INTRODUCTION

The cost of dietary feedstuffs (corn and soybean meal), continue to rise, while supplying the nutritional demands of growing broiler farms is the main of the production costs, and nearly 75% of the total expense. The major component of this cost is the high protein ingredients, such as soybean meal to get maximum tissue accretion. To deal with these constant elevating protein prices, with enhancing or at least maintaining bird performance, it is necessary to find ways to partially replace this high protein feed ingredient. Our results have shown that utilizing digestible formulations, ideal protein ratios and feed formulation software, with providing the total essential amino acids (TEAA) and non-essential amino acids (TNEAA) requirements deliver the least cost per unit of gain and lowering the feed costs. Recent study reported that one percent reduction in the CP value in the diets of turkey saved 5 dollars/ 1000 kg of feed (Mohammaddigheisar and Kim, 2018).

In addition to lowering feed costs, the advancement in poultry nutrition formulations can provide a variety of avenues to increase efficiency and reduce expense, and involve a considerable diversity of feed ingredients (Kerr and Kidd, 1999a) leading to decreased nitrogen excretion through reduced protein diets (Nahm, 2007).

Previous literature reported that reducing CP without fortification of AAs is harmful to broiler productive performance (Kerr and Kidd 1999b), while CP can be successfully lowered to a point with synthetic glutamic
acid and indispensable amino acid fortification, which lead to comparable productive performance to compensate the high CP diets (Dean et al., 2006; Namroud et al., 2008). Moreover, dropped performance in broilers fed low CP, amino acids (methionine, threonine, lysine, valine, isoleucine, arginine, phenylalanine and tryptophan) supplemented diets with reductions in CP in number of cases to 3 or 4 % has been previously reported (Sti et al., 2004; Namroud et al., 2008). So, the current study aims to investigate the growth performance, some serum biochemical parameters and carcass traits and economic efficiency of broiler chickens fed on LCP supplemented with synthetic amino acids and L-carnitine as a new nutrient requirement.

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

The current animal study was conducted at the Poultry Research Farm, Faculty of Veterinary Medicine, Zagazig University, Egypt following the institutional guidelines and ethical rules. Chicks were cared for in accordance with husbandry guidelines of Zagazig University standard operating procedures. Two hundred unsexed one-day old broiler chicks of Cobb 500 chicks, weighing 40±1 g, were purchased from regional hatchery in Abu Kabir Sharkia. Chicks were randomly divided into four experimental treatments with five replicates / treatment (fifty chicks/ treatment; ten chicks/replicate). Diet used in this study was fully analyzed for components (DM, CP and EE) (AOAC, 2002).

Group 1 was negative control group, group 2 supplemented with 2% low crude protein (LCP) plus synthetic essential, non-essential amino acids and L-carnitine, group 3 received 4% LCP plus synthetic essential, non-essential amino acids and L-carnitine and group 4 treated with 6% LCP plus synthetic essential, non-essential amino acids and L-carnitine for 42 days (2 weeks intervals between each treatment). Chicks were vaccinated against Infectious bursal disease virus (IBDV) and Newcastle disease virus (NDV). Chicks kept in separate pens under constant temperature. The diet was formulated to supply the nutrient requirement.

Dietary electrolyte balance (DEB)

The normal value of DEB in broiler chickens is 250 mEq/kg diets. The DEB of various diets was calculated based on the analyzed values of Na, K and Cl (with or without S) of feed ingredients. It was calculated by multiplying the % of the element by a convenient multiplier factor (434.78, 255.75, 281.69 and 208.3 for Na, K, Cl and S, respectively). The DEB equation measures the balance between the levels of sodium and potassium versus chloride as expressed in mEq/kg diet (DEB= Na+ + K+ - Cl-) (Mongin, 1981).

GROWTH PERFORMANCE PARAMETERS

The broilers were weighed at the start and end of the experiment beside that, they weighed weekly to obtain body weight (BW). The average feed intake (FI) was recorded daily in grams as the reduction of feed. Body weight gain (BWG) and feed conversion ratio (FCR) were also calculated.

BIOCHEMICAL ANALYSIS

Blood samples from five broilers per group at 42 day old were collected post-slaughtering in a sterile glass tubes without anticoagulant and placed in a slant position for twenty minutes at room temperature then centrifuged for ten min at 3000 rpm. Serum was then removed and stored at -20 °C until used for further biochemical investigation using various ELISA diagnostic kits (Roch Diagnostics, GmbH, USA). Serum glucose (Tietz, 2006); total cholesterol (Pisani et al., 1993); triglyceride (Stein and Myers, 1995); high-density lipoprotein concentration (Nitschke and Tall, 2005) and low-density lipoprotein (Sonntag and Scholer, 2001). Serum total protein and albumin (Burtis et al., 2006), globulin was calculated by difference (Doumas and Biggs, 1972). Blood urea nitrogen, creatinine and uric acids (Fossati, 1980). Alanine aminotransferase (ALT) was assessed according to the method described by Young (2001). Serum aspartate-aminotransferase (ALT) was measured according to the method developed by Murray (1984) beside serum sodium, potassium and chloride (Stummvoll and Lehmann, 1996).

CARCASS TRADES

After 42 days from the beginning of the trial, five broilers from each treatment were randomly chosen, fasted overnight, weighed then slaughtered by sharp knife for complete bleeding. The dressing percentage, in which the head, neck, feet and lower wing were removed and calculated by final weighting following plucking of the feather, evisceration. Liver, heart and digestive tract (intestine and crop, gizzard, proventiculus, abdominal fat and spleen) were selected, weighed and considered as percentage of live body weight.

ECONOMIC EFFICIENCY MEASUREMENTS

The cost parameters were categorized into total fixed costs (TFC), total variable costs (TVC), and total costs (TC) (Ahmed, 2007; Sara, 2007). On the other hand, returns parameters including total returns (TR) from chick sale.
### Table 1: Ingredient composition (%) and calculated analysis of the experimental diets used in experimental starter, grower and finisher stages (air dry basis).

| Experimental diets | Ingredient |
|--------------------|------------|
| **Finisher stage (2 weeks)** | LCP, 6% | LCP, 4% | LCP, 2% | Control |
| LCP, 6% | 78.52 | 67.96 | 62.34 | 57.27 | 67.48 | 62.67 | 57.17 | 50.34 | Yellow corn |
| LCP, 4% | 8.90 | 20.60 | 26.00 | 11.15 | 17.50 | 23.53 | 29.35 | 16.30 | 22.50 | 28.60 | 34.60 | SBM, 44% |
| LCP, 2% | 3.45 | 3.45 | 3.45 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | 5.00 | Corn gluten, 60% |
| Control | 2.40 | 3.60 | 4.40 | 1.70 | 2.20 | 3.00 | 3.90 | 1.75 | 2.15 | 2.80 | 4.05 | Soybean oil |
| **Grower stage (2 weeks)** | LCP, 6% | LCP, 4% | LCP, 2% | Control |
| LCP, 6% | 1.05 | 1.00 | 1.00 | 1.10 | 1.10 | 1.10 | 1.10 | 1.20 | 1.20 | 1.20 | 1.2 | Calcium carbonate |
| LCP, 4% | 1.55 | 1.50 | 1.45 | 1.40 | 1.75 | 1.70 | 1.60 | 1.55 | 1.85 | 1.80 | 1.75 | 1.7 | Ca. dibasic ph. |
| LCP, 2% | 0.15 | 0.30 | 0.30 | 0.15 | 0.30 | 0.30 | 0.30 | 0.10 | 0.30 | 0.30 | 0.30 | 0.30 | Common salt |
| Control | 0.45 | 0.25 | 0.25 | 0.08 | 0.43 | 0.20 | 0.22 | - | 0.50 | 0.22 | - | - | Sod. bicarbonate |
| **Starter stage (2 weeks)** | LCP, 6% | LCP, 4% | LCP, 2% | Control |
| LCP, 6% | 0.30 | 0.30 | 0.30 | 0.15 | 0.30 | 0.30 | 0.30 | 0.10 | 0.30 | 0.30 | 0.30 | 0.30 | Premix^1 |
| LCP, 4% | 0.44 | 0.26 | 0.1 | - | 0.52 | 0.33 | 0.16 | 0.03 | 0.67 | 0.49 | 0.32 | 0.15 | Lysine, HCl, 78% |
| LCP, 2% | 0.10 | 0.08 | 0.05 | 0.03 | 0.12 | 0.10 | 0.08 | 0.05 | 0.18 | 0.16 | 0.13 | 0.11 | DL-Methionine, 98% |
| Control | 0.12 | 0.05 | 0.01 | - | 0.16 | 0.08 | 0.03 | - | 0.23 | 0.16 | 0.08 | 0.05 | Threonine, 98.5% |
| **Calculated composition** | 3192.27 | 3197.46 | 3187.58 | 3184.61 | 3106.56 | 3107.50 | 3104.84 | 3105.43 | 3001.37 | 3004.70 | 3004.78 | 3011.2 | ME, Kcal/Kg |
| **Calculated composition** | 12.23 | 14.13 | 16.09 | 18.00 | 14.00 | 16.06 | 18.07 | 20.04 | 16.07 | 18.10 | 20.08 | 22.04 | CP, % |
| **Calculated composition** | 3192.27 | 3197.46 | 3187.58 | 3184.61 | 3106.56 | 3107.50 | 3104.84 | 3105.43 | 3001.37 | 3004.70 | 3004.78 | 3011.2 | C/P ratio |
| **Calculated composition** | 3209.27 | 3214.76 | 3217.58 | 3218.84 | 3210.53 | 3210.43 | 3200.84 | 3201.37 | 3100.70 | 3100.78 | 3101.12 | 3101.12 | EE, % |
| **Calculated composition** | 3209.27 | 3214.76 | 3217.58 | 3218.84 | 3210.53 | 3210.43 | 3200.84 | 3201.37 | 3100.70 | 3100.78 | 3101.12 | 3101.12 | CF, % |
| **Calculated composition** | 8.81 | 0.76 | 0.76 | 0.76 | 0.89 | 0.84 | 0.84 | 0.86 | 0.99 | 0.91 | 0.92 | 0.99 | Ca, % |
| **Calculated composition** | 0.38 | 0.38 | 0.38 | 0.38 | 0.42 | 0.42 | 0.42 | 0.42 | 0.45 | 0.45 | 0.45 | 0.45 | Available ph., % |
| **Calculated composition** | 0.77 | 0.76 | 0.76 | 0.80 | 0.89 | 0.89 | 0.89 | 0.91 | 1.12 | 1.12 | 1.12 | 1.12 | Lysine, % |
| **Calculated composition** | 0.32 | 0.33 | 0.32 | 0.32 | 0.37 | 0.38 | 0.38 | 0.37 | o.45 | 0.45 | 0.45 | 0.45 | Methionine, % |
| **Calculated composition** | 0.35 | 0.37 | 0.37 | 0.37 | 0.40 | 0.41 | 0.42 | 0.42 | 0.48 | 0.49 | 0.50 | 0.50 | Cysteine, % |
| **Calculated composition** | 0.62 | 0.73 | 0.83 | 0.92 | 0.68 | 0.79 | 0.90 | 1.00 | 0.75 | 0.87 | 0.98 | 1.08 | Phenylalanine, % |
| **Calculated composition** | 1.41 | 1.42 | 1.40 | 1.42 | 1.64 | 1.65 | 1.66 | 1.66 | 2.07 | 2.07 | 2.09 | 2.09 | Proline, % |
| **Calculated composition** | 0.64 | 0.75 | 0.84 | 0.93 | 0.72 | 0.83 | 0.93 | 1.03 | 0.80 | 0.91 | 1.01 | 1.11 | Serine, % |
| **Calculated composition** | 0.53 | 0.53 | 0.56 | 0.62 | 0.62 | 0.62 | 0.64 | 0.68 | 0.74 | 0.75 | 0.75 | 0.79 | Threonine, % |
| **Calculated composition** | 0.13 | 0.13 | 0.16 | 0.18 | 0.15 | 0.15 | 0.17 | 0.20 | 0.18 | 0.17 | 0.20 | 0.22 | Tryptophan, % |
| **Calculated composition** | 0.53 | 0.61 | 0.68 | 0.75 | 0.58 | 0.66 | 0.73 | 0.80 | 0.63 | 0.71 | 0.79 | 0.86 | Tyrosine, % |
Table 2: Overall performance of broiler chickens fed with low CP diets (LCP) and AAs and L-carnitine supplementation (Means ±SE).

| Item                        | Control | LCP, 2% | LCP, 4% | LCP, 6% |
|-----------------------------|---------|---------|---------|---------|
| Initial body weight (g)     | 44.01±0.42 | 44.57±0.43 | 42.95±0.41 | 43.99±0.28 |
| Final body weight (g)       | 2812.30±129.59 | 3094.30±122.26 | 2684.10±71.03 | 2684.10±71.03 |
| Absolute weight gain (g)   | 2768.30±129.21 | 3049.70±121.83 | 2561.50±73.16 | 2561.50±73.16 |
| Total feed consumption (g) | 4291.00±156.39 | 4262.90±117.41 | 4321.20±78.89 | 4438.70±159.57 |
| Feed conversion ratio       | 1.55±0.02b | 1.40±0.01c | 1.68±0.02c | 1.68±0.02c |

abc Means within the same row carrying different superscripts are significantly different at (P ≤ 0.05).

equals kg price (20 LE in May, 2016) x body weight and net profit (total returns minus total costs) were calculated.

**Statistical analysis**

The obtained results were statistically analyzed using one-way ANOVA by the statistical package for social science (SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp). Variations among treatment means were compared using Duncan’s multiple range tests (Duncan, 1995). Statement of statistical significance was pronounced at (P<0.05).

**Results and Discussion**

Productive performance of broilers fed with the experimental diet is shown in Table 2. Our results revealed that no marked change in total final body weight, body weight gain and total feed intake when compared with the control one (P>0.05). Also, the feed conversion ratio had marked improvement in group 2 fed with low crude protein (decrease by 2%) (P<0.05) while marked decrease in other treated groups when compared with the control one (P<0.05).

Our results are in accordance with previous studies at which report that crude protein can be successfully reduced up to a 25% with using synthetic glutamic acid and indispensable amino acid fortification that results in the same performance for standard higher CP (Dean et al., 2006; Namroud et al., 2008). In addition, CP of broilers starter (up to 3 weeks) can be lowered to 19.20% with depending on indispensable amino acids supplementation without any harmful effect on productive performance under the hot and humid tropics (Awad et al., 2014). Also, feeding Cobb Avian 48 broilers on 1% lower protein diet at constant ME, with the same amino acids levels hadn’t adversely affected the growth performance, liver functions and carcass parameters, whereas; dietary CP and crude fiber utilization were enhanced (Saleh, 2016). However, our results are disagreed with previous studies reported...
Data of some serum biochemical parameters of broiler chicken are presented in Table 3 which revealed no marked change in the total cholesterol, LDL, total protein, albumin, globulin, ALT, AST, creatinine, uric acid, urea, sodium and potassium among various treatments formulated based on low CP diets (LCP) and supplemented with synthetic essential, non-essential amino acids and L-carnitine (P<0.05). On the other side, there was a marked difference among treatments in the serum glucose, triglyceride, HDL and chloride (P<0.05).

Likewise, our results revealed a marked decrease in serum glucose level for group 4 fed on LCP (decrease by 6%) when compared to control group or other dietary treatment groups (P<0.05). The calculated parameters of serum triglyceride or chloride revealed a marked reduced within group 2 fed LCP (decrease by 2%) when compared to control group or other dietary treatment groups (P<0.05). Statistical data analysis revealed a significantly increase in serum HDL for group 4 fed on LCP (decrease by 6%) when compared to control group or other dietary treatments groups (P<0.05).

These results disagreed with previous study reported that chicken fed on low CP diets had significantly increased plasma triglycerides, free fatty acids and decreased uric acid levels while glucose levels were unaffected by the dietary composition which indicates that carbohydrate metabolism was not affected by the diet (Swennen et al., 2006).

Regarding triglyceride and high-density lipoprotein, our results disagreed with previous studies found markedly increased for liver weights in the chickens fed the LCP diet when compared to those fed diet with higher in CP (Swennen et al., 2006) which could be related to increased metabolizable energy (ME): crude protein (CP) ratio in the low CP diets (31.5 vs. 16.5) because increased ME: CP ratio can effectively increase the activity of body lipogenesis (Rosebrough and Steele, 1985). This fact is supported by the increased plasma triglycerides concentration of the chickens fed low CP diets. In our study, we find marked decrease in triglyceride and marked increase in HDL due to addition of L-carnitine that is a zwitterionic compound necessary for the transport of long-chain fatty acids from the cytosol into the mitochondria for β-oxidation (Rosebrough and Steele, 1985). So, dietary L-carnitine fortification could improve energy and fatty acid and utilization as well as decrease esterification reactions and triacylglycerol storage in the adipose tissue, which eventually lead to decrease in body fat storage.

Data of carcass traits are presented in Table 4 which revealed that no marked differences on weight percentages of dressing, gizzard, proventriculus, liver, spleen, heart, abdominal fat and crop relative to live body weight among all experimental treated groups (P>0.05).

The obtained results are in a close agreement with trial reported that no changes in carcass, breast meat yields and abdominal fat in broilers fed LCP diets with constant ME: CP (Hidalgo et al., 2004). Furthermore, the indispensable amino acid status of a diet influences the carcass composition of broilers and while in case of adequate essential AA, there is no effect on the protein and fat content of the carcass even if the CP is lowered (Si et al., 2004).

Regarding to abdominal fat, our study disagrees with study observed that abdominal fat weight was increased by 104% when the broilers were fed with 17% CP diet when compared to those fed 24% CP diet (Neto et al., 2000). Also, broilers fed with low CP diets retained more body fat than the broilers fed control diet. One major factor responsible for increased abdominal fat with low CP diets is the increased ME: CP (Namroud et al., 2008). This increased energy availability surplus that required for protein deposition resulting in increased body lipogenesis of broilers fed with low CP diets which results in increasing the content abdominal fat.

Regarding liver weight, the obtained results agreed with trial that found no effect of dietary CP levels on liver weights (Sterling et al., 2006). In contrast, our results disagreed with studies reported that increased liver weight as consequence of improved lipogenesis in the liver of birds fed with LCP diets due to increase ME: CP (Rosebrough and Steele, 1985; Swennen et al., 2006).

In this study, no marked differences on weight percentages of liver and abdominal fat relative to live body weight between all experimental treated groups has been detected (P>0.05) due to addition of L-carnitine which could improve energy and fatty acid utilization as well as decrease esterification reactions, and triacylglycerol storage in the adipose tissue, which eventually lead to decrease in body fat storage.

Also, our results revealed that no marked differences in TVC, TC and TR between all experimental treated groups (P>0.05) as shown in Table 5 while there was marked increase in the net profit in group 2 fed with LCP (decrease by 2%)
Table 3: Serum biochemical parameters of broiler chickens fed with low CP diets (LCP) and AAs and L-carnitine supplementation (Means ±SE).

| Item                     | Experimental diets          | Control | LCP, 2% | LCP, 4% | LCP, 6% |
|--------------------------|-----------------------------|---------|---------|---------|---------|
| Glucose (mg/dl)          |                             | 225.40±4.19a | 226.13±5.78a | 168.83±14.10 |
| Total cholesterol (mg/dl)|                             | 160.93±6.63  | 159.20±11.85 | 168.83±14.10 |
| Triglyceride (mg/dl)     |                             | 24.61±1.82bc | 33.84±2.36abc | 38.09±6.71abc |
| HDL (mg/dl)              |                             | 100.88±5.29abc | 105.22±7.75abc | 113.70±3.51abc |
| LDL (mg/dl)              |                             | 35.44±3.08  | 20.14±5.29  | 17.03±4.87  |
| Total protein (g/dl)     |                             | 3.34±0.18   | 3.13±0.25   | 3.09±0.12   | 3.30±0.16   |
| Albumin (g/dl)           |                             | 1.47±0.01   | 1.59±0.03   | 1.71±0.13   | 1.97±0.13   |
| Globulin (g/dl)          |                             | 1.86±0.16   | 1.52±0.17   | 1.61±0.12   | 1.71±0.13   |
| ALT (U/l)                |                             | 8.97±0.89   | 10.80±3.84  | 9.76±3.74   |
| AST (U/l)                |                             | 270.07±26.76| 238.73±23.36| 239.90±18.79|
| Creatinine (mg/dl)       |                             | 0.22±0.03   | 0.46±0.24   | 0.17±0.04   |
| Uric acid (mg/dl)        |                             | 1.62±0.08   | 1.10±0.04   | 1.31±0.12   |
| Urea (mg/dl)             |                             | 8.81±1.54   | 7.50±0.47   | 9.45±1.33   |
| Sodium (mEg/l)           |                             | 122.13±1.91 | 124.93±2.25 | 120.80±1.81 |
| Potassium (mEg/l)        |                             | 8.19±1.11   | 8.55±0.46   | 11.18±1.82  |
| Chloride (mEg/l)         |                             | 90.23±1.17a | 96.00±1.15ab| 95.66±4.37ab|

abc Means within the same row carrying different superscripts are significantly different at (P ≤ 0.05).

Table 4: Carcass traits relative to the live weight of broiler chickens fed with low CP diets (LCP) and AAs and L-carnitine supplementation (Means ±SE).

| Item                     | Experimental diets          | Control | LCP, 2% | LCP, 4% | LCP, 6% |
|--------------------------|-----------------------------|---------|---------|---------|---------|
| Live weight, g           |                             | 2163.30±21.85 | 2205.00±85.44 | 2083.00±45.85 | 2210.00±78.10 |
| Dressing, %              |                             | 76.91±3.34  | 73.50±1.03  | 70.87±0.83  | 72.82±0.44  |
| GIT, %                   |                             | 4.85±0.69   | 3.84±0.14   | 4.08±0.08   | 4.23±0.38   |
| Gizzard, %               |                             | 1.69±0.06   | 1.59±0.15   | 1.68±0.03   | 1.82±0.19   |
| Proventiculus, %         |                             | 0.46±0.00   | 0.53±0.08   | 0.48±0.01   | 0.45±0.01   |
| Liver, %                 |                             | 2.24±0.35   | 2.12±0.13   | 2.00±0.14   | 2.11±0.04   |
| Heart, %                 |                             | 0.54±0.07   | 0.45±0.01   | 0.64±0.07   | 0.68±0.23   |
| Abdominal fat, %         |                             | 2.69±0.48   | 2.85±0.36   | 2.88±0.28   | 2.56±0.08   |
| Spleen, %                |                             | 0.23±0.00   | 0.22±0.01   | 0.24±0.01   | 0.22±0.01   |
| Crop, %                  |                             | 0.23±0.00   | 0.29±0.01   | 0.31±0.86   | 0.30±0.06   |

Table 5: Economic efficiency of broiler chickens fed with low crude protein diets (LCP) and amino acids and L-carnitine supplementation (means ±SE).

| Parameters       | Experimental diets          | Control | LCP, 2% | LCP, 4% | LCP, 6% |
|-----------------|-----------------------------|---------|---------|---------|---------|
| TVC             |                             | 15.35±0.59 | 15.45±0.46 | 15.75±0.22 | 16.27±0.67 |
| TC              |                             | 50.79±0.59 | 50.89±0.46 | 51.19±0.22 | 51.71±0.67 |
| Return          |                             | 61.87±2.85 | 68.07±2.68 | 57.29±1.61 | 59.05±4.93 |
| Net profit      |                             | 11.07±2.80abc | 17.17±2.70abc | 6.10±1.40abc | 7.33±0.90abc |

abc Means within the same row carrying different superscripts are significantly different at (P ≤ 0.05).

CONCLUSION

Broiler chickens of all experimental treated groups did not reveal any significant difference in total final body weight, body weight gain and total feed intake when compared with the control group (P>0.05). In conclusion, group 2 fed with LCP (decrease by 2%) showed a highest return and net profit values when compared with other groups.
values. In this study, the crude protein can be reduced with amino acids fortification up to 6% without any adverse effects on broiler performance. So, in future, when amino acid industry expanded and all (20) amino acids distributed as feed grade for animal use, we can reduce crude protein up to 6% which will be more economic. Also, the addition of L-carnitine with LCP ration leads to improvement in carcass traits by preventing excess abdominal fat.

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CONFLICTS OF INTEREST

The authors declare that there are no conflicts of interest.

AUTHORS CONTRIBUTION

All authors contributed equally in this work.

REFERENCES

• Ahmed IAM (2007). Economic and productive efficiency of poultry farms in relation to veterinary management. M.V.Sc. Thesis, Fac. Vet. Med. Menofia Univ. Egypt.
• AOAC (2002). Official Methods of Analysis. 17th ed. Association Official Analytical Chemists; Gaithersburg, MD, USA.
• Awad EA, Fadlullah M, Zulkifli I, Farjamand AS, Chwen LT (2014). Amino acids fortification of low-protein diet for broilers under tropical climate: ideal essential amino acids profile. Ital. J. Anim. Sci. 13: 3166. https://doi.org/10.4081/ijas.2014.3166
• Burtis CA, Ashwood, ER, Bruns DE (2006). Tietz textbook of clinical chemistry and molecular diagnostics, 4th ed., Philadelphia, Pa: WB Saunders, 549.
• Corzo A, Fritts CA, Kidd MT, Kerr BJ (2005). Response of broiler chicks to essential and non-essential amino acid supplementation of low crude protein diets. Anim. Feed Sci. Tech. 118: 319 - 327. https://doi.org/10.1016/j.anifeedsci.2004.11.007
• Dean DW, Bidner, TD, Southern LL (2006). Glycine supplementation to low protein, amino acid-supplemented diets supports optimal performance of broiler chicks. Poult. Sci. 85: 288 - 296. https://doi.org/10.1093/ps/85.2.288
• Doumas BT, Biggs HG (1972). Determination of serum globulin, standard methods of clinical chemistry Vol.7 Edited by cooper, New York, Academic press. https://doi.org/10.1016/B978-0-12-609107-6.50022-2
• Doumas BT, Pinkas M (1971). Albumin standards and the measurement of serum albumin with bromo cresol green. Clin. Chem.Acta.31: 83 - 87. https://doi.org/10.1016/0009-8981(71)90365-2
• Duncan DB (1995). Multiple range and multiple F-tests. Biometrics. 11: 1-42. https://doi.org/10.2307/3001478
• Fossati P (1980). Colorimetric method for determination of serum uric acid clin. Chem.(26): 227.

2019 | Volume 7 | Special Issue 2 | Page 32

Advances in Animal and Veterinary Sciences

• Grant GH, Silverman LM, Christenson RH (1987). Amino acids and protein, in: Fundamental of Clinical Chemistry 3rd Ed., Philadelphia, WB Saunders Company.
• Hidalgo MA, Dozier WA, Davis AJ, Gordon RW (2004). Live performance and meat yield responses to progressive concentrations of dietary energy maintained at a constant metabolizable energy-to-crude protein ratio. J. Appl. Poult. Res. 13: 319 - 327. https://doi.org/10.1093/japr/13.2.319
• Kerr BJ, Kidd MT (1999a). Amino acid supplementation of low-protein broiler diets: 2. Formulation on an ideal amino acid basis. J. Appl. Poultry Res. 8: 310-320. https://doi.org/10.1093/japr/8.3.310
• Kerr BJ, Kidd MT (1999b). Amino acid supplementation of low-protein broiler diets: 1. Glutamic acid and indispensable amino acid supplementation. J. Appl. Poult. Res. 8: 298 - 309. https://doi.org/10.1093/japr/8.3.298
• Mohammaldighiasr M, Kim I (2018). Addition of a protease to low crude protein density diets of broiler chickens. J. Appl. Anim. Res. 46(1): 1377 - 1381. https://doi.org/10.1080/09712119.2018.1512862
• Mongin P (1981). Recent advances in dietary cation-anion balance: Applications in poultry. Pro. Nutr. Soc. 40: 285 - 294. https://doi.org/10.1079/PNS19810045
• Murray R (1984). Aspartate aminotransferase. Kaplan A. Clin. Chem, The C.V. Mosby. Co. st. Louis. Toronto. Princeton.1112 - 1116.
• Nahum KH (2007). Feed formulations to reduce N excretion and ammonia emission from poultry manure. Biorec. Tech. 98: 2282 – 2300. https://doi.org/10.1016/j.biortech.2006.07.039
• Namroud NF, Shivazad M, Zaghari M (2008). Effects of fortifying low crude protein diet with crystalline amino acids on performance, blood ammonia level, and excreta characteristics of broiler chicks. Poult. Sci. 87: 2250 - 2258 https://doi.org/10.3382/ps.2007-00499.
• Neto MG, Pestl GM, Bakalli RI (2000). Influence of dietary protein level on the broiler chicken’s response to methionine and betaine supplements. Poult. Sci.79: 1478 - 1484. https://doi.org/10.1093/ps/79.10.1478
• Nitschke LP, Tall AR (2005). HDL as a target in the treatment of atherosclerotic cardiovascular disease. Nat. Rev. Drug. Discov. 4(3): 193 - 205. https://doi.org/10.1038/nrd1658
• Pisani T, Geksi CP, Warnick GR, Ollington JF (1995). Accurate direct determination of low-density lipoprotein cholesterol using an immuno separation reagent and enzymatic cholesterol assay. Arch. Pathol. Lab. Med. 119 - 127.
• Rosebrough RW, Steele NC (1985). Energy and protein relationships in the broiler. 1. Effect of protein levels and feeding regimens on growth, body composition, and in vitro lipogenesis of broiler chickens. Poult. Sci. 64: 119 - 126. https://doi.org/10.3382/ps.0640119
• Saleh AA (2016). Effect of low-protein in iso-energetic diets on performance, carcass characteristic, digestibilitis and plasma lipids of broiler chickens. Egypt. Poult. Sci. 36 (I): 251 - 262. https://doi.org/10.21608/epsj.2016.33259
• Sara AA (2007). Effect of some feed additives on economic and productive efficiency in Japanese quails, M.V.Sc. Thesis, Fac. Vet. Med. Alex. Univ. Egypt.
• Si J, Fritts CA, Burnham DJ, Waldroup PW (2004). Extent to which crude protein may be reduced in corn-soybean meal broiler diets through amino acid supplementation.Intl. J. Poultry Sci. 3(1): 46 - 50. https://doi.org/10.3923/ijps.2004.46.50
• Sonntag O, Scholer A (2001). Drug interference in clinical chemistry: recommendations of drugs and their concentrations to be used in drug interference studies. Ann. Clin. Biochem. 38: 376 - 385. https://doi.org/10.1258/0004563011900696

• Stein EA, Myers GL (1995). National cholesterol education program recommendations for triglycerides measurement: Executive summary. Clin. Chem. 41: 1421 - 1426.

• Sterling KG, Pesti GM, Bakalli RI (2006). Performance of different broiler genotypes fed diets with varying levels of dietary crude protein and lysine. Poult. Sci. 85: 1045 - 1054. https://doi.org/10.1093/ps/85.6.1045

• Stummvoll HK, Lehmann, P (1996). Electrolytes: clinical and laboratory aspects. Springer Verlag.

• Swennen Q, Janssens GPJ, Collin A, Bihan–Duval EL, Verbeke K, Decuyper E, Buyse J (2006). Diet-induced thermogenesis and glucose oxidation in broiler chickens: Influence of genotype and diet composition. Poult. Sci. 85: 731 - 742. https://doi.org/10.1093/ps/85.4.731

• Tietz NW (2006). Clinical Guide to Laboratory Tests, 4th ed., Philadelphia. WB Saunders Company: 444 - 451.

• Wu G (2014). Dietary requirements of synthesizable amino acids by animals: a paradigm shift in protein nutrition. J. Anim. Sci. Biotech. 5: 34. https://doi.org/10.1186/2049-1891-5-34

• Young DS (2001). Effects of disease on clinical Lab. Tests. 4th ed AACC Press.