) reported that dietary TSAA level for maximum egg production was 811 mg per hen daily, while TSAA for better feed efficiency was 699 mg per hen daily.

Therefore, this experiment was designed to evaluate the effect of different dietary energy and total sulfur amino acid levels on performance and egg quality and profits in Lohman light hens during the first phase of production cycle (21 – 40 wk of age) under Egyptian conditions.

## MATERIALS AND METHODS

This experiment was conducted at Research Unit of Department of Poultry, Faculty of Agriculture, Zagazig University. A total number of 180 Lohman light hens were used. During the initial and growth phases, the birds were managed following the recommendations of Lohman tradition management guide. After 17 weeks of age, the birds were transferred from growth house to the research unit. Birds were randomly distributed to nine treatments (5 replicates/treatment and 4 hens/replicate) based on body weight, and then were placed in layer cages. The birds had received increased stimulation of light until 17 hours of light daily, then maintained until the end of the experimental period. From 20 week of age, hens were submitted to the treatments. The treatments consisted of nine diets varying in energy level (2750, 2850 and 2950 Kcal ME/Kg diet) and TSAA level (0.67, 0.72 and 0.77) in a 3 x 3 factorial arrangement (Table 1). Methionine was supplied in excess of NRC (1994) requirement to achieve the TSAA level desired. Feed and water were provided for *ad libitum* consumption. The experiment lasted 20 week.

Feed samples were collected and analyzed according to A.O.A.C. (1990). Eggs were collected every day and egg production, egg weight, egg mass (g/h/d), feed consumption (g/h/d) as well as feed conversion (g of feed/g of egg mass) were determined weekly on a cage basis.

Eggs from each replicate were sampled (2-d egg production from a cage) to evaluate egg quality (egg shape index, Haugh unit, yolk %, albumen %, Shell %, yolk index and shell thickness) each 2 weeks.

To estimate the economical feed efficiency, the amount of feed intake during experimental period and the total egg number produced for each hen were calculated. The price of one kilogram of the experimental diets was calculated due to the price of local market of the ingredients used in formulating the diets. Also, the price of eggs plate of local market was recorded at the experimental time. The economical return was calculated based on the difference between price of eggs number per kilogram feed and cost per kilogram feed.

Data were statistically analyzed using GLM procedure of SPSS version 14 program for windows (SPSS, 2004). A 3 × 3 factorial design was used according to Snedecor and Cochran (1990) as in the following statistical model:

$Yijk = \mu + Ei + Sj + ESij + eijk$ ,

where :

Yijk = Individual observation,

$\mu$ = Overall mean,

Ti = the effect of energy levels (i= 1, 2 and 3),

Sj = the effect of total sulfur amino acids (levels (J = 1, 2 3),

TSij = the effect of interaction between energy levels and total sulfur amino acids levels (ij= 1, 2, ……9),

eijk = experimental random error.

Significant differences among treatment means were detected using Duncan's multiple range test (Duncan, 1955).

**Table1. Formulation and chemical analysis of the experimental diets**

| Energy level kcal ME/kg | 2750 | | | 2850 | | | 2950 | | |
|---|---|---|---|---|---|---|---|---|---|
| **TSAA levels %** | **0.67** | **0.72** | **0.77** | **0.67** | **0.72** | **0.77** | **0.67** | **0.72** | **0.77** |
| **Ingredients** | | | | | | | | | |
| **Yellow corn** | 62.74 | 62.69 | 62.64 | 59.5 | 59.45 | 59.40 | 56.44 | 56.39 | 56.34 |
| **Soy bean meal 44%** | 22.50 | 22.50 | 22.50 | 23.00 | 23.00 | 23.00 | 22.75 | 22.75 | 22.75 |
| **Corn gluten meal 62%** | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 | 4.15 | 4.80 | 4.80 | 4.80 |
| **Dry fat(super fat)*** | - | - | - | 2.74 | 2.74 | 2.74 | 5.40 | 5.40 | 5.40 |
| **Nacl** | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| **Premix**** | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| **Dicalcium phosphate** | 1.82 | 1.82 | 1.82 | 1.82 | 1.82 | 1.82 | 1.82 | 1.82 | 1.82 |
| **Limestone** | 8.11 | 8.11 | 8.11 | 8.11 | 8.11 | 8.11 | 8.11 | 8.11 | 8.11 |
| **L-lysine Hcl** | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| **Dl-Methionine** | 0.03 | 0.08 | 0.13 | 0.03 | 0.08 | 0.13 | 0.03 | 0.08 | 0.13 |
| **Total** | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| **Chemical analysis** | | | | | | | | | |
| **Crude Protein %** | 18.07 | 18.10 | 18.12 | 18.01 | 18.03 | 18.06 | 18.03 | 18.05 | 18.08 |
| **Calcium %** | 3.61 | 3.61 | 3.61 | 3.61 | 3.61 | 3.61 | 3.61 | 3.61 | 3.61 |
| **Available phosphorous %** | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.45 | 0.45 | 0.45 |
| **Lysine %** | 0.90 | 0.90 | 0.90 | 0.91 | 0.91 | 0.91 | 0.90 | 0.90 | 0.90 |
| **Methionine+cystine%** | 0.67 | 0.72 | 0.77 | 0.67 | 0.72 | 0.77 | 0.68 | 0.73 | 0.78 |
| **Calculated ME(kcal/Kg)***** | 2761 | 2761 | 2761 | 2850 | 2850 | 2850 | 2947 | 2947 | 2947 |

*Fatty acids soap of palm oil (2.5% moisture – 84% dry fat – 12.5 % ash ) produced by Alfa Chema company.

**Layer Vit. & Min. premix: Each 2.5 kg of vitamins and minerals premix (commercial source pfiezer Co.): consist of Vit. A 12 MIU, VIT E 15 KIU, Vit. D3 4 MIU, Vit. B1 1g, Vit B2 8 g, Vit B6 2 g, Vit B12 10 mg, Pantothonic acid 10.87 g, Niacin30 g, Folic acid 1 g, Biotin 150 mg, Copper 5 g, Iron 15 g, manganese 70 g, Iodine 0.5 g, Selenium 0.15 g, Zinc 60 g and antioxidant 10g.

***Calculated according to NRC (1994).

## RESULTS AND DISCUSSION

### Feed Intake

The obtained results Table 2 showed that dietary energy had highly significant effect on feed intake. Increasing dietary energy level from 2750 to 2950 Kcal ME/Kg, feed intake linearly decreased from 96.7 to 90.4 g/hen per day, resulting in a net decrease of 6.3 g/hen/day which represent 6.5% of feed intake.

An increase of 32 Kcal ME/Kg decreased feed intake by 1% calculated from the results of Grobas (1999) and Wu *et al.* (2005b) who indicated that an increase of 33 and 39 Kcal ME/Kg respectively, decreased feed intake by 1%. The authors found that, when dietary energy increased, hens adjusted feed intake to achieve a constant energy intake.

On the other hand, increasing dietary TSAA level from 0.67 to 0.72%, significantly increased feed intake while, increasing TSAA level from 0.72 to 0.77% showed no significant effect on feed intake (Table 2).

These results were in agreement with that of Austic (1986) and Solarte *et al.* (2005) who found that increasing TSAA level had a positive effect on feed intake which may be related to that TSAA could modify the plasmatic amino acidic profile in an animal to activate appetite.

There were no interaction effects between dietary energy and TSAA on feed intake (Table 2).

### Egg Production, Weight and Mass

The results showed no significant dietary energy effect on egg production (Table 2). These results were consistent with that of Harms *et al.* (2000) and Wu *et al.* (2005b) who reported that egg production was not affected by dietary energy. However, dietary TSAA level had a significant positive effects on egg production. With increasing dietary TSAA levels from 0.67 to 0.72%, egg production increased from 86.33 to 88.14%.

However a further increase in dietary TSAA levels from 0.72 to 0.77% had no additional effect on egg production (Table 2). These results are in agreement with those of Liu *et al.* (2005), Wu *et al.* (2005a) and Solarte *et al.* (2005) who reported that increasing levels of TSAA improved egg production.

The results of egg weight and egg mass Table 2 showed that dietary energy had a significant linear effect on egg weight and egg mass during the most experimental period and the overall average. This result was in agreement with that of Bohnsack *et al.* (2002), Sohail *et al.* (2003) and Wu *et al.* (2005b), who observed that increasing dietary energy by addition of corn oil or poultry oil had positive effects on early egg weight. On the other hand, increasing the dietary TSAA level from 0.67 to 0.72% had a significant higher egg weight and egg mass (Table 2). However, no additional positive effects were detected with further increase in TSAA level from 0.72 to 0.77%.Similar results were obtained by Solarte *et al.* (2005) who reported that increasing TSAA level from 0.684 to 0.734% had no further improvement on egg weight and egg mass.

There were no interaction effects between dietary energy and TSAA level on egg production; egg weight and egg mass (Table 2).

### Feed Conversion and Body Weight Change

Dietary energy had a significant positive effect on feed conversion Table 2. As dietary energy increased from 2750 to 2950 Kcal ME/Kg, feed conversion improved from 2.05 to 1.87 (g feed/ g of egg mass), resulting in a net improvement of 8.8%. These results are consistent with those of Wu *et al.* (2005b) who reported that feed conversion improved by 7.9% when Dekalb white hens fed diet contained 2956 Kcal ME/Kg than those fed diet contained lower energy level (2719 Kcal ME/Kg). Also, feed conversion ratio significantly improved as a result of increasing TSAA level from 0.67 to 0.77% (Table 2).

These observations were in accordance with the results of Novak *et al.* (2004), Liu *et al.* (2005) and Wu *et al.* (2005a) who reported that the improved feed efficiency with increasing TSAA level might be attributed to more balanced amino acids.

There was no dietary energy effect on hen body weight change which may be related to that hens adjusted energy intake (Table 2). Similar results were reported by Wu *et al.* (2005b).

**Table 2. Effect of energy and TSAA levels and their interaction on productive performance during the first phase of laying period**

| Items | Feed intake (g/hen/day) | Egg production (%) | Egg number | Egg weight (g) | Egg mass (g /hen/d) | Feed conversion (g feed/g egg) | Body weight change(g) |
|---|---|---|---|---|---|---|---|
| **Energy level kcal ME/kg** | ** | NS | NS | ** | * | ** | NS |
| **Low 2750 (LE)** | 96.72$^{a}$±0.20 | 87.00±0.56 | 121.80±0.78 | 54.20$^{c}$±0.25 | 47.15$^{b}$±0.43 | 2.05$^{a}$±0.007 | +163.917±17.417 |
| **Normal 2850 (NE)** | 93.52$^{b}$±0.12 | 87.24±0.37 | 122.13±0.52 | 54.86$^{b}$±0.20 | 47.86$^{ab}$±0.34 | 1.95$^{b}$±0.005 | +159.920±17.212 |
| **High 2950 (HE)** | 90.43$^{c}$±0.08 | 87.52±0.41 | 122.53±0.58 | 55.36$^{a}$±0.13 | 48.45$^{a}$±0.29 | 1.87$^{c}$±0.004 | +189.670±14.651 |
| **TSAA level %** | ** | * | * | ** | ** | ** | NS |
| **Low 0.67 (LT)** | 93.03$^{b}$±0.65 | 86.33$^{b}$±0.53 | 120.87$^{b}$±0.74 | 54.08$^{b}$±0.24 | 46.69$^{c}$ ±0.39 | 1.99$^{a}$±0.002 | +139.417±14.564 |
| **Normal 0.72 (NT)** | 93.85$^{a}$±0.72 | 88.14$^{a}$±0.42 | 123.40$^{a}$±0.58 | 55.38$^{a}$±0.17 | 48.81$^{a}$ ± 0.32 | 1.92$^{b}$±0.002 | +172.250±16.507 |
| **High 0.77 (HT)** | 93.79$^{a}$±0.72 | 87.29$^{ab}$±0.23 | 122.20$^{ab}$±0.33 | 54.96$^{a}$±0.15 | 47.97$^{b}$ ± 0.19 | 1.95$^{b}$±0.002 | +194.500±17.975 |
| **Interaction (E X T)** | NS | NS | NS | NS | NS | NS | NS |
| **LE X LT** | 95.956±0.323 | 85.857±1.182 | 120.200±1.655 | 53.287±0.411 | 45.75±0.66 | 2.10±0.013 | +144.000±27.152 |
| **LE X NT** | 97.148±0.179 | 88.000±1.093 | 123.200±1.529 | 54.721±0.254 | 48.15±0.78 | 2.02±0.008 | +164.250±20.154 |
| **LE X HT** | 97.052±0.286 | 87.143±0.319 | 122.000±0.447 | 54.598±0.322 | 47.58±0.36 | 2.04±0.009 | +183.500±42.972 |
| **NE X LT** | 93.008±0.113 | 86.143±0.535 | 120.600±0.748 | 54.064±0.268 | 46.57±0.47 | 2.00±0.009 | +129.000±29.099 |
| **NE X NT** | 93.792±0.128 | 88.143±0.485 | 123.400±0.678 | 55.580±0.202 | 48.99±0.40 | 1.91±0.007 | +159.500±32.590 |
| **NE X HT** | 93.768±0.132 | 87.429 ±0.623 | 122.400±0.872 | 54.925±0.187 | 48.02±0.36 | 1.95±0.005 | +185.250±21.573 |
| **HE X LT** | 90.132±0.130 | 87.000±1.045 | 121.800±1.463 | 54.902±0.138 | 47.76±0.66 | 1.89±0.006 | +165.250±15.484 |
| **HE X NT** | 90.620±0.106 | 88.286±0.623 | 123.600±0.872 | 55.825±0.149 | 49.17±0.36 | 1.84±0.005 | +189.000±26.332 |
| **HE X HT** | 90.544±0.091 | 87.286±0.267 | 122.200±0.374 | 55.364±0.196 | 48.32±0.18 | 1.87±0.007 | +214.750±30.435 |

Means in the same column within each classification bearing different letters are significantly different. **($P \leq 0.01$), *($P \leq 0.05$) and NS = not significantly.

However, there is a positive response on body weight change to TSAA level (Table 2). Hens fed 0.67% TSAA had the lowest body change (139.4 g), while hens fed 0.77% TSAA had the highest body weight change (194.5 g). This result was in agreement with that of Novak *et al.* (2004) and Solarte *et al.* (2005) who obtained a quadratic effect on body weight change to TSAA level. No significant interaction effects of dietary energy and TSAA were observed on feed conversion and hen body weight change (Table 2).

## Nutrients Utilization

Data in Table 3 indicate the amounts of nutrients needed to obtain one gram of an egg. When dietary energy increased from 2750 to 2950 Kcal ME/Kg, hens adjusted feed intake from 96.72 to 90.43 g/hen per day to achieve a constant energy intake so that the same amount of dietary energy (4.9 Kcal) was used to produce one gram egg (Table 3). However, the other nutrients intake such as protein, and Lysine linearly decreased with increasing dietary energy (Table 3). The decrease of nutrients intake might explain why increasing dietary energy levels had no effect on egg weight and supports the hypothesis that probably an ideal energy/protein (TSAA& Lysine) ratio is needed for optimal performance.

## Egg Quality Traits

Egg components were affected by both the dietary energy and TSAA levels (Table 4). The results of yolk index, shell thickness and Haugh unit were significantly affected by dietary energy level (Table 4). As dietary energy increased shell thickness increased from 0.37 mm to 0.41 mm, respectively. While the values of Haugh unit significantly decreased from 107 to 102 with increasing energy level from 2750 to 2950 Kcal ME/Kg, respectively (Table 4). The other egg quality traits (yolk, albumen and shell percentage) were not significantly affected by dietary energy level (Table 4).

On the other hand, the values of either internal or external egg quality traits were not significantly affected by TSAA level (Table 4). Also, no significant interactions between energy and TSAA levels were found (Table 4). These results are in agreement with the pervious work of Keshavarz (2003), Novak *et al.* (2004) and Safaa *et al.* (2008) who reported that TSAA level did not affect egg quality.

## Economical Feed Efficiency

The obtained results Table 5 showed that increasing level of energy from 2750 to 2950 Kcal ME/Kg increased the price of Kg feed from 2.46 to 2.57 LE, from 2.475 to 2.59 and from 2.49 to 2.605 LE at o.67, 0.72 and 0.77% TSAA, respectively. The egg number per Kg feed increased on average from 9.08 to 9.68 eggs which increased return from 2.07 to 2.25 LE per Kg feed (Table 5), which equals 8.7% more profits than the lower energy level.

**Table 3. Influence of dietary energy and TSAA levels on nutrients intake for one gram egg of Lohman light laying hens**

| Factors | Energy/TSAA ratio (Kcal ME /g TSAA) | Nutrients used to produce 1g egg | | | |
|---|---|---|---|---|---|
| | | Dietary energy(Kcal) | Protein (g) | TSAA (mg) | Lysine (mg) |
| **Energy level Kcal ME/Kg** | | | | | |
| **Low (LE)** | 383 | 4.92 | 0.32 | 11.96 | 16.06 |
| **Normal (NE)** | 397 | 4.86 | 0.30 | 12.28 | 15.34 |
| **High (HE)** | 411 | 4.82 | 0.29 | 12.58 | 14.70 |
| **TSAA%** | | | | | |
| **Low (LT)** | 425 | 4.73 | 0.310 | 11.52 | 15.48 |
| **Normal (NT)** | 396 | 4.83 | 0.305 | 12.20 | 15.25 |
| **High (HT)** | 370 | 5.03 | 0.307 | 13.14 | 15.39 |
| **Interaction(E X T)** | | | | | |
| **LE x LT** | 410 | 4.95 | 0.324 | 12.06 | 16.21 |
| **LE x NT** | 382 | 4.88 | 0.324 | 12.94 | 16.17 |
| **LE x HT** | 357 | 4.89 | 0.318 | 13.61 | 15.91 |
| **NE x LT** | 425 | 4.90 | 0.306 | 11.39 | 15.30 |
| **NE x NT** | 396 | 4.81 | 0.304 | 11.81 | 15.19 |
| **NE x HT** | 370 | 4.87 | 0.302 | 12.93 | 15.12 |
| **HE x LT** | 440 | 4.84 | 0.297 | 11.06 | 14.86 |
| **HE x NT** | 410 | 4.79 | 0.297 | 11.88 | 14.85 |
| **HE x HT** | 383 | 4.82 | 0.294 | 12.59 | 14.72 |

**Table 4. External and internal egg quality traits (X± SE) as affected by level of energy, total sulfur amino acids and their interaction during the first phase of laying period (at 40 wk)**

| Items | Egg weight( g ) | Egg shape index | Yolk index | Yolk % | Albumen % | Shell thickness | Shell % | Haugh Unit |
|---|---|---|---|---|---|---|---|---|
| **Energy level kcal ME/kg** | NS | NS | * | NS | NS | ** | NS | ** |
| **Low 2750 (LE)** | 57.69±0.87 | 79.39±0.67 | 54.14$^{a}$±0.57 | 22.38±0.32 | 64.89±0.33 | 0.37$^{b}$±0.006 | 12.67±0.19 | 107.22$^{a}$±1.26 |
| **Normal 2850 (NE)** | 56.62±0.97 | 79.15±0.40 | 51.81$^{b}$±0.74 | 22.47±0.57 | 64.48±0.92 | 0.39$^{b}$±0.008 | 13.05±0.43 | 105.43$^{a}$±0.88 |
| **High 2950 (HE)** | 58.32±0.84 | 79.79±0.45 | 53.11$^{ab}$±0.75 | 21.49±0.29 | 65.42±0.36 | 0.41$^{a}$±0.007 | 13.09±0.21 | 101.96$^{b}$±0.75 |
| **TSAA level %** | * | NS | NS | NS | NS | NS | NS | NS |
| **Low 0.67 (LT)** | 55.61$^{b}$±1.09 | 79.46±0.64 | 53.11±0.78 | 22.69±0.58 | 64.17±0.92 | 0.38±0.008 | 13.14±0.42 | 106.39±1.12 |
| **Normal 0.72 (NT)** | 58.42$^{a}$±0.72 | 79.66±0.47 | 53.59±0.68 | 21.71±0.30 | 65.46±0.37 | 0.39±0.007 | 12.82±0.19 | 104.75±1.17 |
| **High 0.77 (HT)** | 58.59$^{a}$±0.73 | 79.20±0.43 | 52.35±0.65 | 21.97±0.28 | 65.16±0.30 | 0.40±0.008 | 12.86±0.22 | 103.48±0.78 |
| **Interaction (E X T)** | * | NS | NS | NS | NS | NS | NS | NS |
| **LE X LT** | 54.653$^{bc}$±1.792 | 80.933±1.504 | 54.103±1.078 | 22.835±0.555 | 64.906±0.488 | 0.353±0.013 | 12.259±0.305 | 110.868±1.824 |
| **LE X NT** | 58.794$^{ab}$±1.109 | 79.068±1.039 | 56.161±0.832 | 21.799±0.553 | 65.245±0.749 | 0.378±0.008 | 12.956±0.409 | 105.008±2.849 |
| **LE X HT** | 59.595$^{a}$±1.132 | 78.158±0.740 | 52.157±0.607 | 22.616±0.517 | 64.535±0.459 | 0.374±0.007 | 12.849±0.237 | 105.797±1.036 |
| **NE X LT** | 53.098$^{c}$±2.208 | 77.882±0.509 | 51.246±1.802 | 23.592±1.599 | 62.523±2.658 | 0.379±0.108 | 13.885±1.147 | 106.091±1.437 |
| **NE X NT** | 56.952$^{abc}$±0.835 | 79.710±0.585 | 51.998±1.025 | 22.576±0.358 | 65.078±0.425 | 0.375±0.015 | 12.346±0.248 | 107.708±1.405 |
| **NE X HT** | 59.824$^{a}$±0.962 | 79.842±0.798 | 52.182±0.939 | 21.251±0.407 | 65.838±0.536 | 0.406±0.016 | 12.921±0.484 | 102.478±1.361 |
| **HE X LT** | 59.079$^{ab}$±1.172 | 79.555±0.945 | 53.980±0.931 | 21.661±0.467 | 65.069±0.618 | 0.417±0.009 | 13.270±0.422 | 102.213±1.575 |
| **HE X NT** | 59.515$^{a}$±1.655 | 80.206±0.798 | 52.624±1.259 | 20.749±0.487 | 66.069±0.719 | 0.402±0.012 | 13.182±0.296 | 101.528±0.985 |
| **HE X HT** | 56.377$^{abc}$±1.437 | 79.600±0.643 | 52.720±1.690 | 22.061±0.489 | 65.119±0.507 | 0.409±0.014 | 12.820±0.398 | 102.152±1.418 |

Means in the same column within each classification bearing different letters are significantly different. **($P \leq 0.01$), *($P \leq 0.05$) and NS = not significantly.

**Table 5. The economical feed efficiency as affected by the experimental diets**

| Items | Energy level kcal ME/kg diet | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2750 | | | 2850 | | | 2950 | | |
| | TSAA% | | | | | | | | |
| | 0.67 | 0.72 | 0.77 | 0.67 | 0.72 | 0.77 | 0.67 | 0.72 | 0.77 |
| **Cost of Kg feed LE** | 2.460 | 2.475 | 2.490 | 2.515 | 2.530 | 2.550 | 2.570 | 2.590 | 2.605 |
| **Egg number per Kg feed** | 9.210 | 9.060 | 8.980 | 9.260 | 9.400 | 9.320 | 9.650 | 9.740 | 9.640 |
| **Egg price* LE** | 4.605 | 4.530 | 4.490 | 4.630 | 4.700 | 4.660 | 4.825 | 4.870 | 4.820 |
| **Return LE** | 2.145 | 2.055 | 2.000 | 2.115 | 2.170 | 2.110 | 2.255 | 2.280 | 2.215 |

*The price of plate of eggs (30 eggs) was 15 LE

On the other hand, increasing TSAA levels from 0.67 to 0.77% shows no significant effects on return (Table 5). The maximum profits were obtained in hens fed the diet containing 2950 Kcal ME/Kg and 0.72% TSAA.

From the obtained results it can be concluded that, Lohman light laying hens required 2950 Kcal ME/Kg and 0.72% TSAA in the diets or 277 Kcal ME/Kg and 676 mg TSAA per hen daily in the first phase of production cycle from 21 to 40 wk of age conditions. This means that increasing energy/TSAA ratio up to 410 maximized the profits under Egyptian conditions.

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# تأثير محتوى الغذاء من الطاقة والأحماض الأمينية الكبريتية على الأداء الإنتاجي وصفات جودة البيض لدجاج اللوهمان لايت البياض

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فى هذا البحث تم استخدام ثلاثة مستويات طاقه (٢٧٥٠، ٢٨٥٠، ٢٩٥٠ ك كالوري طاقه ممثله/ كجم علف) وثلاثة مستويات أحماض أمينية كبريتية (٠,٦٧ ، ٠,٧٢ ، ٠,٧٧٪) في تصميم تجريبي عاملي ٣ x ٣ لبيان أثر محتوى العليقة من الطاقة و الأحماض الأمينية الكبريتية الكلية على الأداء الإنتاجي وخواص جودة البيض والعائد الإقتصادى، وذلك على دجاج اللوهمان لايت البياض في مرحله إنتاجه الأولى (عمر ٢١ – ٤٠ أسبوع). استخدم فى هذه التجربة ١٨٠ دجاجه في مرحلة الإنتاج الأولى (عمر ٢٠ أسبوع) وتم تقسيمها عشوائيا بناء على وزنها إلي تسعة معاملات (٥ مكررات لكل مكررة ٤ دجاجات) واستمرت التجربة لمدة ٢٠ أسبوع. أظهرت النتائج أن زيادة مستوى الطاقة من ٢٧٥٠ إلى ٢٩٥٠ ك كالوري طاقه ممثله/ كجم أدى إلي نقص كمية الغذاء المأكول من ٩٦,٧ إلى ٩٠,٤ جم للدجاجة في اليوم وذلك لتثبيت كمية الطاقة المستهلكة يوميا مع اختلاف مستوى الطاقة، وهو ما يعني أن كمية الطاقة اللازمة لإنتاج واحد جرام بيض هي ٤,٩ ك كالوري طاقه ممثله مهما اختلف مستوى الطاقة بالعليقة. أيضاً أدى زيادة مستوى الطاقة إلي زيادة معنوية في وزن وكتلة وسمك قشرة البيضة والي تحسن معنوي في معامل تحويل الغذاء وانخفاض وحدة هاف، بينما أدى زيادة مستوى الأحماض الأمينية الكبريتية الكلية من ٠,٦٧ إلى ٠,٧٧٪ إلى تحسن كمية الغذاء المأكول، إنتاج و وزن و كتلة البيضة و معامل التحويل الغذائي ولم يكن هناك أي تأثير على صفات جودة البيضة – حقق مستوى طاقه ٢٩٥٠ ك كالورى طاقه ممثله و٠,٧٢٪ أحماض أمينية كبريتية كليه أفضل عائد اقتصادي. الخلاصة أن دجاج اللوهمان لايت البياض يحتاج علائق تحتوي ٢٩٥٠ ك كالوري طاقة ممثلة و ٠,٧٢٪ أحماض أمينيه كبريتيه كليه أو ٢٧٧ ك كالوري طاقه ممثله و ٦٧٦ ملليجرام أحامض أمينيه كبريتيه يوميا لكل دجاجه خلال مرحلة الإنتاج الأولى من ٢١ إلى ٤٠ أسبوع وذلك تحت الظروف المصرية.