
# Effect of the Variation of Diet Energy Content with Palm Oil Residue on Growth Performance of Broiler Chickens

[1]Tadondjou Tchingo Cyrille D'Alex, [1]Nguianaing Noubi Patrick, [2]Houlibele Dour-Yang and [1] Ponka Roger
[1]*Department of Agriculture, Livestock and Derived Product, National Advanced School of Engineering, University of Maroua, Maroua, Cameroon*
[2]*Ministry of Livestock, Fisheries and Animal Industries, Cameroon*

**Key words:** Palm oil residue, diet energy, broiler chicken, growth performance, profitability

**Corresponding Author:**
Tadondjou Tchingo Cyrille D'Alex
*Department of Agriculture, Livestock and Derived Product, National Advanced School of Engineering, University of Maroua, Maroua, Cameroon*

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**Abstract:** The present study was designed to evaluate the effect of the variation of dietary energy density with palm oil residue on growth performance of broiler chickens.For this purpose, 162(81 male and 81 female) Cobb 500 broiler of 21 days old (641g) were used. They were reared from 22-49 days of age. They were randomly assigned to three treatments groups on the basis of diet energy content: A0 (2900 kcal $kg^{-1}$ of Body weight), A4 (3100 kcal $kg^{-1}$ of BW) and A8 (3200 kcal $kg^{-1}$ of BW). Throughout experiment, feed intake, live weight and body weight gain were recorded at weekly intervals and the Feed Conversion Ratio (FCR) determined. At the end of the 49th day, assessment of carcass characteristic was performed. The cost of feed consumed and the cost of feed per kg of weight gain were also determined. During the first week, feed intake (700±4.58 g), live weight (933.66±8.7 g) and daily body weight gain (41.9±1.46 g)of broiler fed on diet containing 2900 kcal $kg^{-1}$ were significantly higher ($p<0.05$) than those obtained with 3200 kcal $kg^{-1}$ or 3100 kcal $kg^{-1}$. At weeks 2 and 3, daily body weight gain (83.61±5.44 and 74.09±15.63 g, respectively) and FCR (1.28±0.07 and 1.95±0.15 g respectively) of chicken fed on diet energy density of 3200 kcal $kg^{-1}$ were significantly higher ($p<0.05$). The carcass weight (1841±17.31 g), yield (80±17.75%) and abdominal fat of broiler chicken fed on diet energy density of 3200 kcal $kg^{-1}$ were significantly higher ($p<0.05$). The cost of feed consumed, the cost of feed/kg weight gain and cost of feed/kg carcass decreased as the diet energy content increased. It can be concluded that the increase of diet energy to 3200 kcal $kg^{-1}$ with palm oil residue during finisher phase improved growth performance, carcass characteristic and profitability.

## INTRODUCTION

In poultry industry one of the most important aspects of production is feeding. In fact, feed cost alone accounts for 65-75% of the total cost of egg and meat production[1, 2]. High productivity and efficiency depend on feeding nutritionally balanced feeds that are formulated to meet the bird's nutritional requirements[2]. This type of ration must be formulated with high level of energy and protein[2, 3].

Dietary energy-contributing ingredients are a major cost to broiler diets. Energy plays a pivotal role in feed consumption and nutrient utilization by poultry. In fact, birds eat primary to satisfy their energy needs. When the energy provided by the diet changes, the feed intake will change and the specifications for other nutrients (protein, minerals, vitamin) must be modified to maintain the required intake[2]. Control over energy intake is therefore important because it affects growth rate and carcass characteristics[4]. Dietary energy for broilers are provided mostly by grains such as maize, sorghun and soybean. Because of the high cost of these energy-rich feedstuffs, lipids have been used as alternative sources of energy in poultry.

Lipids (fats and oil) are used in poultry diets to increase the energy density as they yield 2.25 times more calories than carbohydrates and protein[5]. The addition of lipids to diet supply energy, improves the absorption of fat-soluble vitamins, diminishes the pulverulence, increases the palatability of the feed and increases the efficiency of the consumed energy. Furthermore, lipids reduces the passage rate of the digesta in the gastrointestinal tract which allows a better absorption of all nutrients present in the diet[6]. Several studies showed that addition of oil in broiler diet decreases feed intake and increases growth rate and feed efficiency which leads to decrease age at market[1, 7]. The inclusion of 4% palm oil in broiler diets resulted in better growth performance, feed consumption and feed conversion ratio[1, 3]. Moreover, palm oil may have a positive effect on firmness of meat quality[8]. If the effect of palm oil on broiler production are documented, very little information are available on the use of palm oil residue as alternative source of energy in poultry.

Palm oil residue is rich in energy (6681 kcal kg$^{-1}$ of dry matter of metabolizable energy) and fat (70.7% of dry matter)[9, 10]. It has a fairly close lipid content to that of palm oil. As compared to maize, palm oil residue has a higher lipid and cellulose content but its dry matter content is very low[10]. Based on the chemical composition of palm oil residue, the present study was designed to evaluate the effect of the variation of dietary energy density with palm oil residue on growth performance of broiler chickens.

Table 1: Ingredients and nutrient composition of experimental finisher diets

| Ingredients | A0 (2900 kcal kg$^{-1}$) | A1 (3100 kcal kg$^{-1}$) | A2 (3200 kcal kg$^{-1}$) |
|---|---|---|---|
| Palm oil residue | 0 | 4 | 8 |
| Maize | 61 | 56,5 | 54 |
| Premix* | 10 | 10 | 10 |
| Groundnut cake | 5 | 5,5 | 4 |
| Soyabean meal | 18,8 | 18,5 | 18,5 |
| Fish meal | 3 | 3,5 | 3,5 |
| Methionine | 0,1 | 0 | 0 |
| Lysine | 0,1 | 0 | 0 |
| Bone meal | 1 | 1 | 1 |
| Oyster shell | 1 | 1 | 1 |
| Total | 100 | 100 | 100 |
| ME (kcal kg$^{-1}$) | 2971 | 3100,69 | 3265,4 |
| CP (%) | 21 | 22 | 21,7 |
| Energy/Protein | 1414, 47 | 140,94 | 150,47 |
| DM (%) | 86 | 84 | 81 |
| Lysine (%) | 1,35 | 1,26 | 1,19 |
| Methionine (%) | 0,65 | 0,54 | 0,28 |
| Calcium (%) | 1,25 | 1,23 | 1,33 |
| Phosphorous (%) | 1 | 1 | 1 |

ME: Metabolizable Energy ; CP: Crude protein; DM; Dry Matter; *Premix : crude protein = 40%; Metabolizable energy = 2078 kcal kg$^{-1}$; Calcium = 8%; Phosphorous = 2.05%; Lysine = 3.30%; Met (Methionine) = 2.40%

## MATERIALS AND METHODS

**Study area:** The study was carried out at the poultry farm of GIC AgriMax, Koume-Bonis, Bertoua, Cameroon (4°11'-5°97'N and 12°80'-14°63'E).

**Extraction of palm oil residue:** Palm oil residue was produced by the oil mill of the GIC AgriMax, throughout a long process. After harvesting, the palm nuts were boiled in barrels and then introduced into the manual press machine. During pressing, it comes out the palm oil and palm nut juice made partly of oil on the surface. The oil present on surface was collected and the remaining pellet heated again to extract the remaining oil. The oil-free pellet remaining is called palm oil residue.

**Diets and experimental design:** A total of 162 (81 male and 81 female) Cobb 500 broiler of 21 days old (average live weight of 641 g) were used. They were reared from 22-49 days of age. They were randomly assigned to three treatments groups on the basis of diet energy content. Each group consisted of three replicates and each replicate was made up of 18 chickens. Three isonitrogenous finisher diets were formulated: A0 (2900 kcal kg$^{-1}$ of Body weight), A4 (3100 kcal kg$^{-1}$ of body weight) and A8 (3200 kcal kg$^{-1}$ of body weight). The gross and proximate composition of the experimental finisher diets are shown in Table 1. During experimental period, food and water were given ad libitum.

**Data collection:** Throughout experiment, feed intake, live weight and body weight gain were recorded at weekly intervals. At the end of the 49th day, 4 chickens per replicate (2 males and 2 females) were randomly selected for assessment of carcass characteristic. The cost of feed consumed and the cost of feed per kg of weight gain were also determined[9].

**Statistical analysis:** Data collected were expressed as Mean±Standard Deviation. They were analysed using the one-way ANOVA procedure of SPSS 20.0. When dietary treatment was significant (p = 0.05), means were compared using Duncan multiple comparison test.

## RESULTS AND DISCUSSION

**Effect of dietary energy content on feed intake:** The effect of diet energy content on individual feed intake of Cobb broiler chicken are presented in Fig. 1. During the first week, feed intake of diet containing 2900 kcal $kg^{-1}$ (700±4.58 g) was significantly higher (p<0.05) than those obtained with 3200 kcal $kg^{-1}$ (622±4.35 g) or 3100 kcal $kg^{-1}$ (666±5.01 g). At weeks 2, 3 and 4, there were no significant difference of feed intake between treatments.

**Effect of dietary energy content on live weight:** As shown in Fig. 2, dietary energy content affected weekly evolution of live weight. At the end of the first week, live weight of broiler fed on diet containing 2900 kcal $kg^{-1}$ BW (933.66±8.7 g) was significantly higher (p = 0.05) as compared to other treatments (880.66±17.8 g with 3100 kcal $kg^{-1}$ and 866.33±31.2 g with 3200 kcal $kg^{-1}$). From week 2-4, live weight of chickens fed on diet energy of 3200 kcal $kg^{-1}$ (1453±29.7, 1972.33±48.1 g and 2317.66±17.2 g, respectively for week 2, 3 and 4) were significantly higher (p = 0.05) when compared to values obtained with 2900 kcal $kg^{-1}$ or 3100 kcal $kg^{-1}$.

**Effect of dietary energy content on body weight gain:** The effect of diet energy density on the weekly evolution of daily body weight gain are presented in Fig. 3. During the first week, daily body weight gain (41.9±1.46 g) of broiler fed on diet containing 2900 kcal $kg^{-1}$ increased significantly (p<0.05) than with other diet energy (34.14±4.2 g with 3100 kcal $kg^{-1}$ and 32.18±4.5g with 3200 kcal $kg^{-1}$). At weeks 2 and 3, daily body weight gain of chicken fed on diet energy density of 3200 kcal $kg^{-1}$ (83.61±5.44 and 74.09±15.63 g, respectively) were significantly higher (p<0.05) as compared to values of the same parameter obtained with 2900 kcal $kg^{-1}$ (60.18±5.05 g and 40.52±10.10 g) or 3100 kcal $kg^{-1}$ (70.9±7.54 and 42.37±4.5 g). During the last week (week 4) of experiment, there were no significant difference between treatments.

**Effect of dietary energy content on Feed Conversion Ratio (FCR):** The weekly evolution of feed conversion ratio with different treatment are presented in Fig. 4. At weeks 1 and 4, FCR were statistically comparable between treatments. At weeks 2 and 3, FCR of chickens fed on diet energy content of 3200 kcal $kg^{-1}$ (1.28±0.07 and 1.95±0.15, respectively) were significantly lower (p<0.05) as compared to values obtained with diet energy 2900 kcal $kg^{-1}$ (1.80±0.11 and 2.71±0.18) and 3100 kcal $kg^{-1}$ (1.54±0.08 and 2.74±0.41).

**Effect of dietary energy content on carcass characteristics:** Results of some carcass characteristics at the end of experiment are presented in Table 2. The carcass weight (1841±17.31 g) and yield (80±17.75%) of broiler chicken fed on diet energy density of 3200 kcal

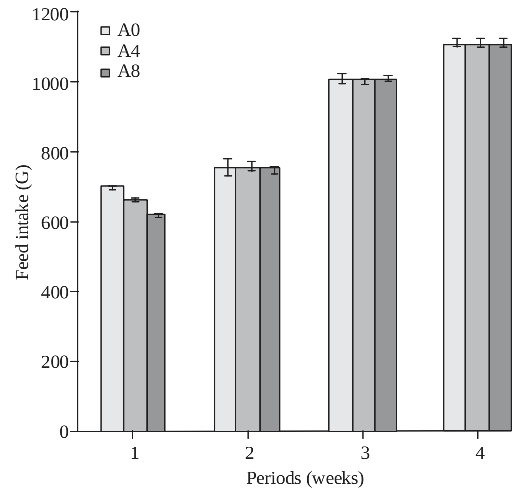


Fig. 1: Weekly evolution of individual feed intake of broiler chicken fed on diets of different energy content

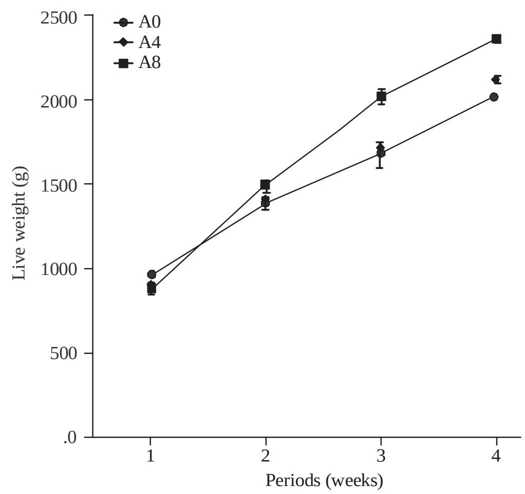


Fig. 2: Weekly evolution of live weight of broiler chicken fed on diets of different energy content

Table 2: Carcass characteristics and relative organ weight of broiler chicken fed on diets of varying energy content

| Factors | A0 | A4 | A8 |
|---|---|---|---|
| Carcass weight (g) | 1514±7.51[a] | 1585±22.03[a] | 1841±17.31[b] |
| Carcass yield (%) | 76±1.14[a] | 76±1.02[a] | 80±0.75[b] |
| Head (%) | 4.02±0.12 | 3.78±0.15 | 3.74±0.09 |
| Legs (%) | 4.16±0.24 | 4.10±0.19 | 4.50±0.22 |
| Gizzard (%) | 2.11±0.36[a] | 2.39±0.15a | 3.09±0.17[b] |
| Liver (%) | 2.37±0.16[a] | 2.27±0.09[a] | 3.14±0.06[b] |
| Abdominal fat (%) | 2.09±1.12[a] | 2.76±0.43[b] | 4.38±0.87[c] |
| Heart (%) | 0.33±0.01 | 0.31±0.03 | 0.32±0.03 |

Mean values with different superscript in a row differ significantly (p<0.05)

Table 3: Cost and return of different dietary energy content of broiler chicken

| Factors | A0 | A4 | A8 |
|---|---|---|---|
| Cost of feed consumed (CFA F) | 310.80 | 285.15 | 275.40 |
| Cost of feed/kg weight gain (CFA F) | 564.77 | 503.54 | 415.73 |
| Cost of feed/kg carcass (CFA F) | 735.87 | 660.8 | 523.37 |

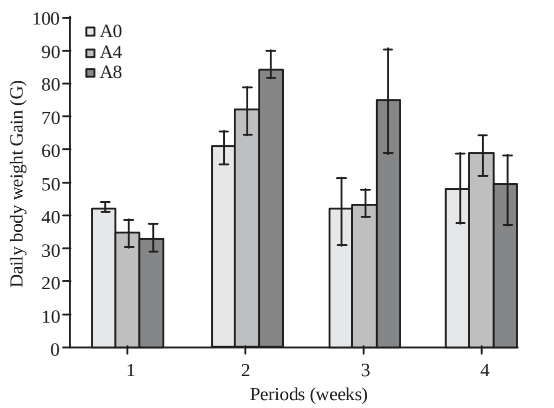


Fig. 3: Weekly evolution of daily body weight gain (g day$^{-1}$) of broiler chicken fed on diets of different energy content

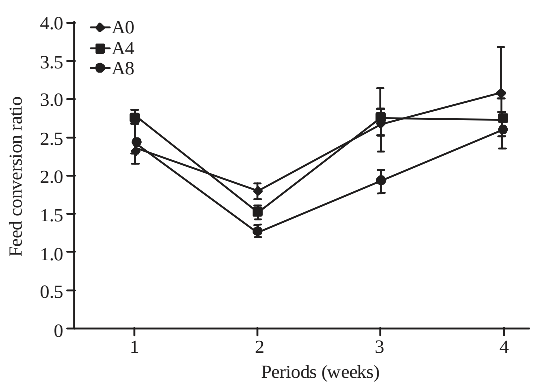


Fig. 4: Weekly evolution of feed conversion ratio of broiler chicken fed on diets of different energy content

kg$^{-1}$ were significantly higher (p<0.05). Relative weight of organ revealed that gizzard, liver and abdominal fat of chicken fed on diet energy of 3200 kcal kg$^{-1}$ were significantly increased (p<0.05) as compared to other diet energy. However, abdominal fat obtained with diet energy 3100 kcal kg$^{-1}$ was statistically higher (p<0.05) than that recorded in broiler fed on diet energy of 2900 kcal kg$^{-1}$.

**Effect of dietary energy content on production cost:** The cost of production and return of the different treatment used are summarized in Table 3. The cost of feed consumed, the cost of feed/kg weight gain and cost of feed/kg carcass decreased as the diet energy content increased. To produce one kg carcass, diet containing 2900 kcal kg$^{-1}$ (735.87 CFAF) cost two hundred more than that containing 3200 kcal kg$^{-1}$ (523.37 CFAF).

In poultry industry, it has always been a challenge to maintain a high rate of growth to achieve market weight at an early age and at low production cost. In this study, we evaluated the effect of the variation of diet energy density by palm oil residue on growth performance of broiler chicken.

Results showed that feed intake was statistically affected by diet energy content during the first week of experiment. Individual feed intake decreased significantly as diet energy content increased. This result is in agreement with the findings of several authors who stated that once energy requirements are achieved, bird will not consume any more feed[11-13]. Our results may be attributed to a combination effect of diet energy density and palm oil residue. In fact, previous studies reported a depressing effect of high level (>5%) of palm oil supplementation on feed intake of broiler chicken[3, 13]. The result can also be explained by an acclimatization of broilers to palm oil residue supplemented feed, since, there were no palm oil residue in their starter or grower feed. This acclimatization to feed may explain the feed intake obtained during the third following weeks. From week 2 till the end of experiment, feed intake was comparable irrespective of the diet energy content. It has been reported that palm oil decreases the pulverulence and increases the palatability of the diet which may consequently increase feed intake. Other studies pointed out that a diet containing palm oil showed considerably high amounts of long chain saturated fatty acids such as palmitic and stearic acids which are well appreciated by chickens[14]. Palm oil residue may then contain such fatty acids.

Broiler chickens that showed the highest feed intake during the first week of treatment also showed the highest live weight and daily body weight gain during the same period. It is well known that poultry, especially, growing birds are unique among domestic animals in that any change in nutrition is reflected in bird performance almost immediately[2]. Between week 2 and 3, chickens fed on the highest diet energy showed the highest and significant values of live weight and daily body weight gain. Similar results were obtained by other authors who reported that high dietary energy level significantly increase live weight and body weight gain[15]. From our results, Feed Conversion Ratio (FCR) appeared to improve with increasing diet energy content and diet inclusion of palm oil residue. As for body weight gain, the best FCR was obtained at weeks 2 and 3 with diet containing 3200 kcal $kg^{-1}$. This is in agreement with other studies which pointed out that FCR improved with increasing energy density during finishing period[15, 16]. Our results may be partially attributed to palm oil residue which is known to contain about 70% of lipid. It is well established that addition of lipids to diet supply energy, improves the absorption of fat-soluble vitamins, increases the efficiency of the consumed energy, reduces the passage rate of the digesta in the gastrointestinal tract and so, allows a better absorption of all nutrients present in the diet[6, 14].

The present work showed that broiler chicken fed on diet energy content of 3200 kcal $kg^{-1}$ which expressed the highest body weight gain had the significantly higher carcass weight and yield and abdominal fat. These results are different from those of several others authors who reported that dietary energy level doesn't influence carcass weight and yield[12]. However, our findings are in accordance with those by Ayed *et al*.[14] who reported that palm oil supplemented diet increase live weight gain and carcass weight. Previous studies reported that increased energy density or palm oil supplementation increased abdominal fat[5, 14, 15]. In fact, palm oil contains 50% saturated fatty acids which have been reported to increase abdominal fat deposits than unsaturated fats[12]. In addition, the energy derived from saturated sources is less promptly utilized and accumulated as body fat[14].

The weight of gizzard and liver of broiler fed on the highest diet energy content increased significantly. These results are different from the findings by Ayed *et al*.[14] and Kolani *et al*.[12] who pointed out that those organs were not influenced by oil supplementation. Our findings can then be explained by the palm oil residue impurities which may have increased gizzard and liver activities and hence their hypertrophy.

The increase of diet energy content with palm oil residue reduced the cost of feed consumed and the cost of feed per kg weight gain or carcass. In palm oil industry, palm oil residue is considered as waste and is then free of charge. As a result, the feed containing palm oil residue is cheaper. The increase in gross margin of diet containing 3200 kcal $kg^{-1}$ was probably due to the significant improvement in live weight live body weight gain and feed conversion ratio when compared with other treatment groups.

## CONCLUSION

This study showed that the variation of diet energy content with palm oil residue affected growth performance and production cost of finisher broiler chickens. It can be concluded that the increase of diet energy to 3200 kcal $kg^{-1}$ with palm oil residue during finisher phase improved growth rate, feed conversion ratio, carcass weight and yield and profitability.

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