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Performance and Egg Quality Characteristics of Isa White Strain of Layer Chicken Fed Different Energy Levels in a Semi-Arid Zone of Nigeria

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Abstract: *An experiment was conducted to evaluate performance of Isa White strain of layer chicken fed diets of different energy levels. A total of one hundred and sixty (160) layer birds aged 42 weeks were used in the experiment. The birds were randomly allocated into four (4) treatment groups of four energy levels (2500, 2600, 2700 and 2800 Metabolizable Energy kcal/kg) replicated four times; each replicate containing 10 birds in a completely Randomized Design (CRD). Daily feed intake and egg production were recorded for eight (8) weeks at mean temperature of 35.5^{0}C and relative humidity of 29%. Egg quality assessment was conducted at the end of the feeding trial. The results indicated that the daily feed intake was significantly higher foranimals fed diets containing lowest energy content (2500 Kcals/Kg). Results indicated that hen day egg production and egg shell thicknessdid not differ significantly (P>0.05) between the treatments.Feed Conversion Ratio (FCR)and egg Haugh unit was betteras the energy content of the diets increased from 2500 to 2800Kcal/Kg. However, weight of egg increased with increasing energy content. Cost of feed consumed was better for animals fed diet containing 2600 Kcal/Kg ME. It was concluded that 2600 Kcals/Kg diet resulted in optimum performance of the birds in terms of feed intake, egg production and cost of feed consumed.*

Key words: *Performance, Egg Quality Characteristics, Isa White Strain, Energy Levels*

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I. Introduction

Poultry production is the fastest means of alleviating shortage of animal protein in Africa due to characteristic efficiency of nutrient transformation by poultry birds to high quality animal protein. Increasing production of eggs and poultry meat could be the best option to meet the nutritional needs of growing Nigerian population. However, high feed cost has been the greatest challenge to the expansion of the poultry industry. This resulted in serious animal protein deficiency among Nigerians, especially the low income earners leading to malnutrition (Adebajo*et al.,* 2008 and Abu *et al.,* 2009).Owen *et al.* (2009) reported that growth in the livestock industry in Nigeria has recently fallen below expectation due to rising prices of feed and shortage of feed supplies. Poultry generally compete with humans for grains and making the industry expensive in terms of feeding (Awosanmi, 1999). It is estimated that feeds accounts for 60 - 80% of the recurrent expenditure in intensive poultry production and management system(Ehtesham and Chowdhury, 2002).In addition, prevailing environmental conditions especially temperature has been contributing to the inefficiency in poultry production (Banerjee, 2007). High ambient temperature and relative humidity causes heat stress which is a major limiting factor to poultry productivity in tropical semi-arid zones of the world (Ubosi and Gandu, 1995). The negative influence of heat stress was also reported by Sinkalu and Ayo (2008).

Feed intake in Poultry birds is influenced by both environment and energy density of feeds (Leeson and Summers, 1986). The prevailing negative effects of unpredictable weather condition on poultry performance in semi-arid zone of Nigeria affect the profitability of poultry production. Inadequate calorie intake, insufficient supply of nutrients in adequate proportions and poor provisions of necessary vitamins and minerals were the major causes of production failure. Generally, birds adjusts feed intake to meet their energy requirement. Therefore, energy isa factor that should be first considered in ration formulation. Diets containing low energy than the recommended levelsin poultry could result in reduced growth rate, low feed conversion and cessation of lay (Yahaya, 2008). Higher energy supply in diets above optimum had negative effect on egg production. The current study therefore evaluated performance of Isa White strain of layer chickens fed diets containing different levels of energy in a semi-arid zone of Nigeria.

II. Materials And Methods

Experimental Location

The study was conducted at Sovet Farm. The farm is located at Danbare village opposite the new site of Bayero University, Kano, Nigeria. Kano State is located between longitude 9^0 30' and 12^0 30' North and latitude 9^0 30 and 8^0 42' East. The area is characterized by tropical wet and dry seasons (Olofin, 1987).The wet season lasts from May to September and dry season from Octoberto April. Mean annual rainfall and temperature ranges between 888.6 and 960mm and 21 and 46^0C respectively. The humidity of the area ranges between 20 to 40% in dry season and 60 to 80% in wet season(KNARDA, 2006).

Sources of experimental feed ingredients and formulation of diets

Ingredients used for feed formulation of feeds included maize, soybean meal, Limestone, wheat offal, rice milling waste, fish meal and bone-meal. The ingredients were purchased from feed Market at Tafawa Balewa Road, Kano, Nigeria.Lysine and Methionine used was obtained from JubailiAgrotech Nigeria Ltd whilevitamins/minerals premix were sourced from Bio-organics nutrient Company Nigeria Ltd. A fabricated mechanical crusher and mixer at Sovet Farm were used to mill the feed. The experimental diets were formulated to contain different levels of energy as shown in Table 1.The diets were formulated to contain 16- 17 % crude protein as shown in table 2.

Table 1: Gross Composition of Experimental Diets with Different Levels of Energy

Ingredients (%)	Different Levels of Energy (kcal/kg)			
	A	B	C	D
Maize	44.50	50.00	57.00	64.00
Wheat offal	17.00	10.00	3.00	3.00
Rice milling waste	6.00	7.00	7.00	5.10
Soybean	9.00	10.00	11.50	3.00
Groundnut cake	7.30	7.30	4.30	4.00
Fish Meal	4.20	4.20	5.20	9.70
Bone Meal	5.00	5.00	5.00	4.50
Salt	0.50	0.50	0.50	0.50
Limestone	6.00	6.00	6.00	6.00
Vitamins/Mineral Premix	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Cost of feed (N/kg) diet	71	72	76	83

Table 2: Calculated Composition of Experimental Diets with Different Levels of Energy

Ingredients (%)	Different Levels of Energy (kcal/kg)			
	A	B	C	D
Metabolizable Energy (Kcal/kg)	2500	2600	2700	2800
Crude protein	17.00	17.00	16.60	16.50
Ether extract	3.81	3.9	3.7	3.6
Lysine	0.90	0.90	0.90	0.90
Methionine	0.40	0.40	0.40	0.40
Calcium	3.50	3.50	3.60	3.60
Available Phosphorus	0.90	0.90	0.90	0.90
Fibre	6.00	6.00	5.10	4.00

**Bio-Mix premix supplied per kg of diet vitamin A 12500 I.U Vit-D3 2500 I.U Vit-E-500mgL- Vit K3. 2.5mg; Vit B1, -3.0mg: Vit B2 6.0mg; Vit B6 6.0mg: Niacin 40.0mg; calcium pantothenate 10.0mg; Biotin 0.80mg; Vit B12 0.25mg; Folic acid 1.0mg;Chloline Chloride 300mg; manganese 100mg; Iron 50mg; Zinc 45; copper 2.0mg; cobalt0.25mg; iodine 1.55, selenium 0.1mg

Experimental Birds and their Management

A total of one hundred and sixty (160) birds of Isa White strain were used in the experiment. The birds were housed in battery cages measuring 40cm length, 35cm width and 40cm height. The house is well ventilated with short walls measuring 0.75m. The birds were fed with a commercial layer mash prior to the commencement of the experiment. The birds were dewormed with piperazine, treated for coccidiosis with amprolium, vaccinated against common poultry diseases and deloused in case of lice infestation. Feed and water were provided *ad-libitum*.

Experimental Design

The birds were randomly allocated into fourtreatment groups of four varying energy levels. Each group had four replicates of 10 birds each. Each group was assigned to one of the following test diets: Treatments A with energy content of 2,500 kcal ME/kg; B: 2,600 kcal ME/kg; C: 2,700kcal/kg and D: 2,800 kcal ME/kg(Table 1). The experimental design was a completely Randomized Design (CRD).

Data Collection

The data was collected at mean temperature of 35.5^{0}C and mean relative humidity of 29%.Feed and water intake, egg productionand mortality wererecorded on daily basis. Egg quality assessment wasconducted at the end of the experiment. Data was collected for a period of eight weeks (at 42 – 50 weeks of age). The data on feed intake and egg mass were used to determine feed conversion ratio (feed intake / egg mass; g/g) and cost of feed per egg produced.

Feedintake

The experimental diets were offered *ad libitum* during the experimental period. Feed was measured and served at about 08 to09 hours. The leftover was weighed the following morning and the difference between the served and the left over feed was calculated as feed intake.

Egg production

Egg laid was collected once daily between the hours of 4.00–5.00 pm. Percentage hen-day egg production was obtained by dividing the number of egg produced by the number of birds and multiplied by 100. The data generated (number of egg and weight) was used for the calculationof egg mass per bird per day (daily egg number x average egg weight).

Feed Cost

The cost of the experimental feed ingredients was taken in accordance with the prevailing prices (one Nigerian naira = 160 U. S. doller) during the formulation of the experimental diets. The cost of each experimental diet, the average cost of actual feed consumed (₦/kg) and the cost of feed per egg (₦/egg) was calculated by using the cost of each ingredient (₦) used in the diet formulation, average feed consumption values (kg) and the total number of egg produced for each experimental diet.

Egg Quality Assessment

Three fresh eggs were randomly selected from each replicate for external and internal quality assessment for three consecutive days at the end of the 8th week.The length of the eggs was measured using vernier caliper. This was measured between the point end and the large rounded end.Similarly, width of the eggs was taken at the widest point.Egg shape index (ESI) was determined as the ratio of maximum width to maximum length (Tsarenko and Kurova, 1989).Each egg was weighed and broken into a petri-dish and the yolk was separated from the albumen using a yolk separator. Albumen and yolk weights were measured using a sensitive electronic scale to the nearest 0.01g.Shell thickness was measured with the aid of micro-meter screw gauge (Panda *et al*., 2003).Yolk and albumen heights were measured using vernier caliper.Yolk width (length) was measured using a divider, which was placed on a meter rule to determine the length (Sufianu, 2004).Yolk index was obtained by dividing yolk height by its diameter, and egg shape index calculated as egg diameter divided by the length.Albumen index was calculated as the ratio between the height and diameter of the albumen (Ihekoronye and Ngoddy, 1985).

Haugh unit was calculated by taking the average values of albumen height and weight of the eggs using the formula reported by Kul and Seker (2004)).

$HU = 100 \log (H7.57 – 1.7W^{0.37})$

Where,

HU = Haugh unit,

H = albumen height in millimeters,

W = observed weight of eggs in grammes

Yolk index was calculated using the formula:

Yolk index (YI) = Yolk height (YH) ÷ Yolk diameter (YD)

Egg shell weight was determined after emptying the egg contents. The shell interior was cleaned with a tissue paper and allowed to dry. Thereafter, the weight was taken using a sensitive scale.

The colour of the yolk was scored visually with the aid of the Roche colour fan (numbered from 1 -15, indicating very light to orange colouration). The colour fan was placed near the yolk to determine the colour that matches the yolk and the colour number was noted.

Statistical Analysis
The data generated from the experiment was subjected to analysis of variance (ANOVA) using statistical Analysis System SAS (1999).

III. Results And Discussion

The proximate composition of experimental diets (Table3) shows that the diets contained Metabolizable Energy (kcal/Kg) of 2507kcal/Kg, 2605kcal/Kg,2698kcal/Kg and 2803kcal/Kg forTreatments A, B, C and D respectively.The result also shows an average of 17% crude protein,4-6% crude fibre, 3.5% Calcium, 0.9% Phosphorus and 3.5% Ether extract.

The calculated proximate composition of the experimental diets contained an average of 17% Crude Protein, 4-6% Crude Fibre and 2500- 2800 kcal/kg ME. The crude protein content is within the range of 16 to 20% recommended for layer chickens byBabatunde and Fetuga (1976) and Apata (2003). The crude protein content of the diets was adequate to support growth and egg production without wastage as evident from its utilization.The crude fibre values used in the present experiment are similar to those obtained in similar studies.Fafiolu*et al*. (2004) reported 5.3 – 6.6% while Apata (2003) used 5.5 – 6.7%.

Table3: Proximate Composition of Experimental Diets

	A	B	C	D
Crude protein (%)	17.2	16.9	16.8	16.9
Metabolize energy(kcal/kg)	2507	2605	2698	2803
Ether extract (%)	3.4	3.41	3.54	3.60
Crude fibre (%)	6.10	6.30	5.53	4.54
Calcium (%)	3.60	3.44	3.53	3.46
Available Phosphorus (%)	0.91	0.98	0.97	1.01

Performance of Isa White strain of layer chickens fed with different energy levels is shown in table 4. The results showed no significant difference (P>0.05) between treatment means in terms of hen day egg production, final weight and average daily gain. Values on feed intake (table 4) was significantly higher (P<0.05) for treatment A (128.50 g/d/b) compared to treatments B (120.86 g/d/b), C (115.24 g/d/b) and D (114.17 g/d/b).

Daily feed intake of the birds was higher for animals fed diet containing the lowest energy content (2500 Kcals ME/kg). This is an indication that the layer birds consumed more feed to meet their energy requirement when energy content is low (2500 kcal/kg ME). In previous studies, Aduku (1993) recommended 2500 kcal/kg ME and 2550 kcal/kg ME respectively as the lowest energy requirement for laying chickens irrespective of the strain. The feed intake of the birds (observed between 114 – 129g/d/b) is higher than 108 – 112g/d reported by Yahaya (2008) when 2715 kcal/kg ME energy was fed to layer birds in Sokoto environment. However the values are closer to 120 – 126g/b obtained by Ayorinde*et al.*(1999)when seasonal variations in Hen day, feed consumption, mortality and culls on Bovans Black Layer chickens was studied. Variations in feed intake were due to energy levels which normally occur specifically as a result of temperature variations. Scott (1974) reported that at a temperature of 33^0C, laying hensrequire about 2750kcal/kg ME diet for maximum egg production. Higher temperature observed in the present study (36^0C)might have caused reduction in feed intake when energy level of the diet is increased to 2800 kcal/kg ME. However, the trend in feed intake of the birds is similar towhat has been reported in the literature. Peguri and Coon(1991),Eruvbetin and Oguntona(1997) observed significant decrease in feed intake with increased dietary energy.

Average weight of the experimental birds after the trial (50 weeks of age) ranges between 1.60 – 1.65kg. similar to the values reported by NRC (1994). NRC (1994) observed that the approximate weight of a layer ranges from 1.5 – 2.5kg at 20 weeks of age. An average body weight of 1.8kg was also reported for white Leghorn layers at the end of lay. Leeson and Summers (1986) reported mature body weight in the range of 1.8 – 2.0kg for White Leghorn chickens. In addition, body weight of between 1.67 and 1.69kg and between 1.76 – 1.87kg (at 30 weeks of age) was reported by Abdullahi (2004) and Yusuf (2008), respectively with layers in Sokoto. Average daily gain (g/d/b) was not affected by dietary energy of the diet. Excessive intake of energy initially accelerates growth, but eventually lead to accumulation of fat and reduced feed intake, with consequent deficiencies in other nutrients. There is optimum energy concentration in diets beyond which the performance of chicks does not appear to improve, and may even depreciate (Farrell *et al*., 1973; Olomu, 1976).

Egg production in Isa white was not affected by increased energy. However, about 95% production was obtained at the energy level of 2700 kcal/kg ME. This value is far greater than 42% for Shika Brown obtained by Yahaya (2008) when 2715 kcal/kg ME was fed in Sokoto environment. It is equally higher than the reported 60% for Black Harco reported by Ahmad (2008) when diet containing 2670 kcal/kg ME energy was fed at a temperature of 28.8^0C in Sokoto environment. This is an indication that Isa white could have improved egg production at higher temperature, lower energy level.

Feed conversion ratio (FCR) in kg feed per egg indicated no significant variations (P>0.05) between treatments A (2.21) and B (2.20) as well as those in treatments C (1.96) and D (1.86) whose values were significantly lower (P<0.05) than those in treatments A and B.

The FCR values (1.86 – 2.21) obtained in the present were higher than the values (1.5 – 1.7) reported by Ademola and Farinu (2006) when forage meals of *Tithoniadiversifolia* were used in the diets of laying chickens. Feed conversion ratio (FCR) was found to be 2.65 per 10 eggs in an experiment conducted by Aduku (1993) with layers in Northern Guinea Savanna Zone of Nigeria. A range of 3.6 – 4.22 was reported by Yahaya (2008) with layers at Sokoto. Compared to these findings, FCR obtained in the present study is an indication that feed wastage is controlled and the birds are healthy which was also further buttressed with the absence of mortality. This could be because poor feed conversion ratio may be due to wastage, infection with internal worms, and age of birds or rat infestation.

Average weight of egg was significantly higher (P<0.05) in treatment D (67.26g) compared to those in treatments B (58.61g) and C (62.58g). However values in treatments B and C; A and C as well as A and D aresimilar (P>0.05). Egg mass indicated no significant variations (P>0.05) between treatments A, C and D, as well as between treatments A, B and C. However the highest value was obtained in treatment D (61.77g) and lowest in treatment B. It was previously observed that egg size varies with age and strain of birds and gave an average egg weight of 58g. The result of the present study shows that weight of egg increased with increasing energy content of the diet. This was similar to the previous reports that egg weight and body weight could be increased or decreased by changing the dietary energy concentration (Oluyemi and Roberts,2000).

Total cost of feed consumed (N/d) was significantly higher (P<0.05) in treatment D compared to the rest of the other treatments. Significantly the lower (P<0.05) values were obtained for treatments B and C whose values did not differ significantly (P>0.05). Cost of feed consumed per egg (N) was not significant (P>0.05) between treatments A and D as well as between treatments B and C. However values in treatments A and D gave significantly higher (P<0.05) values compared to other treatments.

Cost feed (N/kg) increased with increasing energy content in the diets. This clearly supports the assertions that grains that are the major sources of energy in poultry diets are very expensive due to competition between man and animals.The high price of maize has resulted in an unprecedented increase in cost of poultry feed production (Oladunjoye*et al.,* 2004). Olewola and Longe (2001) reports that energy could account for up to 60% of the overall cost of poultry production and the use of wrong energy level will adversely affect cost (David, 2010). Total cost of feed consumed by the layer birds in the present study was lower for animals fed diets containing 2600 kca/kg ME diet. This clearly violated the trend in the cost of feed per kg naira which increases as the level of energy increases.

The cost of feed consumed per egg in naira indicated better result in the diet containing 2600 Kcal/kg ME diet. The result obtained contradicts the report that environment inflicts heavy economic losses on poultry production as a result of stunted growth (Sahin*et al*., 2001), decrease in hen-day egg production, increased cost of production, high rate of mortality due to depressed immunity, and reproductive failure (Ayo *et al*.,2010).

Table 4: Performance of Isa White strain of layer chickens fed different energy levels

Parameter	Different Levels of Energy (kcal/kg)				LSD
	A	B	C	D	
Feed Intake (g/d/b)	128.50^{a}	120.86^{b}	115.24^{c}	114.17^{c}	1.14
Hen day egg production (%)	91.88	94.07	94.51	91.83	6.03
FCR (kg feed /egg)	2.21^{a}	2.20^{a}	1.96^{b}	1.86^{b}	0.19
Average weight of egg (g)	63.52^{ab}	58.61^{c}	62.50^{bc}	67.26^{a}	3.98
Egg mass (g/d/b)	58.39^{ab}	55.13^{b}	59.07^{ab}	61.77^{a}	5.72
Initial weight of birds (kg/d/b)	1.50	1.50	1.50	1.50	-
Final weight of birds (kg/d/b)	1.60	1.63	1.64	1.65	0.07
Average daily gain (g/d/b)	1.83	2.37	2.40	2.72	1.32
Cost of feed (N/kg)	71.00	72.00	76.00	83.00	-
Total cost of feed consumed (N/d)	9.12^{b}	8.70^{c}	8.76^{c}	9.48^{a}	0.09
Cost of feed consumed per egg (N)	9.94^{a}	9.26^{b}	9.27^{b}	10.35^{a}	0.65
Mortality	0.00	0.00	0.00	0.00	0.00

a, b, c means with different superscripts within the same row are significantly different (P<0.05)

Results on quality of eggs produced by Isa White strain of layer chickens fed with different energy levels were presented in Table 5. Percentage haugh unit was significantly higher (P<0.05) for treatment D (69.16%) compared to the rest of the treatment whose values did not differ significantly (P>0.05). Values on albumin weight followed similar trend withhaugh unit. Values on shell thickness and yolk colour indicated no significant variations (P>0.05) between treatment. Shell weight was significantly higher (P<0.05) for treatment A compared to the other treatmen whose values did not differ significantly (P>0.05).

Yolk weight was significantly higher (P<0.05) for treatment A compared to the other treatments. Yolk width was significantly higher (P<0.05) for treatments A and C whose values did not differ significantly (P>0.05).

Likewise there were no significant differences (P>0.05) between treatments B, C and D. Values on yolk height did not differ significantly (P>0.05) between treatments B, C and D whose values were similar (P>0.05). Albumin width was higher (P<0.05) for treatment C and similar (P>0.05) with to treatments A and D. Results on egg length and egg width followed similar trend in which treatments C and D gave significantly higher (P<0.05) values followed by treatments B. Albumin index indicated significantly higher (P<0.05) value for treatments B followed by treatments D then treatment C and lastly treatment A.

Haugh unit (HU) which is a measure of the freshness of eggs indicated a better results at high (2800kcal/kg ME diet) energy. However, the values for HU obtained from the present study are lower than the cut-off level of 75% set for high quality fresh eggs reported by Card and Nesheim (1972). This might be attributed to the fact that egg quality assessment in this experiment was conducted after three days of the collection due to weekend period and distance of the laboratory. The results of HU obtained from the present study were closer to 66 – 70% obtained by Egbewande (2012) and Dongmo and Fomunyam (2005). Brandt *et al.* (1991) reported that eggs of inferior quality have HU values of less than 40% indicating that the HU obtained from the present study is of good quality.

Shell thickness is a manifestation of the hen's Calcium metabolism and its relative efficiency in assimilating and secreting Calcium and other minerals involved in shell information. Results on average shell thickness obtained from the present study ranges from 0.41 – 0.47mm.These values are higher than the recommended minimum by Oluyemi and Roberts, (2000) who reported that the average shell thickness of a fowl egg is about 0.34mm and it tends to be thinner in the tropics than in the temperate regions. Isa white requires high energy for effective mobilization of calcium. These results contradicted the reports of Grobes*et al*. (1999) and Garba (2012) who reported that eggshell quality was not affected by dietary energy levels. However, the claim of the authors is very comfortable with Isa white strains of layer chickens. If eggs spend a short period of time in the shell gland, then shell thickness will be less (Koelkebeck, 2007). This could be the contributing factor for the variations obtained from this study.

Table 5: Quality of Eggs produced by Isa White strain of layer chickens fed different energy levels

Parameter	Different Levels of Energy (kcal/kg)				LSD
	A	B	C	D	
Haugh (%)	68.12^{b}	67.21^{b}	68.05^{b}	69.16^{a}	0.94
Shell thickness (mm)	0.43	0.46	0.44	0.43	0.04
Shell weight (g)	7.64^{a}	6.05^{b}	6.20^{b}	6.23^{b}	1.30
Yolk Index	0.31^{b}	0.39^{a}	0.39^{a}	0.43^{a}	0.05
Yolk Colour	1.00	1.00	1.00	1.00	0.00
Yolk weight (g)	22.95^{a}	18.87^{c}	20.33^{b}	18.79^{c}	1.15
Yolk width (cm)	5.05^{a}	4.35^{b}	4.73^{ab}	4.33^{b}	0.58
Yolk height (cm)	1.53^{b}	1.68^{ab}	1.83^{a}	1.83^{a}	0.15
Albumin weight (g)	32.93^{b}	33.68^{b}	35.98^{b}	42.24^{a}	6.32
Albumin width (cm)	6.43^{ab}	5.53^{b}	7.05^{a}	6.63^{ab}	1.12
Albumin height (cm)	0.30^{b}	0.86^{a}	0.80^{a}	0.88^{a}	0.15
Egg length (cm)	4.35^{c}	5.69^{b}	6.30^{a}	6.12^{a}	0.39
Egg width (cm)	2.93^{c}	4.23^{b}	4.45^{a}	4.49^{a}	0.17
Egg Shape Index	0.67^{b}	0.75^{a}	0.71^{ab}	0.74^{a}	0.05
Albumin Index	0.05^{d}	0.16^{a}	0.12^{c}	0.14^{b}	0.02

a, b, c means with different superscripts within the same row are significantly different (P<0.05)

Yolk quality is extensively estimated by its colour (Degroote, 1972), and it is influenced mainly by the bird's diet and the metabolism of carotenoids extracted from the feed, deposited in the skin, body fat and egg yolk. Yolk colour did not differ at all levels of dietary energy used in the present study. This is due to the fact that white maize was used as the main ingredient for energy source and the birds were exposed to the same light intensity.

The quality of an egg depends mainly on the albumen of that egg because the larger the proportion of the dense albumen and the firmer its consistency the higher its quality. The albumin weight ranges from 32.93 – 43.72g irrespective of dietary energy levels. The results did not show any specific trend in terms of energy levels. However, the values are comparable to 35.87 – 37.27g and 34.52 – 37.29g obtained by Garba (2012) and Adedeji *et al.* (2008) respectively.

IV. Conclusions

It was concluded that for optimum growth and egg production and reduced production cost for Isa white layer strains, the energy levels of 2600kcal ME/kg should be adopted.

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