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Influence of pre-breeder dietary energy and protein levels on subsequent laying performance of FUNAAB - alpha chickens

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Target audience: *Farmers, Breeders, Poultry Nutritionist, and Researchers*

Abstract

The effects of pre-breeder dietary energy and protein on subsequent reproductive performance of FUNAAB - Alpha chickens were studied using a total of 120 (96 hens and 24 cocks) birds. The birds were fed standard exotic grower diet (2650 Kcal/kg, 14%CP; Control), high energy low protein (2800Kcal/kg, 12%CP; HELP), high energy high protein (2800Kcal/kg, 16%CP; HEHP) and low energy low protein (2500Kcal/kg, 16%CP; LEHP) diets during pre-breeder phase (10 – 22 weeks of age). During, lay all the birds were fed the same breeder diet (2600 Kcal/kg and 16%CP) for twelve weeks. The diets and water were allowed ad libitum throughout the experimental period. The response criteria include; feed intake, body weight, egg production, fertility and hatchability. Data obtained were analysed for variance as a Randomized Complete Block Design. Hen day egg production was significantly (P<0.01) influenced by dietary treatment. Egg weights of 42.85, 43.55, 42.85 and 43.05g for control, HELP, HEHP and LEHP respectively were similar. A significant (P<0.01) difference was observed among means of egg mass with HEHP being highest (17.31) and control lowest (11.40). Pre-breeder dietary treatment had a significant (P<0.05) influence on FCR. Pre-breeder HEHP diet supported the best hen day egg production (41.06%), fertility (86.67%) and hatchability (68.98%). It was concluded that feeding high energy high protein (HEHP) diet during pre-breeder phase subsequently supported high egg production, fertility and hatchability.

Key words: Breeder chicken, fertility, hatchability, nutrition, reproduction

Description of Problem

Appropriate nutrition is essential for adequate productivity in animals. Diet plays a pivotal role in maintaining growth, health and reproduction. Among the many dietary factors, protein and energy have special importance in maintaining growth and reproduction in poultry (1; 2). Protein and energy-yielding feed substances therefore are the most important and most expensive nutrient sources for poultry (2). They are usually selected as the starting ingredients in poultry diet formulations (1). In the management of breeder poultry, feed is regulated to prevent excessive weight gain, a major cause of poor ovulation and at extremes, early ovarian regression (3). This will ensure production of good quality and number of eggs. Maternal nutrition plays an important role in subsequent development and hatching of avian embryos (4). Avian embryos develop and grow from energy and nutrients stored in the egg. It is therefore extremely important for the embryonic development and successful hatching of high quality chick (5). The egg supplies protection and nutrients to the embryo during development (6).

Zeweil *et al.* (7) observed that low hatchability is associated with high protein levels in the diets of hens. However, increasing methionine in the diet had the opposite effect.

In a study on the effects of protein during rearing and energy during lay, (8) reported that low dietary protein during rearing increased hatchability due to reduced embryonic mortality during days 10 – 21.On the other hand high energy (3000Kcal/Kg) diet during lay also resulted in increased hatchability and number of first grade chicks. Similarly, (9) reported that feeding broiler breeders based on apparent metabolizable energy and total amino acids as against true metabolizable energy and digestible amino acids resulted in significantly better hatchability. In an earlier work with the Kenyan indigenous chicken however, (10) observed non-significant effect of dietary protein on hatchability.

In Nigeria, efforts have been geared towards the development of indigenous chicken breeds with improved meat and egg production. These efforts have led to the development of the Shika brown layers by National Animal Production Institute (NAPRI) (11). Similarly, the Federal University of Agriculture Abeokuta (FUNAAB) has developed the FUNAAB – alpha (12). However, there is little information on the nutritional requirements of these strains as it affects growth and sexual maturity. A full understanding of protein and energy metabolism is essential for all poultry classes and is fundamental for diet formulation and profitable production. The objective of this study was to evaluate the effects of varying pre-breeder dietary energy and protein levels on subsequent reproductive performance of FUNAAB - alpha chickens.

Materials and Methods

The experiment was conducted at the Abubakar Tafawa Balewa University Bauchi, Bauchi state, Nigeria and is located between latitudes 10.17° north and longitudes 9.96° east of the equator. Bauchi State is located at an elevation of 537 meters above sea level. The land area is 49,119 km² representing 5.3% of Nigeria's total land mass. The society is primarily agrarian contributing 75% to the State's economy. The climate is characterized by two well defined seasons: The rainy season (May to October) and the dry season (November to April). The mean annual rainfall and temperature range are 905.33 mm 11 – 41°C but rainfalls are between 700 and 1250 mm in the north and south – south west zones of the state respectively (13).

A total of 120 ten week old FUNAAB – alpha chickens were randomly allotted to four treatments replicated three times in a completely randomized block design (with three blocks). Each replicate consisted of two cocks and eight hens in a flock mating system with a mating ratio of one cock to four hens. Four experimental grower diets (Table 1) were prepared using locally available feed materials and as fed follows; Standard diet for exotic grower (Control), high energy, low protein (HELP), high energy, high protein (HEHP) and low energy, high protein (LEHP). The birds were fed the growers diet until 22 weeks of age when they were switched to a uniform breeder diet (Table 2) for the next 12 weeks. All diets were provided in mash form. The diets and water were given *ad libitum* throughout the experimental period. The birds were reared on deep litter in an open sided house. Each replicate were placed in pens measuring 1.5meters by 1meter.

Table 1: Ingredients and percentage composition of different energy and protein diets fed to grower FUNAAB - alpha chickens

Ingredients	Control	HELP	HEHP	LEHP
Maize	60.47	69.94	63.24	51.00
Soya bean meal	10.60	5.79	18.30	15.41
Wheat bran	25.33	20.67	14.85	29.99
Bone meal	1.75	1.75	1.75	1.75
Limestone	1.25	1.25	1.25	1.25
Salt	0.35	0.35	0.35	0.35
Premix*	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Analysis				
ME (Kcal/Kg)	2650.00	2800.00	2800.00	2500.00
Crude Protein (%)	14.00	12.00	16.00	16.00
Calcium (%)	1.02	1.00	1.02	1.03
Phosphorus (%)	0.59	0.52	0.53	0.65
Proximate composition				
Dry matter (%)	92.31	93.49	91.90	89.41
Crude protein (%)	14.14	12.11	16.23	16.12
Ether extract (%)	2.08	3.98	4.51	2.01
Crude fibre (%)	6.56	5.53	4.48	8.51
Ash (%)	7.84	8.58	10.87	8.50
NFE (%)	61.69	62.29	55.81	54.27

HELP – High energy low protein, HEHP – High energy high protein, LEHP – Low energy High protein; NFE – Nitrogen free extract, ME – Metabolizable energy

*Each 2.5kg Optimix vitamin/mineral premix contains; Vitamin A – 8,000,000 I.U, Vitamin D3 – 1,700,000 I.U, Vitamin E – 5,000 mg, Vitamin K3 – 1,500mg, Folic Acid – 200mg, Niacin – 15,000mg, Calpan – 5,000mg, Vitamin B2 – 3,000mg, Vitamin B12 – 5mg, Vitamin B1 – 1,000mg, Vitamin B6 – 1,000mg, Biotin – 20mg, Antioxidant – 125,000mg, Cobalt – 100mg, Selenium – 100mg, Iodine – 1,000mg, Iron – 25,000mg, Manganese – 45,000mg, Copper – 3,000mg, Zinc -35,000mg, Choline Chloride – 100,000mg.

Table 2: Ingredients and percentage composition of breeder diet fed to FUNAAB – alpha chickens during lay

Ingredients	Percentage
Maize	56.83
Soya bean meal	20.61
Wheat bran	12.01
Bone meal	2.75
Limestone	7.00
Salt	0.35
Premix*	0.25
Methionine	0.10
Lysine	0.10
Total	100.00
Calculated Analysis	
Metabolizable energy (Kcal/kg)	2600.00
Crude Protein (%)	16.00
Calcium (%)	3.47
Phosphorus (%)	0.78
Proximate Composition	
Dry matter (%)	91.34
Crude protein (%)	16.13
Ether extract (%)	3.05
Crude fibre (%)	8.11
Ash (%)	14.27
Nitrogen free extract (%)	49.78

*Each 2.5kg HI-Mix® vitamin/mineral premix contain; Vitamin A – 10,000,000 I.U, Vitamin D3 – 2,000,000 I.U, Vitamin E – 12,000mg, Vitamin K3 – 2,000mg, Vitamin B1 – 1,500mg, Vitamin B2 – 4,000mg, Vitamin B6 – 1,500mg, Niacin – 15,000mg, Vitamin B12 – 10mcg, Pantothenic Acid – 5,000mg, Folic Acid – 500mg, Biotin – 20mcg, Choline Chloride – 100,000mg, Manganese – 75,000mg, Zinc – 50,000mg, Iron – 20,000mg, Copper – 5,000mg, Iodine – 1000mg, Selenium – 200mg, Cobalt – 5,000mg, Antioxidant – 125,000mg.

A pre-weighed diet was fed each morning and left-over of each day was weighed the next morning. The difference between the amount fed and the left-over represented the feed intake for the day. Average feed consumption in a group was obtained by dividing the weight of feed consumed in the group by the number of birds in it. Each bird was weighed at the beginning of the experiment and weekly thereafter and weight gain was the difference between two consecutive weighing. Feed conversion ratio (FCR) for egg production was obtained as feed intake divided by dozen eggs produced. The birds were mated naturally with a mating ratio of one cock to four hens.

Eggs were collected twice a day (morning and evenings). Egg weights were recorded individually to the nearest gramme using an electronic scale (SF – 400).

Hen day egg production (HDEP) was calculated using the following formula;

$$HDEP = \frac{Total\ number\ of\ eggs\ produced\ in\ a\ day}{Total\ number\ of\ hens} X\ 100$$

Egg mass was obtained daily by multiplying average egg weight by the HDEP in each replicate.

Once each month eggs were collected for seven consecutive days from each replicate and labelled appropriately. They were sorted on the 7^{th} day to remove cracked eggs and eggs of abnormal size before being set in an incubator. A locally fabricated incubator as described by 14 was used for this work. Between day 1 to 18 of incubation, temperature and relative humidity were maintained at 37.6^{o}C and 55 – 60%, while between day 19 to 21 it was 37.3^{o}C and 55 – 70% respectively. Eggs were turned every 90 minutes. Candling was done on the 10^{th} and 18^{th} day of incubation and all clear eggs and dead embryos were removed. Eggs were considered fertile if there is development of embryo. Fertility was then calculated as follows;

$$Fertility\ (\%) = \frac{Number\ of\ fertile\ eggs}{Number\ of\ eggs\ set} X\ 100$$

Hatchability referred to the number of eggs that hatched at the end of the incubation period. It was calculated as follows;

$$Hatchability\ (\%) = \frac{Number\ of\ eggs\ that\ hatched}{Number\ of\ fertile\ eggs\ set} X\ 100$$

Analysis of variance was carried out on all data collected using the general linear model of SPSS 20.0 (15). Where means differed, Duncan multiple range test (DMRT) was used to separate them (16).

Results

Table 3 shows the effect of pre-breeder diets on performance of FUNAAB- alpha chickens during the breeder phase. Daily feed intake was significantly (P<0.05) different among treatments. Birds fed control and HELP consumed more feed than those on LEHP while HEHP was similar to all the other groups The overall averages of daily energy intake (Kcal/Kg/bird/day) for the treatments (control, HELP, HEHP and LEHP) were 275.33, 290.03, 270.00 and 220.67 respectively with birds in the LEHP group consuming the least (P<0.001). There was in addition a significant (P<0.05) influence of pre-breeder dietary treatment on daily protein intake with the control birds consuming more than those on HELP and LEHP. Birds in the HEHP group however, similar protein intake to the control, HELP and LEHP groups.

The initial weights of the birds were similar across treatments. Cock body weight was however influenced (P<0.001) by dietary treatment at the end of the pre-breeder phase with those on the control diet having the highest, followed by LEHP. Hens had similar bodyweight across treatments. Average body weights at 34 weeks of age ranged from 2283.30 to 3016.70g and 1836.00 to 2030.40g for cocks and hens, respectively. Body weight values for hens did not differ but those of cocks differed significantly (P<0.05). Cocks on control during the pre-breeder phase were the heaviest while those fed HELP diets had the lowest values. On the other hand, pre-breeder dietary treatments had no effect on subsequent body weight gain for both cocks and hens during the breeder phase.

The values of HDEP revealed a significant (P<0.01) influence of dietary treatment where HEHP and LEHP did not differ from each other but were superior (P<0.01) to control and HELP. Average egg weights of 42.85, 43.55, 42.85 and 43.05g for control, HELP, HEHP and LEHP respectively were similar. A significant (P<0.01) difference was observed among means of egg mass with HEHP being highest (17.31) and control lowest (11.40).

Pre-breeder dietary treatment had a significant (P<0.05) influence on FCR (Feed/dozen eggs). Mean FCR for HELP, HEHP and LEHP did not differ significantly, and those of control, HELP and HEHP were also similar.

Percentage mortalities during the pre-breeder and breeder phases were 13.33, 33.33, 16.67 and 13.33% for control, HELP, HEHP and LEHP respectively with significantly (P<0.05) highest value for HELP and lowest for control and LEHP (13.33%).

The influence of pre-breeder diets on subsequent fertility and hatchability are shown on Table 4. Fertility was better (P<0.05) for the HELP (86.67%) and HEHP (86.67%) as compared to the control group, while the LEHP group had similar value (P>0.05) to all the others. Hatchability was best (P<0.05) for birds fed LEHP during the pre-breeder stage although it was not statistically different from those in the control and HEHP groups. The HELP birds had the lowest (P<0.05) hatchability of 43.05% although it was similar to control and HEHP.

Table 3: Effect of Pre-breeder Dietary Energy and Protein on Performance of Breeder FUNAAB – alpha Chickens.

Parameter	Control	HELP	HEHP	LEHP	± SEM
Daily Feed Intake (g/bird)	105.90^{a}	103.58^{a}	96.43^{ab}	91.95^{b}	4.11*
Daily Energy Intake (Kcal/Kg/ bird)	275.33^{a}	290.03^{a}	270.00^{a}	220.67^{b}	11.10*
Daily Protein Intake (g/bird)	16.94^{a}	14.50^{b}	15.43^{ab}	14.71^{b}	0.62*
Initial cock weight (10weeks)(g)	1217.00	1062.00	1014.00	1066.00	149.45^{NS}
Initial hen weight (10weeks)(g)	739.00	689.00	734.00	674.00	74.84^{NS}
Cock body weight at EPB (g)	2754.00^{a}	2189.00^{c}	2257.00^{c}	2568.00^{b}	69.32*
Hen body weight at EPB (g)	1763.00	1475.00	1729.00	1721.00	56.99^{NS}
Body Weight Cocks at 34weeks (g/bird)	3016.70^{a}	2283.30^{b}	2350.00^{b}	2700.00^{ab}	631.57*
Body Weight Hens at 34weeks (g/bird)	1940.70	1949.70	2030.40	1836.00	236.54^{NS}
Body Weight Gain Cocks (22-34wk)(g/bird)	400.00	416.67	533.33	483.33	157.09^{NS}
Body Weight Gain Hens (22-34wk) (g/bird)	136.36	247.43	200.71	169.31	95.59^{NS}
Hen Day Egg Production (%)	26.54^{b}	29.89^{b}	41.06^{a}	38.81^{a}	3.08*
Average Egg Weight (g)	42.85	43.55	42.85	43.05	0.79^{NS}
Egg Mass	11.40^{c}	13.26^{bc}	17.31^{a}	16.40^{ab}	1.98*
FCR (Dozen Eggs)	8.72^{a}	5.71^{ab}	6.65^{ab}	4.99^{b}	1.23*
Mortality (%)	13.33^{b}	33.33^{a}	16.67^{ab}	13.33^{b}	6.87*

HELP- High Energy Low Protein, HEHP- High Energy High Protein, LEPH- Low Energy High Protein; EPB- End of pre-breeder phase (22wks of age)

[a, b, c….] Means within the same row bearing different superscripts differ significantly (P<0.05);
SEM: standard error of mean; NS: not significant (P>0.05); *: Significant (P<0.05).

Table 4: Effect of Pre-breeder Dietary Energy and Protein on Fertility and Hatchability of FUNAAB - alpha Chicken

Parameter	Control	HELP	HEHP	LEHP	± SEM
Fertility (%)	66.67[b]	86.67[a]	86.67[a]	76.67[ab]	4.71*
Hatchability (%)	50.00[ab]	43.05[b]	68.98[ab]	77.97[a]	9.08*

HELP- High Energy Low Protein, HEHP- High Energy High Protein, LEPH- Low Energy High Protein
[a, b, c….] Means within the same row bearing different superscripts differ significantly (P<0.05); SEM: standard error of mean; NS: not significant (P>0.05); *: Significant (P<0.05).

Discussion

During the breeder phase (22 to 34 weeks of age), feed intake was influenced by the pre-breeder diet in a similar way as during the pre-breeder phase. Birds in the LEHP and HEHP combinations consumed less than those offered the control and HELP diets. This observation differs from that of (17) who observed that grower's diets (8 to 18weeks of age) had no influence on feed intake of pullets during early lay (18 to 38 weeks of age). It was similarly observed by (18) that for growers, protein did not affect feed intake, but energy level did, with low ME (2650Kcal/kg) and high ME (3050Kcal/Kg) birds consuming more feed than medium ME (2850Kcal/Kg).

Pre-breeder diet had no effect on body weight and body weight gain of hens at 34 weeks of age. This confirms the report of (17) that grower dietary energy and protein did not affect pullet body weight at 38 weeks of age.

Hen-day egg production and egg mass were greater in the HEHP and LEHP diet groups. This is an indication that feeding pullets' high protein levels during the growing period improves egg production during the early laying stage. This agrees with the observations of (19) who reported that hen-day egg production and egg mass were significantly higher for pullets fed high protein in the diet. Egg weight was similar for all groups at this phase. This concurs with the reports of (17) that egg weight and size during 20 to 38 week of age were not influenced by treatment variables used during the growing period. Egg mass was however influenced by dietary treatment. This was as a result of the influence of dietary treatment on hen-day egg production. This observation confirms the report of (18) that high dietary protein during the growing period improves egg production and egg mass.

Birds in the HELP combination had the highest mortality rate which may be as a result of high abdominal fat deposit as seen at post mortem examination. This concurs with the report of (8) that birds fed high dietary energy level showed increased mortality during the first phase of lay, and the entire laying period, as compared to those on standard or low energy diets. Similarly, (20) observed increased mortality rate when birds were fed a low protein diet.

Birds fed the high energy diets irrespective of protein levels during pre-lay had better fertility while the low dietary protein regardless of energy level during grower phase lowered hatchability. In an earlier observation, (21) reported that fertility seemed to be enhanced by high dietary energy and protein levels in Chukar partridge as evident in higher fertility when levels of energy, protein or their combination were fed. Similarly, (22) and (23) reported that pullets fed high crude protein exhibited better fertility overall than those fed marginal levels. Likewise, (24) also found higher hatchability values in brown-egg laying hens fed high protein diets. On the contrary, (8) observed that fertility during the first phase of lay was not affected by dietary crude protein during rearing. They further reported that a high-energy diet did not affect fertility but improved hatchability.

Conclusion and Applications

It was concluded that feeding high energy high protein (HEHP) diet during pre-breeder phase subsequently supported high egg production and quality, fertility and hatchability.

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