The Effect of Different Sources of Fat on Broiler Performance

Alla Eldeen Ali[1], Osama Elshaikh[2], Omer Masaad[2]

[1]*Master Program of Animal production, Faculty of Animal Production Science &Technology, Sudan University of Science and Technology*

[2,3]*Department of Animal Production, Faculty of Animal Production Science &Technology, Sudan University of Science and Technology*

Abstract: **A completely randomized design was carried out to evaluate the effects of five different fat sources (cattle bone marrow, camel bone marrow, cattle fat, camel fat and fish oil at the rate of 3%) on performance, carcass yield and blood metabolites content in broiler chickens. Two hundred and forty one-day-old of unsexed (Ross 308) were randomly divided into 6 different treatments of 40 birds and each group was divided in to 4 replicates of 10 birds: (T1) basal diet containing no supplemented fat (control group), (T2) basal diet containing 3%beef fat supplementation, (T3) basal diet containing 3% camel fat supplementation, (T4) basal diet containing 3% beef bone marrow supplementation, (T5) basal diet containing 3% camel bone marrow supplementation, and (T6) basal diet containing 3% fish oil supplementation. The treatment diets were applied to the chicken from day 2 till 49 days. The following parameters were measured : live body weight (LBW) ,body weight gain(BWG) ,feed intake(FI) , feed conversion ratio (FCR) , water consumption (WC) ,relative water consumption, (RWC) ,protein efficiency ratio (PER), energy efficiency utilization(EEU) , lysine efficiency ratio(LER) ,production efficiency factor (PEF),and carcass characteristics .Moreover, blood samples were analyzed for cholesterol HDL , LDL , urea , uric acid , total protein , albumin , triglycerides and glucose. Results showed significant difference at ($p<0.01$) in both weeks five and week 6 for FI, BW, WC, and PN. Week five showed significant difference ($p<0.01$) for EER, LER, however PEF didn't show significance difference in week 6. Weight gain and carcass dressing % showed significant difference ($p<0.01$) in week 5 and ($p<0.05$) in week 6. Both week 5 and 6 did not show significant difference ($p<0.05$) for both FCR and RWC. Blood analysis did not show significant difference in all parameters analyses except for urea. These data indicated that fat supplementation could improve production performance of broiler chickens in the finishing period.**

Keywords: **Fat, Broiler, performance**

I. INTRODUCTION

The growing poultry industry in the Sudan is developing on the utilization of local ingredients to minimize feed cost, which limits poultry production in developing countries as financial constraint. In addition the competition between man and animal for protein and energy sources in developing countries made the utilization of non-conventional feed sources to increase the nutrient utilization efficiency of cheap feed ingredients [1].

Feeding poultry with diets that contain fat can counter several economic advantages by providing increased energy levels and fatty acid composition [2]. If the poultry is expected to show high performances, their high energy and protein needs should be provided through their feed. Providing their high energy needs requires the use of different fat sources (Lopez- Ferrer .et al, 2001). When diets with similar energy and protein are compared with chickens fed with rations that contain oil showed better performances than birds fed diets without the inclusion of oil [3].

Fats are frequently included in broiler diets to increase the energy density. Several experiments have shown that an increase in energy concentration produces a decrease in feed intake but does not negatively affect daily gain, resulting in an improvement in feed efficiency [4;5] Dietary fatty acids (FA) are absorbed and deposited in tissues in monogastric animals without significant modification [5;6]. Deaton et al. [7] reported that body fat increases with the amount of dietary tallow (composed essentially of saturated fatty acids). However, some studies have reported opposite results. Zollitsch et al. [8] observed that unsaturated vegetable oils produce lower fecal energy losses and consequently, higher metabolizable energy value (ME) than animals fats. Low fat utilization at 1 wk of age in the young chickens has been attributed to limited bile salt secretion and low lipase activity [9]. Improved bile salt secretion and lipase activity with age in young chickens resulted in increased fat utilization at 3 wk by making their digestive systems fully functional to digest dietary lipids [10].

The objective of this study to compare the effect of different fat sources (cattle fat, camel fat, fish oil, sheep primal, and camel primal) on broiler performance

II. LITERATURE REVIEW

2.1 Poultry nutrition

Poultry nutrition is more than just giving any available feed to your birds. Market poultry – broilers and turkeys - require proper nutrition to grow and finish out. Similarly, poultry require the correct balance of five classes of nutrients (proteins, carbohydrates, fats and oils, vitamins, minerals, and water) for optimum growth, maintenance, finishing, work, reproduction, and production. Poultry diets must supply daily

nutrient requirements from the five classes of nutrients. National Research Council (NRC) nutrient requirements for poultry assume an average of approximately 85% ingredient bioavailability [11].

2.1.1 Carbohydrates

Carbohydrates are organic compounds that include sugars, starches, celluloses, and gums. Carbohydrates are produced by photosynthetic plants and contain only carbon, hydrogen, and oxygen, usually in the ratio 1:2:1. Sugars and starches are highly digestible and make up almost 75% of an animal's diet. Starch and sugar carbohydrates contain 4 kilocalories per gram. Excess carbohydrates are deposited as the fat in the animal body [11].

2.1.2 Fats and Oils

In terms of providing energy, fats and oils serve the same function as digestible carbohydrates. Fats and oils are the densest forms of energy and derived from plants and animals. At room temperature, fats are solid and oils are liquid. They both provide 2.25 times more energy than do carbohydrates (9 kilocalories per gram versus 4 kilocalories per gram for digestible carbohydrates and protein). Poultry require only small amounts of fats and oils [11].

2.1.3 Minerals

Minerals are naturally occurring as inorganic solids, with a definite chemical composition, and an ordered atomic arrangement which are important for life and good health. Many are essential components of body substances, such as the calcium and phosphorus in bones and the iron in hemoglobin. Calcium to phosphorus ratio is very important in poultry diets; 2 to 1 with respect of dietary calcium to available phosphorus. Animals need very small amounts of trace minerals, usually ranging from 0.05% to 0.25%. However, this small percentage is critical for performing essential body functions associated with life [11].

2.2 Fat and Oil in broiler nutrition

The term fat (animal or vegetal) is used as a synonym for lipid in the human food as well as in the ingredients for animal nutrition. The addition of fat to diets, besides supplying energy, improves the absorption of fat-soluble vitamins, diminishes the pulverulence, increases the palatability of the rations, and increases the efficiency of the consumed energy (lower caloric increment). Furthermore, it reduces the passage rate of the digesta in the gastrointestinal tract, which allows a better absorption of all nutrients present in the diet.

The terms fat and oil refer to triglycerides of several profiles of fatty acids. The fats and oils are esters of glycerol; the former are solid, whereas the latter are liquid at room temperature. Lipids constitute the main energy reserve of animals and it has the highest caloric value among all nutrients. The carbon atoms of the fatty acids are chemically more reduced than carbon atoms found in sugar; therefore, the oxidation of triglycerides releases more than twice as much energy as carbohydrates. The deposition of 1 g of energy from carbohydrates or protein by an animal requires higher quantities of these nutrients in comparison to the deposition of 1 g of energy from fat. Moreover, carbohydrate and protein reserves would be larger in function of the polar characteristic of these substances, which would include water in these deposits [12]. Considering diets with similar nutritive value, chickens fed rations containing oil showed better performance than birds fed diets without oil inclusion [13]. Deaton et al. [7] (1981) used diets with similar nutritive values added with 4, 7 and 10% of animal fat, and observed that the increasing fat level of the diet increased the quantity of abdominal fat, corroborating results reported by [14].

III. RESEARCH METHODS

The present study was carried out at faculty of Animal production Science and Technology farm, Sudan University of Science & Technology, Khartoum, Sudan from age 28-43 days.

3.1 Experimental birds

A total of two hundred, one day old, unsexed broiler chicks (ROSS 308) from Enema Poultry Production Company was provided. The rearing period extended for 28 day and the experimental treatment was started from finishing period (28 days till 49 day- old).

3.2 Experimental Houses

The experiment was conducted in an open side deep litter house 8×5m dimensions 4 m central height and 2.5m side height. The roof was constructed from corrugated iron sheets. The sides were made from wire netting sheets supported by 50cm cement wall at the sides and concrete floor. The long axis of the house extended east-west facing the wind direction for efficient ventilation.

The house was divided into four experimental sections (replicates) of equal area $(1.5m)^2$ each walls height was 75 cm which separates the experimental sections. The experimental house and equipments were cleaned, and disinfected. Then fresh wood shaving litter were spread on the floor at depth of 5cm, moreover, each section was provided with one circular metal feeder and circular plastic drinker, 8 lamps at 1m high from ground were provided for all the house.

3.3 Experimental design

The experiment consisted of sex treatment groups designated as group T1 fed basal diet without supplementation (control), group T2 fed (3%) fish oil, group T3 fed (3%) camel bone marrow, group T4 fed (3%) cattle bone marrow, group T5 fed (3%) camel fat, group T6 fed (3%) beef fat.

The birds were divided into six groups, each group consisted of 40 birds and each group contained four replicates of ten birds each replicate.

3.4 Experimental Diets

All birds were fed on pre starter ration for the 1st week, then starter diet (day 7-28) of age then fed on the experimental diets (from day 28 to 49 day). Experimental diets were composed of one type of diet, and then the bird were allocated in % experiment finisher diet. All rations were formulated to be approximately iso -caloric and iso -nitrogenous to meet the nutrient requirements for broiler chicks as outlined by [15]. Feed and water were supplied adlibitum during the experimental period.

3.5 Health program

1. Water was supplemented with multi – vitamin from day 28 to 31. (Doxycycline HCL- Colistin sulphate / AVICO. CO - Made in Jordan)) as aprevention dosage from 35-40 day.
2. Feeding system added.
3. Experiment design.

3.6 Analysis of the experimental ratio

Table 1 composition % and calculated analysis of experimental finisher diets

Treatment / Ingredients	Control (%) (T1)	Fish oil (3%) (T2)	Camel bon (3%) (T3)	Cattle (3%) bon (T4)	Camel fat (3%) (T5)	Beef fat(3%) (T6)
Sorghum grains	74.6	60.8	51.5	51.4	51.4	51.4
Wheat bran	0.1	10.9	3.25	3.25	3.25	3.25
Ground Nut Cake	18.85	18.88	35	35	35	35
Lime stone	.83	0.85	.4	.4	.4	.4
D.C.P	0.01	0.01	1	1	1	1
L-Lysine	0.5	0.48	0.05	.05	.05	.05
Dl-Methionine	0.06	0.06	0.05	.05	.05	.05
Cemmon Salt	0.04	.01	0.3	.3	0.3	0.3
Super Concentrate*	5	5	5	5	5	5
Fish oil	0	3	3	3	3	3
Premix	0.01	0.01	.1	0	.1	1
Total	100	100	100	100	100	100
Calculated analysis						
ME(Mj /Kg)	13.397	13.398	13.389	13.389	13.389	13.389
CP (%)	19.85	19.86	19.92	19.92	19.92	19.92
CF (%)	4	4.8	3.7	3.72	3.7	3.7
Ca (%)	1	1	1	1	1	1
Av. p (%)	45 .	45 .	45 .	45 .	45 .	45 .
Lysine (%)	1.01	1	1.1	1.2	1.2	1.2
Methionine (%)	0.50	0.50	.54	.54	.54	.54

3.7 Growth performance parameters

3.7.1 Weight gain (g/ bird/day^{-1})

Weight gain was recorded weekly basis for each replicate by subtracting the initial body weight from the final body weight every day.

3.7.2 Feed intake (g/bird / day-1):

Feed consumption the day was calculated by subtracting the amount of feed remained from the amount of feed given.

3.7.3 Feed conversion ratio (FCR) (g feed /g /gain)

Feed conversion ratio was calculated by dividing the amount of feed consumed by body weight gain (g feed intake / g body weight gain).

3.7.4 Live Body weight (LBWT) (g /bird / day):-

Body weight (BWT) was determined daily using sensitive balance.

3.7.5 Mortality:

The rate of mortality is the ratio between the number of dead birds and the initial total number of birds multiplied by 100.

$$\text{Mortality \%} = \frac{\text{Number of dead birds}}{\text{Total number of birds}} \times 100$$

3.7.6 Protein efficiency ratio (PER)

$$\text{PER} = \frac{\text{Weight gain (g)}}{\text{Protein IIntake (g)}}$$

3.7.7 Lysine efficiency= $\frac{\text{Lysine intake}}{\text{Weight gaing (g)}}$

3.8 Blood sampling

Two birds were randomly selected from each replicate (12 bird treatment) for blood sampling.

Blood samples (volume) were collected from the jugular vein and received in two labeled test tubes; one with anti-coagulant (EDTA), the other without which were placed horizontally on racks at room temperature. Blood serum was separated by centrifugation.

3.9 Statistical Analysis

The data were subjected to (Anova) using the Statistical Package of social science (SPSS) version 16.0. A probability of ($p \leq 0.05$) was used for statements of significance.

Table 2 Chemical composition of concentrate

Item Ingredients	ME Mj/kg	CP %	Ca %	Lysine %	Methionine %	CF %
Concentrate	10.02	35	10.6	1.1	4.3	1.5

IV. RESULTS AND DISCUSSION

Table 3 The overall broiler performance birds fed different fat sources and rations cost

Item / Treatment	LBW g/bird/day	WG g/bird/day	FC g/bird/day	Feed Conversion Ratio g/bird/day	WC g/bird/day	Dressed carcass %	Production cost 1/kg feed (SDG)
Control	1253.2±13 3.2 [b]	50.27 ± 12.3 [b]	88.81±16.1	2.1 ± 0.2 [a]	455.2±58.8[b]	62.20 ± 1.5 [b]	12
Beef fat	1621.5±143.9 [a]	60.31 ± 11.9 [a]	102.9±10.9	1.7 ± 0.8[b]	481.64±25.8[a]	66.30 ± 1.7 [a]	10
Camel fat	1630.3±129.72[a]	57.53 ± 10.9[a]	101.5±8.6	1.8 ± 0.09[b]	490.9±18.69[a]	62.5 ± 1.3 [ab]	10
Beef bone marrow	1657.7±151.3[a]	59.41 ± 11.5[a]	108.6±11.2	1.99 ± 0.9[b]	487.6±28.7[a]	63.2 ± 1.8 [a]	11
Camel bone marrow	1667.6±119.7[a]	58.8 ± 11.4[a]	104.5±9.6	1.8 ± 0.1[b]	482.5±38.6[a]	64.5 ± 1.5 [a]	11
Fish oil	1649.5±99.2[a]	56.7 ± 11.1[a]	105.6±11.1	1.89 ± 0.08 [b]	491.6±39.7[a]	65.2 ±1.6 [a]	11.5
Significant	**	**	NS	**	**	*	

± + MeanStandard deviation
Means within the same column followed by different superscript are at (a, b) significantly (P<0.05) different
* Significance different at (>.p 0.01)
**: Highly significance different)at < .p 0.01)
NS: No significant different

Table 4 blood analysis of broiler chicks.

Item / Treatment	Glucose Mg/dl	Cholesterol Mg/dl	LDL Mg/dl	HDL Mg/dl	Trigliceridos Mg/dl	Uricacid Mg/dl	Urea Mg/dl	Total protein Mg/dl
Control	1.38 ± .342	3.2 ±.375	8.25 ± .88	5.1 ± 1.32	23.2 ± 2.5	1.77 ± 1.6	91 ± 30 [a]	1.2 ± 19.7
Ration added beef fat	.99 ± .304	2.69 ± .473	8.84 ± 1.58	4.3 ± .62	23.2 ± 2.5	9.2 ± 1.9	71 ± 15 [b]	90 ± 20
Ration added camel fat	1.1 ± .175	2.3 ± .80	8.72 ± 1.72	4.2 ± 1.4	23.2 ± 2.5	8.7 ± 1.9	73 ± 19 [b]	89 ± 15
Ration added beef bone marrow	1.22 ± .360	2.69 ±.375	9.05 ± 1.60	4.7 ± 1.5	27.5 ± 6.3	7.4 ± 1.2	83 ± 15 [b]	1 ± 17
Ration added camel bone marrow	1.14 ± .286	2.94 ±.375	10.12 ± 2.25	5 ± 1.6	24.5 ± 7.2	7.6 ± 3.9	72 ± 13 [b]	1.3 ± 24
Ration added fish oil	1.12 ± .225	2.75 ± .456	10.7 ± .812	4.4 ± .75	26 ± 10.4	5.7 ± 1.6	82 ± 41 [b]	1 ± 18.6
Significant	NS	NS	NS	NS	NS	NS	*	NS

± Mean + Standard deviation
means within the same column followed by different superscript are at [a] [b] significantly (P<0.05) different
* significance different at (p.> 0.01)
** : Highly significance different at (p< 0.01)
NS : No significant different

The overall result showed that no significant difference were found in feed consumption, efficiency of energy utilization and protein efficiency ratio. Highly significant difference (p<0.01) were found for live body weight, body weight gain, carcass weight، Water consumption ، feed conversion ratio ،lysine efficiency ratio and production efficiency factor and significant different (p<0.05) were found in Dressing% which improved by entered beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil while significant difference were found in blood cholesterol (p<0.05) which control was better than other groups. Growth performance of broilers fed beef fat, camel fat ,camel bone marrow , beef bone marrow and fish oil has improved performance due to the addition, Dietary fat reduces passage rate of the digest through the gastrointestinal trait, allowing for better nutrient absorption and utilization [16;17;]. This might be due to that dietary fat composition increase diet digestibility and to stimulate growth and feed efficiency. Result from the higher percentage of long chain fatty acids and higher contents of triglycerides، results are in agreement with those reported by[18;19]. The result of water consumption showed high significant difference (p<0.01). Birds fed with 3% beef fat recorded the highest consumption of water, which might be due to the dietary energy content these results are in agreement with those reported by [20]. The result of Feed consumption showed t no significant difference among different experimental groups but high significant difference (p<0.01) in feed conversion ratio during the experimental period this is because of the dietary fat composition that affects feed intake and decrease it feed efficiency was improved as reported by [21].The result showed that supplementation by 3% of beef fat, camel fat ,camel bone marrow , beef bone marrow and

fish oil to broiler chicks showed high significant ($p<0.01$) live body weight، ،body weight gain ، studied by [22], reported that high dietary energy level significantly increased (LBWG) during the finishing period, increasing energy level significantly increased LBW and LBWG [23;24]. In contrast, [25] concluded that LBW and LBWG were not significantly affected by dietary energy levels. The results showed no significance ($p<0.05$) in blood analysis level (mg/dl) increased by adding beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil. Also the present study results are agreement with those reported by (Wardlaw and Snook, 1990) tallow produced a significant rise in blood analysis. These results may be explained on basis that the high SFAs and low PUFAs contents in beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil, which are important contributing factors to raising sigma blood components analysis level. Elmansy [23] reported that the higher level of energy (3200Kcal ME/kg diet) induced higher level of triglyceride and cholesterol. The results showed that supplementation by 3% of beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil to broiler chicks highly significant at ($p<0.01$) for carcass weight compared to control diet. Also the present study results are in agreement with those (reported by [26] who found that carcass weight was significantly improved by increasing dietary energy levels. The dietary treatments had no effect on mortality percentage. Currently beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil not have high economic value, but the value increase in case of increase of sorghum price or plant oils price (energy source). Also beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil can be substitution energy source as alternative for local feedstuffs to decrease competition between human and animals.

Finally addition of beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil improved the weekly performance of broiler chicks, while the overall had significant different except the feed consumption, efficiency of energy utilization and protein efficiency ratio.

V. CLOSING

A. Conclusion

The results showed that use of beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil as poultry feed at 3% had improved some broiler performance parameters as feed conversion ratio, live body weight،water consumption ،body weight gain، Production Efficiency Factor (PEF)، lysine Efficiency Ratio (LER), dressing% and carcass weight, when compared with the control diet. This indicates that beef fat, camel fat, camel bone marrow, beef bone marrow and fish oil could be used as broiler feed to reduce the production cost. As a cheap feed supplement.

REFERENCES

[1] Kinsella, J.E., Lokesh, B. & Stone, R., 1990. Dietary n-3 polyunsaturated fatty acids and amelioration of cardiovascular disease. Am. J. Clin. Nutr. 52, 1-28.

[2] Newman RE, Bryden WL, Fleck E, Ashes JR, Buttemer WA, Storlien LH, Downing JA. Dietary n-3 and n-6 fatty acids alter avian metabolism: molecular-species composition of breast-muscle phospholipids. Br J Nutr. 2002; 88:19–28.

[3] Moura, B. H. S. Desempenho e composicao da carcaca de frangos de cortealimentados com differentesniveisenergeticos com e semoleo [dissertacao]. Belo Horizonte: Escola deVeterinaria, UFMG. Brazilian. J. Poultry Sci. 2005, 7: 129-141.

[4] Pinchasov, Y., Nir, I.: Effect of dietary polyunsaturated fatty acid concentration on performance, fat deposition and carcass fatty acid composition in broiler chickens. Poult. Sci., 1992; 71: 1504- 1512.

[5] Scaife, J.R., Moyo, J., Galbraith, H., Michie, W., Campbell, V.: Effect of different dietary supplemental fats and oils on the tissue fatty acid composition and growth of female broilers. Br. Poult. Sci., 1994; 35: 107-118.

[6] Crespo, N., Esteve-Garcia, E.: Dietary fatty acid profile modifies abdominal fat deposition in broiler chickens. Poult. Sci., 2001; 80: 71-78.

[7] Deaton, J.W., Mcnaughton, J.L., Reece, F.N., Lott, B.D.: Abdominal fat of broilers as influenced by dietary level of animal fat. Poult. Sci., 1981; 60: 1250-1253.

[8] Zollitsch, W., Knaus, W., Aichinger, F., Lettner, F.: Effects of different dietary fat sources on performance and carcass characteristics of broiler. Anim. Feed Sci. Tech., 1996; 66: 63- 73.

[9] Mossab, A., Hallouis, J.M., Lessire, M.: Utilization of soybean oil and tallow in young turkeys compared with young chickens. Poult. Sci., 2000; 79: 1326-1331.

[10] Crew, L.B., Machemer, R.H., Sharp, R.W., Foss D.C.: Fat absorption by very young chick. Poult. Sci., 1972; 51: 738-742.

[11] Baker, J. K. et al. (2000) Animal Health. Danville, IL: Interstate Printers & Publishers, Inc.

[12] Linscheer WG, Vergroesen AJ. Lipids. In: Modern Nutrition in Health and Disease. Shils ME, Olson JA, Shike M, eds. Lea and Febiger, Philadelphia, 1994.

[13] Moura BHS. Desempenho e composição da carcaça de frangos de corte alimentados com diferentes níveis energéticos com e sem óleo [dissertação]. Belo Horizonte: Escola de Veterinária, UFMG; 2003.

[14] Yalçin S, Ozkan S, Açikgoz Z. Influence of dietary energy on bird performance, cacass parts yield and nutrient composition of breast meat of heterozygous naked neck broilers reared at natural optimum and summer temperatures. British Poultry Science 1998; 39(5):633-640.

[15] National Research Council. (1994) Nutrient Requirements of Poultry. 9 revised edition. National Academy Press. Washington, DC, USA.

[16] Baião, N.C. and Lara, L.J.C., 2005. Oil and fat in broiler nutrition. Braz. J. Poult. Sci. 7, 129-141.

[17] Latshaw JD. Daily energy intake of broiler chickens is altered by proximate nutrient content and form of the diet. Poult Sci. 2008; 87:89–95.

[18] Thacker PA, Campbell GL, XUY. Composition and nutritive value of acidulated fatty acids, degummed canola oil and tallow as energy sources for starting broiler chicks. Animal Feed and Technology 1994; 46:251-260.

[19] Celebi S, Utlu N. Laying performance, serum lipoproteins, cholesterol and triglyceride of hens as influenced by dietary fat sources. J Appl Anim Res. 2004; 25:121–124.

[20] Marks, H.L. and Pesti, G.M. (1984). The roles of protein level and diet form in water consumption and abdominal fat pad deposition of broilers. Poultry Sci. 63:1617-1625.

[21] Jeffri D, Firman H, Kamyab A. (2010) Comparison of soybean oil with an animal/vegetable blend at four energy levels in broiler rations from hatch to market. Int Poult Sci. 2010; 9: 1027–1030.

[22] Hussein, A. S.; Cantor, A. H.; Pescatore, A. J. and Johnson, T. H. (1996). Effect of dietary protein and energy levels on pullet development. Poult. Sci., 75:973-978.

[23] Elmansy, M. M. (2006). Assessment of the effect of L-carnitine supplementation to the diet with different dietary energy levels on broiler performance. M. Sc. Thesis, Fac. Agric., Tanta Univ., Tanta, Egypt.

[24] Greenwood, M.W; Cramer, K. R.; Clark, P.M.; Behnke, K.C. and Beyer, R.S. (2004). Influence of feed on dietary lysine and energy intake and utilization of broiler from 14 to 30 days of age. Inter. J. of Poult. Sci., 3: 189-194.

[25] Saxena, V. P. and Thakur, R.S. (1985). Performance of starting commercial pullets on different protein and energy levels in Haryana. Haryana Agric. Univ. J. of Res. 15: 1-6.

[26] Nahashon, S. N.; Adefope, N.; Amenyenu, A. and Wright, D. (2005). Effects of dietary metabolizable energy and crude protein concentrations on growth performance and carcass characteristics of French guinea broilers. Poult. Sci., 84: 337-344.