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Impact of Dietary Inclusion of Fermented Palm Kernel Cake on Growth Performance of Broiler Chickens

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ABSTRACT

The study was conducted to evaluate the effect of fermented palm kernel cake on the growth performance of broiler chickens. The milled palm kernel cake was mixed with sterile water; thereafter, it was autoclaved for 20 minutes at 120°C and was inoculated with Bacillus subtilis, and was fermented at room temperature for 7days. The fermented PKC was oven-dried at 50oC for 48 hours and was used in the formulation of experimental diets. Eighty (80) day old broiler chicks were assigned to four dietary treatments (0%, 10%, 20% and 30% of FPKC) which are designated as diet 1, 2, 3 and 4 respectfully. Each treatment was replicated four times with five (5) birds per replicate and twenty (20) birds per treatment. Performance parameters measured include feed intake, initial body weight, weight gain, and final body weight. The study revealed that the final body weight of birds fed diet 2 was significantly ($p<0.05$) higher compared to other diets. Daily weight gain recorded in birds fed diet 2 was significantly ($p<0.05$) similar to those fed diet 3 but higher compared to values obtained in diet 1 and 4. There was a significant ($p<0.05$) difference in the daily feed intake recorded among all the diets. The value of the protein efficiency ratio obtained in birds fed diet 1 was significantly ($p < 0.05$) higher compared to other diets. This study revealed that broiler chickens fed 10% FPKC recorded more efficient feed utilization than other higher inclusion levels (20% and 30%), all of which led to higher h production efficiency in the birds fed 10% of FPKC.

***Keywords*—Broiler chickens, growth performance, palm kernel cake, mannanolytic bacteria, fermentation**

I. INTRODUCTION

The high cost of feeding livestock resulting from the use of conventional feedstuffs such as maize and soyabeans poses a major challenge to broiler production in developing countries, and this is affecting the development of the poultry industries in the developing nations [1]. Therefore, the need for alternative feedstuff as a source of carbohydrate and protein in animal feed becomes imperative.

Palm kernel cake (PKC) is an agro-industrial by-product (AGIP) obtained from palm kernels; it is the residue left after the extraction of palm kernel oil (PKO) from the kernel. The nutrient content of the PKC

depends upon the oil extraction method used, the species of the palm nut, and the amount of shell content remaining in the PKC [2]. It is considered a potential source of carbohydrate and protein, which makes it a useful ingredient in the poultry diet as a substitute for maize and soybeans. Recently, there has been an increased interest in PKC due to its nutritional potential as a prebiotic, which helps to improve chicken gut health and maintain their immune systems [3] and [4].

The use of fermentation technology has been widely used at the research level to improve the quality of various feedstuffs, such as copra meal [5], rice bran [6], and coconut dregs [7]. Solid-state fermentation (SSF) improves the quality of low-quality crop residue through the use of microbes, most especially bacteria. Mannanolytic bacteria as an inoculant in SSF can break down non-starch polysaccharides, which are very high in PKC, which is otherwise indigestible by the host [8]. This bacterium is capable of degrading the complete fibrous molecules of feed material into smaller units that can be easily digested by the poultry. It reduces the fiber content and increases the protein content of the PKC in the fermentation process [9].

Bacillus subtilis (mannanolytic bacteria) is a Gram-positive, catalase-positive bacterium. It can produce a tough, protective endospore, which allows it to tolerate extreme environmental conditions, making it possible for it to function as an agent of degradation in the fermentation process, capable of degrading cellulose, hemicellulose, xylan, β-mannan, etc. It can also function as a probiotic in poultry gut [9].
The presence of NSPs in poultry diets may decrease the absorption and utilization of nutrients in the small intestines [10]. Therefore, fermented PKC with mannanolytic microorganisms in SSF may help to solve this problem. Consequently, it appears important to evaluate the nutritional effect of PKC fermented with Bacillus subtilis to establish its effect on growth performance of broilers.

II. MATERIALS AND METHODS

A. Experimental site

This study was carried out at the Poultry Research Unit of Teaching and Research Farm of Department of Agricultural Technology, Federal Polytechnic, Ado-Ekiti, Ekiti State, Nigeria.

B. Preparation of Test Ingredient

The Palm kernel meal was purchased from a commercial feedstuff dealer in Ado-Ekiti, Ekiti State. Bacillus subtilis was cultured at the Microbiology laboratory of Department of Science Technology, Federal Polytechnic Ado-Ekiti. The fermentation process was conducted according to the methods developed by [11] and [12]. The milled palm kernel cake was autoclaved for 20 min at 121^0C and then

cooled to room temperature. The sterile water was added to the palm kernel cake and was thoroughly mixed. The 60 kg moistened palm kernel cake was inoculated with 6g of Bacillus subtilis at the rate of 0.1g/kg of PKC (approximately $2.0x10^{10}$cfu/g) was used and incubated under anaerobic conditions at room temperature for 7days. After the termination of the fermentation, the fermented PKC was oven-dried at 50^{o}C for 48 hours and was packed inside airtight containers prior to its use in feed formulation.

C. Experimental Design

The broiler chicks were randomly assigned to four (4) dietary treatments. Each treatment was replicated four times with five (5) birds per replicate and 20 birds per treatment in a completely randomized design (CRD).

D. Management of Experimental Birds

Eighty (80) day old broiler chicks were purchased from a reputable hatchery. The birds were weighed on arrival and were allocated to the four dietary treatments in a completely randomized design (CRD). Each treatment was replicated four times with twenty-four (24) birds per treatment and six (6) birds per replicate. Feed and water were served ad libitum throughout the period of the experiment. Standard management routines were carried out appropriately. The experiment lasted for 56 days. Weight gain was measured weekly while feed intake was recorded daily.

E. Experimental Diet

Four diets were formulated to meet nutrient requirements of broiler chicks. Fermented Palm Kernel Cake (FPKC) was included in the diets at varying levels of 0%, 10%, 20% and 30% at the expense of maize and soya bean meal in the control diet and they were designated as dietary treatments 1, 2 & 3 and 4 respectively. The feed composition for starter and finisher broiler diets are shown in Tables 1 and 2 respectively. The experimental diet was analyzed to determined proximate compositions of the diets according to [13].

F. Data Collection and Growth Performance

The feed supplied and leftovers were weighed weekly to determine the average feed intake per chick for the different treatment groups. Feed intake was calculated by subtracting leftover from the feed supplied and divide by the number of birds in each group. The birds were weighed every week to determine the average weight gain per chick for the different treatment groups. Weight gain was calculated as the difference between two successive weekly body weights and divide by the number of birds in each group.

Weight Gain = Final weight – Initial weight (1)

The feed conversion ratio was calculated as the total amount of feed consumed divided by the weight gain

of the birds in each treatment. Protein efficiency ratio was calculated by dividing the average body weight gain (g) with protein intake (g) in the feed.

Table 1: Composition of Broilers Starter Diet Containing Fermented Palm Kernel Cake (0 – 28 days)

Ingredients	Dietary Treatments			
	FPKC (0%)	FPKC (10%)	FPKC (20%)	FPKC (30%)
Maize	48	43.2	37.0	32.4
Soybean meal	36.1	33.9	32.1	28.7
Wheat offal	10	7	5	3
Vegetable oil	1.5	1.5	1.5	1.5
FPKC	-	10	20	30
Bone meal	2.0	2.0	2.0	2.0
Limestone	1.5	1.5	1.5	1.5
DL-Methionine	0.2	0.2	0.2	0.2
L-Lysine	0.2	0.2	0.2	0.2
Salt (NaCl)	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Total	100	100	100	100
Nutrient Analysis				
Crude protein (%)	22.54	22.45	22.12	22.00
Digestible energy (Kcal/kg)	2757.06	2709.9	2639.04	2579.86
Ether extract (%)	7.55	8.32	9.22	9.57
Crude fibre (%)	4.34	5.70	6.33	6.76

**Vitamin/Mineral Premix (Animal Care®) Vitamin A12000000IU, Vitamin D3 3000000IU, Vitamin E 30000mg, Vitamin K3 25000mg, Folic Acid 1000mg, Niacin 40000mg, Vitamin B2 5000mg, Vitamin B12 20mg, Vitamin B1 2000mg, Vitamin B6 3500mg, Biotin 80mg, Antioxidant 125000mg, Cobalt 250mg, Selenium 250mg, Iodine 1200mg, Iron 40000mg, Manganese 70000mg, Copper 8000mg, Zinc 60000mg Choline chloride 200000mg .*

Table 2: Composition of Broilers Starter Diet Containing Fermented Palm Kernel Cake (29 – 56 days)

Ingredients	Dietary Treatments			
	FPKC (0%)	FPKC (10%)	FPKC (20%)	FPKC (30%)
Maize	53.0	48.2	42.0	37.7
Soybean meal	29.6	27.4	25.6	22.9
Wheat offal	10	7	5	2
Vegetable oil	2	2	2	2
FPKC	-	10	20	30
Bone meal	3.0	3.0	3.0	3.0
Limestone	1.5	1.5	1.5	1.5
DL-Methionine	0.2	0.2	0.2	0.2
L-Lysine	0.2	0.2	0.2	0.2
Salt (NaCl)	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Nutrient Analysis				
Crude protein (%)	20.12	20.00	20.07	20.01
Digestible Energy (Kcal/kg)	2753.16	2706	2635.14	2591.66
Ether extract	6.24	5.80	6.10	6.04
Crude fibre	5.66	6.78	7.20	7.48

**Vitamin/Mineral Premix (Animal Care®) Vitamin A12000000IU, Vitamin D3 3000000IU, Vitamin E 30000mg, Vitamin K3 25000mg, Folic Acid 1000mg, Niacin 40000mg, Vitamin B2 5000mg, Vitamin B12 20mg, Vitamin B1 2000mg, Vitamin B6 3500mg, Biotin 80mg, Antioxidant 125000mg, Cobalt 250mg, Selenium 250mg, Iodine 1200mg, Iron 40000mg, Manganese 70000mg, Copper 8000mg, Zinc 60000mg Choline chloride 200000mg .*

G. Statistical Analysis

The data was subjected to one way analysis of variance (ANOVA) in a completely randomized design arrangement using the statistical package for social scientist [14]. Significant means was separated using Duncan's Multiple Range Test.

The statistical model below was used in the experiment:-

$yij = \mu + \tau i + \varepsilon ij$

where:

yij = observation of i^{th} treatment (FPKC) on experimental unit j^{th}

μ = the overall mean

τi = the fixed effect due to i^{th} treatment (FPKC) on the birds

εij = random error associated with ij^{th} observation

III. RESULTS

The growth performance of broiler chicken fed varying levels of fermented PKC diet is shown in Table 3.

Table 3. Growth performance of broiler chickens fed varying levels of fermented PKC

Parameters	Dietary Treatments				±SEM	*p*-Value
	FPKC (0%)	**FPKC (10%)**	**FPKC (20%)**	**FPKC (30%)**		
Initial body weight (*g*)	30.43	32.74	33.81	33.26	0.72	0.39
Final body weight (*g*)	1968.00^{ab}	2091.50^{a}	2031.50^{ab}	1764.00^{b}	51.43	0.01
Daily weight gain (*g*)	30.73^{b}	33.56^{a}	32.71^{ab}	27.33^{b}	0.93	0.05
Daily feed intake (*g*)	82.87^{a}	84.02^{a}	83.67^{a}	79.52^{b}	0.56	0.03
Feed Conversion Ratio	2.73	2.51	2.57	2.94	0.07	0.16
Protein Efficiency Ratio	12.89^{a}	12.44^{b}	11.42^{c}	9.94^{d}	0.30	0.02

abcd; Means in the same row with different superscripts are significantly ($p<0.05$) different.
SEM: Standard error of Mean, FPKC: Fermented Palm Kernel Cake.

The final body weight of birds fed diet 2 was significantly ($p<0.05$) higher (2091.50g) but similar to those of diet 1 and 3 (1968g and 2031.50g) respectively. The highest value of daily weight gain (33.56g) recorded among birds fed diet 2 was significantly ($p<0.05$) different from diet 3 and 4 (32.71g and 27.33g). The daily feed intake in the birds fed diet 1, 2, and 3 were significantly ($P<0.05$) similar and higher than those fed diet 4. There was no significant ($p>0.05$) difference recorded in the feed conversion ratio, highest value of 2.94 was recorded in diet 4 while the lowest value of 2.51 was obtained in diet 2. The values of protein efficiency ratio obtained for the birds fed diet 1 birds (12.89) were significantly ($p<0.05$) higher compared to those birds on other diets while lowest value of 9.94 was recorded in those birds fed diet 4.

IV. DISCUSSION

The weights recorded in broilers fed diets containing 10% and 20% of FPKC may be attributed to the nutritional contents of the fermented PKC, which resulted to an increased in the digestibility of the diets thereby increasing body weight gain according to [15]. This finding corroborate with [16] which reported that broiler fed diet containing 5 - 20% FPKC had significantly higher body weight than those fed diets without FPKC. This result agreed with report of [17] who observed that the high content of FPKC, improved daily gain and growth rate of broiler chickens. The increased in feed intake recorded in diet 2 and 3 may be attributed to the palatability of FPKC which resulted from the increase in the aroma of FPKC. [8] reported that fermented product has better nutritional quality than the original material because it can increase the aroma thereby increase feed palatability, digestibility and composition of feed matter. The feed conversion is influenced by the feed intake and body weight gain [18]. The low percentage of feed conversion is an indication that the birds efficient utilized the lower quantity of feed to gain more weight [19]. The result of these findings agreed with [20] which reported that the addition of 10% or 20% PKC in broiler diets had negative effects on feed conversion ratio (FCR) as well as daily feed intake.

V. CONCLUSION AND RECOMMENDATION

Fermented palm kernel cake in broiler diet enhances the growth performance of broiler chickens without exerting any deleterious effect on the birds. 10% of FPKC can be used to replace other conventional feedstuffs in broiler feed for optimal broiler feed efficiency.

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