

Effects of varying dietary energy levels on growth, carcass and economy of broiler chickens fed straight diets

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Abstract

The effects of varying dietary energy levels with same protein level on growth performance, carcass traits and economy of broiler chickens fed straight diets was evaluated. Diets were compounded and labeled diets 1, 2, 3 and 4 with Metabolizable Energy (ME) levels of 2800, 3000, 3200 and 3400 kcal/KgDM, respectively with a constant protein level of 24 %. 120 1-old chicks were randomly allocated to the four dietary treatments with 30 birds per treatment. Each treatment was replicated 3 times and each replicate had 10 birds. The birds were fed experimental diets for 7 weeks. Significant differences ($p < 0.05$) were observed in daily feed intake, energy efficiency ratio, daily ME intake, cost of feed intake/kg body weight gain and % weights of drumstick, shank, breast and wing. The initial body weight, daily body weight gain, final body weight gain, feed conversion ratio, protein efficiency ratio and other carcass traits were similar ($p > 0.05$). It was concluded that feeding broiler chicken with diet containing 2800kcalME/kgDM and 24 % crude protein for 7 weeks gave optimal performance with the least cost of feed intake per Kg body weight gain, least feed conversion ratio and highest gross margin (profit).

Keywords: Energy level, growth performance, carcass, broiler chicken



Effets de différents niveaux d'énergie alimentaire sur la croissance, carcasse et l'économie des poulets de chair nourris avec des régimes simples

Résumé

Les effets de différents niveaux d'énergie alimentaire avec le même niveau de protéines sur les performances de croissance, les caractéristiques des carcasses et l'économie des poulets de chair nourris avec des régimes simples ont été évalués. Les régimes ont été composés et étiquetés régimes 1, 2, 3 et 4 avec des niveaux d'énergie métabolisable (EM) de 2 800, 3 000, 3 200 et 3 400 kcal/KgMS, respectivement avec un niveau de protéines constant de 24 %. 120 poussins d'un an ont été répartis au hasard entre les quatre traitements alimentaires, à raison de 30 oiseaux par traitement. Chaque traitement a été répété 3 fois et chaque répétition concernait 10 oiseaux. Les oiseaux ont été nourris avec des régimes expérimentaux pendant 7 semaines. Des différences significatives ($p < 0,05$) ont été observées dans la consommation alimentaire quotidienne, le rapport d'efficacité énergétique, la consommation quotidienne d'EM, le coût de la consommation alimentaire/kg de gain de poids corporel et le pourcentage de poids du pilon, du jarret, de la poitrine et de

l'aile. Le poids corporel initial, le gain de poids corporel quotidien, le gain de poids corporel final, le taux de conversion alimentaire, le taux d'efficacité protéique et les autres caractéristiques de la carcasse étaient similaires ($p > 0,05$). Il a été conclu que nourrir des poulets de chair avec un régime contenant 2 800 kcalME/kgMS et 24 % de protéines brutes pendant 7 semaines donnait des performances optimales avec le moindre coût de consommation alimentaire par kg de gain de poids corporel, le plus faible taux de conversion alimentaire et la marge brute (bénéfice) la plus élevée.

Mots-clés: Niveau d'énergie, performance de croissance, carcasse, poulet de chair

Running title: Performance of broiler chickens on straight diets with varying energy levels

Introduction

There is always scarcity of broiler feed with its attendant high cost towards the end of the year in Nigeria. Feed cost constitutes about 70 % of the total cost of producing broiler chickens (Oluyemi and Roberts, 2003). Among the different feed ingredients used in formulating poultry diets, the source of dietary energy account for a major portion of feed cost. Optimizing the dietary energy level is therefore important for lowering the feed cost per unit of poultry products (Fan *et al.*, 2008). Energy has been described as one of the most important factors in broiler rations that influence or determines the feed intake and performance of the birds (Erwan *et al.*, 2008; NRC, 1994) and that birds eat to meet their energy requirements or satisfaction (Erwan *et al.*, 2008; NRC, 1994; MacDonald *et al.*, 2002). It has been reported (FAO, 2013) that poultry of different classes need varying amounts of energy for their metabolic activities and that production performance will undoubtedly suffer if the right amount is unavailable.

Most poultry farmers nowadays raise their birds with commercial feed to evade the risk often encountered when using on-farm produced feeds. The on-farm produced feeds are often contaminated with pathogens and toxins from the locally sourced feed ingredients, that most time poses danger to production and profitability of poultry enterprise. The high demand for

the well-known commercial feeds makes them expensive and scarce sometimes, which make some farmers far from the distribution point or shops in the city unable to get the right type of feed for their birds. Some farmers during the end of the year feed scarcity resorted to buying layers or growers mash for their finisher broiler birds to survive when the right type of feed (broiler finishers mash) was not available. Since researchers and broiler chicken farmers are always interested in different approaches for better growth and economy of production, this prompted this study to investigate the possibility and economy of feeding the same diet or straight diet to broilers from day-old to finishing without changing feed types along the way. Compounding such feed might be easier for farmers to do on the farm using locally available feed ingredients during feed scarcity. There is need to take cognizance of the bird energy requirements especially in the tropical rainforest zone of Nigeria while compounding such feeds on the farm by rural farmers. Hence, this study examined the effects of varying dietary energy levels with the same crude protein level on growth performance, carcass traits and economy of broiler chickens fed straight diets for seven weeks.

Materials and Methods

Study Site

The experiment was carried out at the Poultry Unit, Teaching and Research Farm, University of Uyo, Uyo Akwa Ibom State, Nigeria. It has an average monthly rainfall range of 200 to 800 mm with average monthly temperature and annual relative humidity of 28 – 36 °C and 71 – 88 % respectively. Sunshine is between 1400 - 1500 hours per year (World wealth online, 2021).

Study Design, Experimental Birds and Management

Standard method of husbandry was used to clean, fumigate and prepare the partitioned experimental poultry pens. The experimental design was a Completely Randomized Design (CRD). Feed ingredients like corn, full fat soybean, wheat offal, bone meal, table salt, vitamin-mineral premix, DL-Methionine and L-Lysine were procured from a local livestock feed ingredients seller in Uyo metropolis and used to compound four diets which were labeled diets 1, 2, 3 and 4 with Metabolizable Energy (ME) levels of 2800, 3000, 3200 and 3400 kcal/KgDM respectively with a constant protein level of 24% crude protein as shown on Table 1. One hundred and twenty day old chicks of Arbor Acres strain were randomly allocated to the four dietary treatments with 30 birds per treatment. Each treatment was replicated 3 times and each replicate had 10 birds.

The chicken had access to feed and fresh water *ad libitum* throughout the study period on a deep litter house with 24 hours lightening. Broilers were stocked at a spacing of 1 m² per bird. The feeding trial lasted for 7 weeks from the day of arrival. They were vaccinated against Newcastle and Gumboro diseases following a prepared and scheduled routine vaccination regime for humid tropical southern rainforest of

Nigeria. Newcastle vaccine was given intracocularly on the first day and orally on the 21st day of age; while Gumboro (Infectious bursal disease) vaccine was administered on the 7th and 28th day of age orally. Standard management practices were dully observed. Birds in all treatments were exposed to similar standard routine management practices such as drug administration and sanitation maintenance within and outside the poultry houses.

At the end of the seventh week, five (5) birds were selected per replicate for carcass analysis. The selected broiler chickens were fasted overnight with access to drinking water to clear the gut, weighed, stunned and slaughtered by severing the jugular vein at the joint between the skull and the cervical bones. The birds were carefully stunned, to avoid stress, slaughtered, dipped in hot water (70 °C) for few seconds and defeathered before they were eviscerated in the laboratory. The carcasses were eviscerated by removing the visceral organs and other gut contents. The dressed body weight (carcass) and internal organs were weighed and expressed as percentage of the live weight (Aduku and Olukosi, 1990; Afolabi *et al.*, 2019).

Data Collection

The day-old broiler chicks were weighed on the first day (recorded as the initial body weights) and thereafter every week until the end of the experiment. From these values, the daily Body weight gains (BWG) and final body weight were estimated. Measured quantity of feed was given to the chicken on daily basis and the quantity consumed was also noted and calculated by deducting the leftover (if any) from the quantity served. This was used to obtain the Daily feed intake (DFI) as well as Total feed intake (TFI) per bird at the end of the feeding trial. Daily protein intake (DPI) was calculated by multiplying the percentage CP in the feed by the daily feed intake and the ratio of DFI to

daily BWG was used to calculate the Feed conversion ratio (FCR). Protein efficiency (PE) was obtained using the ratio of BWG to protein consumed. The energy efficiency (EE) was calculated using the ratio of BWG to metabolizable energy consumed. Economic analysis of broiler production was based on the cost of the diets that was derived from the prevailing market price of feed ingredients at the time of purchase. The dressed body weight (carcass), cut parts and internal organs were weighed and expressed as percentage of the live weight. These pieces of information were used to compute the cost of feed intake per kg body weight

gain for each diet, revenue per dressed bird, and the gross margin.

Statistical Analysis

Data obtained were subjected to descriptive analysis and Analysis of Variance (ANOVA) and their means were separated by the Duncan Multiple Range Test Option of SPSS (Version 2017). The following model was adopted:

$$Y_{ij} = \mu + t_i + e_{ij}$$

μ : overall mean

t_i : Effect of dietary energy treatment

e_{ij} : error incurred while applying the treatment.

Table 1: Gross Composition of diets with varying energy levels fed to broiler chickens

Treatments/Diets	1	2	3	4
ME levels	2800	3000	3200	3400
<i>Feed ingredients:</i>				
Maize	31.80	44.90	52.00	46.20
Full fat soyabean meal	39.50	39.65	38.00	39.60
Fishmeal	0.10	2.00	4.00	4.00
Wheat offal	14.00	8.5	-	-
Palm oil	0.00	0.50	1.55	5.75
Bone meal	3.60	3.50	3.50	3.50
Table salt	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
DL-Methionine	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.20	0.20	0.20
Total	100	100	100	100
<i>Calculated Nutrients:</i>				
ME (Kcal/kgDM)	2807	3014	3207	3406
Crude protein	24.02	24.05	24.00	24.09
Ether Extract	3.40	2.96	2.91	2.70
Crude fibre	7.02	4.58	3.21	3.17
Calcium	1.50	1.52	1.61	1.61
Total phosphorus	1.60	0.99	0.95	0.96
Lysine	1.65	1.67	1.71	1.74
Methionine	0.64	0.64	0.66	0.66

ME = Metabolizable energy; DM = Dry matter.

*Premix supplied per kg starter diet: vitamin A 15000 I.U., Vitamin D3 13000 I.U., thiamine 2mg, riboflavin 6mg, pyridoxine 4mg, cobalamin 0.05g, biotin 0.08mg, choline chloride 0.05g, manganese 0.096g, iron 0.024g, copper 0.006g, iodine 0.014g, Selenium 0.24mg, Cobalt 0.024mg and antioxidant 0.125g.

Results and Discussion

Growth Performance

The growth performance and economy of broiler chickens fed varying dietary energy levels for 7 weeks is as shown on Table 2. The initial body live weights (38.91 – 39.57 g) were similar. The least daily feed intake (80.57 g) was obtained for birds on diet 1 (2800 kcalME/kgDM) which was also similar to what obtained for broilers on diet 2 (88.52 g) and 3 (88.47 g) but significantly lower than what was obtained for those on diet 4 that recorded the highest daily feed intake of 90.27 g. The daily feed intake of birds in this study were within the range of values (76.95 – 86.96 g) reported (Eko *et al.*, 2020; Afolabi *et al.*, 2017) for broiler chickens fed diets with turmeric powder and hot red pepper respectively. However, the values were lower than what was reported (100.17 – 150.51 g) by Obasi, (2020) for Marshal white broiler finisher chicks fed scent leaf extract (*Occimum grafissimum*) and neem leaf extract (*Azadirachta indica*) as feed additive for 5 weeks. The daily ME intake (225.59 – 306.91kcal) increased significantly ($p < 0.05$) as the level of ME of the feed increased. This is similar to the report of Kassim and Suwanpradit (1996) who fed three metabolizable energy levels (3000, 3200 and 3400 kcal/kg ME) with 0.79% total sulphur amino acids to broilers. Olomu (1995) had observed that chicks aged 0 – 6 weeks were so able to adjust feed intake to diet energy variations and thus tend to consume slightly more energy as the energy level of the diet increases.

The highest energy efficiency was obtained for broiler chickens fed diet with 2800 kcalME/kgDM, which was significantly higher than what was obtained for birds on other dietary energy levels (3,000 - 3400 kcalME/kgDM). Energy efficiency of broiler chickens on other diets was similar.

The daily body weight gain (45.01 – 48.63 g), daily protein intake (19.34 – 21.25 g), FCR (1.79 – 1.97 g), protein efficiency (2.12 – 2.33), and final body weight (2245.20 – 2422.00 g) were not significantly different ($p > 0.05$) or affected by the energy levels across treatments or diets.

Tancharoenrat and Ravindran (2014) observed that an increase in energy level improved weight gain and feed conversion ratio with no effect on feed intake but in this study, there was an increase in feed intake with increasing ME levels while the weight gain was similar, though it increased numerically. The FCR were also similar. The disparity will depend on the feed ingredients used, their nutrient digestibility, and how close the diets are to the nutrient requirements of the broiler chicken breed or strain used. Houshmand *et al.* (2011) found that broiler chickens fed low energy diets (2800ME) were heavier than those on the standard diets which is in contrast with the result of this work. Tang *et al.* (2007) had reported an increase in live body weight with the increasing dietary energy content. Dietary energy level had no significant effect on the final body weight in this study. However, diets with ME 3000, 3200 and 3400Kcal/kgDM displayed no significant advantage on FCR.

Table 2: Growth performance of broiler chickens fed varying dietary energy levels for 7 weeks

Diets	1	2	3	4	
ME levels	2800	3000	3200	3400	SEM
<i>Performance parameters</i>					
Initial body weight (g)	38.95	39.57	39.39	38.91	0.21
Daily feed intake (g)	80.57 ^c	88.52 ^{bc}	88.47 ^{bc}	90.27 ^a	1.51
Daily body weight gain (g)	45.08	45.01	45.39	48.63	0.81
Final body weight (g)	2248.00	2245.20	2263.60	2422.00	39.44
Daily ME intake (kcal)	225.59 ^c	265.57 ^b	283.08 ^{ab}	306.91 ^a	9.50
Daily protein intake (g)	19.34	21.25	21.23	20.64	0.42
Feed conversion ratio	1.79	1.97	1.97	1.86	0.04
Protein efficiency	2.33	2.12	2.14	2.24	0.04
Energy efficiency	0.20 ^a	0.17 ^b	0.16 ^b	0.16 ^b	0.004

^{a-c} Means along the same row with different superscripts are significantly ($p < 0.05$) different.

ME = Metabolizable energy; SEM = Standard error of mean.

Carcass and internal organ weights

These carcass and internal organ weights (expressed as % live weight) of broiler chickens fed varying dietary energy levels for 7-weeks is as shown on Table 3. The percentage drumstick (9.13 – 10, 91 %), shank (3.11 – 3.63 %), breast (23.89 – 26.22 %), wing (6.63 – 8.42 %), spleen (0.05 – 0.09 %) and large intestine (0.47 – 0.89 %) varied significantly ($p < 0.05$). The dressed weights and its percentage of carcass, thigh, back, neck, heart, liver, trachea, gizzard, small intestine and the pancreas were similar ($p > 0.05$) across diets. The values obtained for the dressing percentage, % thigh, breast and large intestine in this study were within the range of values reported (Eko *et al.*, 2020) for broiler chickens fed graded dietary levels of turmeric (*Curcuma longa* L.) powder as feed additives and when broiler chickens were fed diets with hot red pepper (Afolabi *et al.*, 2017). **Dietary energy levels that had no significant effect on carcass yield and most internal organs in this study is in line with the reports of some researchers (Nunes *et al.*, 2012; Daurte *et al.*, 2014) who**

found no effect of dietary energy level on carcass yield or abdominal fat. In contrast, other authors (Marcu *et al.*, 2012; Kassim and Suwanpradit, 1996) reported improved growth performance and carcass yield for the main cuts of broiler chickens fed diets with high energy and protein levels. Rosa *et al.* (2007) used 2950, 3200 and 3400kcal/kgME, but found no effect on carcass yield, breast or back fat, although the increase in energy concentration depressed yield of thigh + drumstick and increased abdominal fat. Also, Wang *et al.* (2014) found that broiler chickens fed extra energy and amino acids levels, showed increased abdominal fat, while weight of the carcass cuts were not affected. Marcu *et al.* (2013) found that increasing dietary energy and protein elevated breast weight and muscle mass, and reduced fat content, while reducing nutrient levels decreased protein content and elevated fat content in pectoral muscle. In contrast, Ferreira *et al.* (2015) produced meat with less fat in broiler chickens fed low energy diets, although growth was decreased.

Table 3: Carcass and internal organ weights (% live weight) of broiler chickens fed varying dietary energy levels for 7-weeks

Diets	1	2	3	4	
ME levels	2800	3000	3200	3400	SEM
<i>Carcass & Internal organ traits:</i>					
Body live weight (g)	2580.33	2556.67	2610.33	2750.00	57.18
Dressed weight (g)	2069.33	2047.67	2125.67	2230.67	50.44
Dressing percentage	80.19	80.06	81.47	81.06	0.43
Drumstick	10.32 ^a	9.13 ^b	10.91 ^a	10.23 ^a	0.23
Thigh	11.87	9.80	11.18	16.06	1.14
Shank	3.11 ^b	3.41 ^{ab}	3.63 ^a	3.45 ^{ab}	0.08
Breast	24.10 ^b	26.22 ^a	24.09 ^b	23.83 ^b	0.39
Wing	7.56 ^{ab}	6.63 ^b	8.42 ^a	8.23 ^a	0.27
Back	14.41	16.41	15.38	16.72	0.47
Neck	3.26	3.18	3.25	3.28	0.12
Heart	0.30	0.33	0.39	0.36	0.02
Gizzard	2.21	2.18	1.91	2.05	0.06
Liver	1.85	1.61	1.76	1.60	0.06
Spleen	0.08 ^{ab}	0.07 ^{ab}	0.05 ^b	0.09 ^a	0.01
Pancreas	0.28	0.30	0.26	0.31	0.02
Lungs	0.50	0.55	0.54	0.39	0.03
Trachea	0.09	0.08	0.09	0.11	0.01
Small intestine	6.38	5.61	4.85	5.94	0.29
Large intestine	0.89 ^a	0.74 ^{ab}	0.73 ^{ab}	0.47 ^b	0.06

^{ab} Means along the same row with different superscripts are significantly ($p < 0.05$) different.

ME= Metabolizable energy; SEM = Standard error of mean.

Economy of Production

The economy of broilers fed varying dietary levels of energy for seven weeks is as shown on Table 4. The cost of feed per kg (N195.26 – 245.07) increased with increasing levels of metabolizable energy (ME) in the feed which made cost of feed intake per birds (N770.63 – 1085.66) to increase significantly ($p < 0.05$) with increasing ME. Cost of feed intake per kg body weight gain for broilers on 3000 to 3400 ME (N426.79 – 457.10) were similar and significantly higher than what was obtained (N349.51) for those on 2800 ME diet (Diet 1). It is well known that energy supplying ingredients are expensive and form bulk of broiler feed and dictate the

price of the feed. The least cost of feed to produce a kg of broiler meat in this study was obtained for broilers fed 2800 kcalME/kgDM and 24 % CP and it is the most economical for producing live broiler. The revenue and gross margin for dressed broiler chicken were similar across diets. The least and highest revenue were obtained for broiler chicken fed diets 2 (N1740.52) and 4 (N1896.07) respectively. The least gross margin of dressed chicken in this study (N798.69) was obtained for birds on diet 2 (3000 KcalME/kg and 24 % CP) followed by those on diet 3 (3200 kcalME/kg) while the highest gross margin or profit (N988.31) was obtained for broilers fed 2800 kcalME/kg and 24 % CP.

Table 4: Economy of broilers fed varying dietary levels of energy for seven weeks (0 – 7 week)

Diets	1	2	3	4	
ME levels	2800	3000	3200	3400	SEM
Cost/kg of feed (₦)	195.26	217.01	231.64	245.07	5.57
Cost of feed intake/bird (₦)	770.63 ^c	941.82 ^b	1003.77 ^{ab}	1085.66 ^a	36.65
Cost of feed intake/kg body weight gain (₦)	349.51 ^b	426.79 ^a	457.10 ^a	455.83 ^a	14.77
Revenue/dressed bird (₦)	1758.93	1740.52	1806.82	1896.07	42.88
Gross margin (₦)	988.31	798.69	803.04	810.41	43.33

^{a-c}Means along the same row with different superscripts are significantly ($p < 0.05$) different.

ME= Metabolizable energy; SEM = Standard error of mean.

Conclusion

Broiler chickens can be fed with diet containing 2800 kcalME/kgDM and 24 % crude protein for 7 weeks as it enhanced optimal growth performance, carcass traits and economy of production with least feed conversion ratio and least cost of feed intake per Kg body weight gain with the highest energy efficiency ratio and highest gross margin or profit.

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