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Research Article

Effect of Palm Kernel Cake Fortified with Natural Carotenoids on Productivity of Meat Chickens

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Abstract

An experiment was conducted to determine the effect of palm kernel cake (PKC) fortified with *Calopogonium mucunoides* (CM) on growth performance of broiler chickens. A total of 180 Anak day old chicks were used. There were six dietary treatments (T). Each treatment had 30 birds replicated three times with 10 birds per replicate. The experiment was arranged in completely randomized design (CRD). Diet 1 (T1) which contained unfortified PKC was the control, while T2, T3, T4, T5 and T6 contained PKC fortified with 10, 20, 30, 40 and 50% CM respectively. Feed and water were given *ad libitum* for 7 weeks starting from the first week. Results showed that the crude protein of CM was 24.54%, ether extract 0.31%, ash 6.25% and crude fibre 12.46%. At the starter phase final live weight at all the levels of fortification was better ($P < 0.05$) than the control. Daily gain followed the pattern of final live weight. Fortification at 40 and 50% reduced daily feed intake ($P < 0.05$). Both feed: gain ratio and protein efficiency ratio were improved above 10% but was best at 40 and 50%. At finisher phase, fortification at all levels improved final live weight ($P < 0.05$). Total feed intake was increased by 30, 40 and 50% of fortification. There were no differences ($P > 0.05$) in daily feed intake, daily gain, feed: gain ratio, daily protein intake and protein efficiency ratio. In conclusion PKC could be fortified with CM up to 50% and used successfully in broiler diets.

Keywords: *Palm Kernel Cake; Natural Carotenoids; Meat Chickens*

Introduction

Poultry production remains the most wide spread of all livestock enterprises. It constitutes an important pillar of food security improvement as well as socio-cultural and economic development in most countries [1]. Broiler production is a good source of protein and it has quick returns on investment. However, the industry in the developing countries is facing some challenges. These challenges include high feed to gain ratio and increase in the cost of feed because of high prices of feed ingredients [2]. Poultry rations are formulated to contain an optimum nutrients concentrations obtainable at a reasonable cost for desirable productivity. These nutrients concentrations can easily be achieved by use of different feed ingredients. The major feed ingredients are maize, soya bean meal and fish meal. In achieving this, feed produced should not be expensive, and at the same time should have good quality. Balancing feed cost and feed quality usually is achieved by inclusion of agro-industrial by-products such as palm kernel cake (PKC). The use of palm kernel meal in broiler diets has been practiced for several decades [3]. Due to its low level of key essential amino acids (lysine and methionine in particular), high dietary fibre, non-starch polysaccharides (particularly in the form of β-mannan) and its grittiness it has been a challenge for its inclusion in poultry diets [4]. Certain practices have been proffered to mitigate these challenges by Ndelekwute., *et al* [5]. These include use of enzymes such as cellulase and β-mannanase; inclusion of edible oil like palm oil to reduce its grittiness and dustiness of the feed. However, another shortcoming of palm kernel cake is that apart from protein and fatty acids, it does not contain any other known beneficial bioactive compound as found in some other feedstuffs. For instance, yellow maize contains carotenoids (cryptoxanthin and xanthophyll), soya bean meal contains isoflavone, phytosterols, glycinin and β- conglycinin, and fish meal contains docosahexaenoic acid

(DHA) and eicosapentaenoic acid (EPA) [6-9]. With these nutritional challenges efforts should be geared toward improving the quality of palm kernel cake. Hence palm kernel cake could be industrially fortified with a natural bioactive substance.

The natural and abundant bioactive compounds that most qualified can be obtained naturally from forages especially legumes like *Calopogonium spp.* The nutritional value of forage in poultry diet has received new emphasis [10]. It has been recognized for centuries that green feeds were paramount in poultry diet if birds were to be kept in good health. *Calopogonium spp* contains carotenoids, flavonoids and crude protein.

Carotenoid is a group of pigments naturally present in vegetal raw materials that have biological properties which have been used mainly in food, pharmaceutical, and cosmetic industries [11]. They are major group of vitamin A and are naturally occurring organic pigments found in the chloroplasts of plants [12]. According to Mezzomo and Ferreira [11] carotenoids are largely responsible for giving red, orange, and yellow fruits and vegetables their vibrant colours. They are also found in abundance in leafy, green vegetables. There are six most commonly carotenoids; β-carotene, alpha-carotene, lycopene, β-cryptyzanthin, lutein and zeaxanthin [13].

Carotenoids and vitamin A in general play pivotal roles in the normal functioning of the human body. Their roles include helping the body to regulate cell growth, regulate hormones, and help enzymes to act as catalysts in metabolism. Furthermore, carotenoids are strong antioxidants, which can bind to free radicals in the body. These molecules called free radicals can damage cells and cause chronic diseases and cancer [11-13].

Objective of the Study

The objective of this work was to fortify palm kernel cake with *Calopogonium mucunoides* as a natural source of carotenoids and evaluate its dietary effect on productivity of broiler chickens.

Materials and Methods

Experimental site

The experiment was conducted at the poultry unit of Teaching and Research Farm of the University of Uyo, Nigeria, located on latitude 5° 32’ N and longitude 7° 54’ E with average annual rainfall of 1600 mm. The average relative humidity during the experiment was 68% and average ambient temperature was 30°C.

Processing of fortified palm kernel cake and proximate analysis

Fresh leaves of *Calopogonium mucunoides* were harvested from fallowed land in the University Farm. The leaves were chopped and mixed thoroughly with PKC and ground with grinding machine. After grinding, the mixture was sundried. After drying, the enriched PKC was sieved to separate fibrous matter from the mixture and was bagged for further use as feed ingredient. The proximate analysis of the *Calopogonium mucunoides* was carried out according to AOAC [14].

Experimental design

The experiment was carried out using completely randomized design (CRD). A total of one hundred and eighty birds (180) were used. There were six dietary treatments (T1, T2, T3, T4, T5, T6) each having 30 birds. Each treatment was replicated three times with ten (10) birds per replicate. T1 was the control diet with non-fortified PKC, T2 - T6 were diets which contained PKC fortified with 10, 20, 30, 40 and 50% *C. mucunoides* respectively. The fortified PKC was included in the feed at the same level (10%) for starter and 15% for finisher. The experiment started from day old.

Management of experimental birds

On the arrival day, the day old chicks were weighed and the initial weight recorded. The chicks were given glucose orally via drinking water. There were randomly allotted to different treatments. Kerosene stove was used to supply heat to provide warmth for the first three weeks. On the second day vitamins, minerals and antibiotic were added to their drinking water for a week. Feed and water were offered *ad libitum* throughout the experimental period which lasted for seven weeks (four weeks for starter phase and three weeks for the finisher phase).

Ingredients	T1 Control (0%)	T2 10%	T3 20%	T4 30%	T5 40%	T6 50%
Maize	51.0	51.0	51.0	51.0	51.0	51.0
SBM	30.0	30.0	30.0	30.0	30.0	30.0
PKC (fortified)	-	10	10	10	10	10
PKC (non-fortified)	10	-	-	-	-	-
Crayfish dust	4.0	4.0	4.0	4.0	4.0	4.0
Bone meal	4.0	4.0	4.0	4.0	4.0	4.0
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20	0.20
Premix	0.35	0.35	0.35	0.35	0.35	0.35
Total	100.00	100.00	100.00	100.00	100.00	100.00

Calculated nutrient content (%)

KcalME/kg	2863	2854	2826	2872	2835	2849
Crude protein	22.12	22.21	22.29	22.35	22.37	22.45
Ether extract	3.53	3.41	3.31	3.23	3.17	3.11
Crude fibre	4.84	4.81	4.78	4.76	4.74	4.72
Ash	5.23	5.32	5.39	5.45	5.50	5.55

Table 1: *Ingredient s and nutrients composition of experimental starter diets.*

**Premix supplied per Kg starter diet: vitamin A 15,000 i.u., vitamin D3 13,000 i.u., thiamine 2 mg, riboflavin 6 mg, pyridoxine 4 mg, cobalamin 0.05g, biotin 0.08 mg, choline chloride 0.05g, manganese 0.096g, iron 0.024g, copper 0.006g, iodine 0.014g, selenium 0.24 mg, cobalt 0.024 mg and antioxidant 0.125g.*

Ingredients	T1 Control (0%)	T2 10%	T3 20%	T4 30%	T5 40%	T6 50%
Maize	51.0	51.0	51.0	51.0	51.0	51.0
SBM	28.30	28.30	28.30	28.30	28.30	28.30
PKC (fortified)	-	15.3	15.3	15.3	15.3	15.3
PKC (non-fortified)	15.3	-	-	-	-	-
Crayfish dust	2.0	2.0	2.0	2.0	2.0	2.0
Bone meal	3.0	3.0	3.0	3.0	3.0	3.0
Salt	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10	0.10	0.10
Premix	0.25	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00	100.00

Calculated nutrient content (%)

KcalME/kg	2890	2883	2879	2874	2871	2869
Crude protein	20.31	20.38	20.40	20.42	20.44	20.46
Ether extract	4.05	4.06	4.01	3.98	3.90	3.82
Crude fibre	4.22	4.20	4.18	4.31	4.01	4.05
Ash	5.76	5.70	5.66	5.90	6.40	6.35

Table 2: *Ingredient and nutrient composition of experimental finisher diets.*

**Premix supplied per Kg finisher diet: vitamin A 10,000 i.u., vitamin D3 12,000 i.u., vitamin E 20 i.u., vitamin K 2.5 mg, thiamine 2.0 mg, riboflavin 3.0 mg, pyridoxine 4.0 mg, niacin 20 mg, cobalamin 0.05 mg, pantothenic acid 5.0 mg, folic acid 0.5 mg, biotin 0.08 mg, choline chloride 0.2 mg, manganese 0.006g, zinc 0.03g, copper 0.006g, iodine 0.0014g, selenium 0.24g, cobalt 0.25g and antioxidant 0.125g.*

Data collection and analysis

Live weight was measured weekly and feed intake daily using a 20 kg capacity Camry weighing scale. The live weight and feed intake were used to calculate the feed: gain ratio. Daily protein intake was calculated by multiplying the daily feed intake by the percentage protein content of the feed. Protein efficiency ratio was obtained by dividing the daily weight gain by daily protein intake.

Statistical analysis

Data collected were subjected to Analysis of Variance (ANOVA). Where significant effects were detected from analysis of variance, treatment means were compared using Duncan's Multiple Range test [15].

Results and Discussion

Chemical Composition of *Calopogonium mucunoides*

The values of the chemical composition for *Calopogonium mucunoides* leaf is shown in table 3. The *C. mucunoides* CP value of 24.54% obtained in this study agreed with a CP range of 22.6 - 27.6% [16]. Asongwed-Awa [16] and Aderinola., *et al.* [17] reported CF values of 21.7%, 24.19% and 21.73% respectively for *C. mucunoides.* These CF values differ from the CF value of 12.46% reported in this study for the same plant.

Parameters	%
Crude protein	24.54
Ether extract	0.31
Ash	6.25
Crude fibre	12.46

Table 3: *Proximate Composition of Fresh Leaves of Calopogonium mucunoides*

This is because the CF value in this study was obtained from fresh leaves of *C. mucunoides* and not dry as in Aderinola., *et al* [17]. The Ash and Ether extract content of the *C. mucunoides* of the study is lower than that reported by Ahamefule., *et al.* [18] which were 10.64% and 4.50% respectively.

Effect on growth performance of starter broilers

The effect of PKC fortified with *Calopogonium mucunoides* as a source of natural carotenoids and flavonoids on starter broiler chicks is shown in table 4. There were no significant differences ($P > 0.05$) in initial live weight, total feed intake and daily protein intake. Significant differences ($P < 0.05$) were observed in final live weight, daily feed intake, feed; gain ratio and protein efficiency ratio. Fortified PKC improved the final live weight at all levels of fortification.

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
Initial live weight (g)	42.80	41.80	41.60	42.02	41.95	41.85	3.05
Final live weight (g)	762^b	845^a	847^a	851^a	821^a	821^a	55.85
Daily live weight gain (g)	25.68^b	28.68^a	28.75^a	28.89^a	27.86^a	27.82^a	2.08
Total feed intake (g)	1644	1720	1730	1720	1570	1563	121
Daily feed intake (g)	58.71^a	61.43^a	61.79^a	61.43^a	56.08^b	55.82^b	5.01
Feed; gain ratio	2.29^a	2.14^b	2.21^b	2.13^b	2.01^c	2.01^c	0.08
Daily protein intake (g)	12.92	13.56	13.64	13.70	12.75	12.75	1.33
Protein efficiency ratio	1.99^c	1.99^c	2.11^b	2.11^b	2.19^a	2.18^a	0.09

Table 4: *Effect of natural carotenoids and flavonoids fortified palm kernel cake on starter broiler chickens.*

^{abc}: Means along the same row with different superscripts are significantly different.

There was no significant difference (P > 0.05) among the groups that consumed fortified PKC. Inclusion of fortified PKC reduced daily feed intake above 30% of fortification. Fortification led to improvement of the feed; gain ratio which was observed to improve better at 40% and 50% levels of fortification. Above 30% protein was effectively utilized better compared to control and 10% fortification. It was further observed that protein utilization was similar at 20 and 30% fortification. The result of starter phase showed the efficacy of natural carotenoids and flavonoids to improve growth of broilers. Carotenoids and flavonoids are known to be antioxidant, antifungal and antibacterial [19]. Feed ingredients known to exhibit these properties have been reported to promote growth [20]. In addition, flavonoids were reported to have oestrogenic effect because of their content of isoflavone which is a growth factor [19].

Effect on growth performance of finisher broilers

Table 5 is indicating the effect of fortified PKC on finisher broiler chickens. There were no significant differences (P > 0.05) in daily weight gain, daily feed intake, feed; gain ratio, daily protein intake and protein efficiency ratio. Only final live weight and total feed intake showed significant differences (P < 0.05). As observed in starter phase, all the levels of fortification improved final live weight. Fortification of 40 and 50% resulted to increase in total feed intake.

Parameters	T1 (0%)	T2 (10%)	T3 (20%)	T4 (30%)	T5 (40%)	T6 (50%)	SEM
Initial live weight (g)	762^b	845^a	847^a	851^a	821^a	821^a	55.85
Final live weight (g)	1934^b	2023^a	2020^a	2072^a	2093^a	2113^a	125
Daily live weight gain (g)	55.81	56.10	55.86	58.14	60.52	61.52	6.34
Total feed intake (g)	2800^b	2815^b	2850^b	3075^a	3125^a	3158^a	205
Daily feed intake (g)	133	134	136	146	149	150	45
Feed; gain ratio	2.38	2.39	2.43	2.51	2.46	2.44	0.21
Daily protein intake (g)	26.91	27.11	27.51	29.56	30.14	30.35	4.32
Protein efficiency ratio	2.07	2.07	2.03	1.97	2.01	2.03	0.16

Table 5: *Effect of natural carotenoids and flavonoids fortified palm kernel cake of finisher broiler chickens.*

^{abc}: *Means along the same row with different superscripts are significantly (< 0.05) different.*

The result of finisher phase is an indication that fortification of PKC with *Calopogonium mucunoides* as a source of carotenoids and flavonoids was not detrimental to the chickens. The performance of the chicken could be ascribed to these bioactive compounds. Norton [21] has stressed the importance of feeding green forages to monogastric animals because they contain important nutrients such as vitamins and proteins. This result was in consonant with the result of Iheukwumere., *et al.* [22] that green forages improved growth of broilers.

Conclusion

The purpose of the experiment was to investigate the effect of palm kernel cake fortified with various levels (10%, 20%, 30%, 40% and 50%) of *Calopogonium mucunoides* as a natural source of carotenoids and flavonoids on the growth performance of broiler chickens. Incorporation of palm kernel cake fortified with *Calopogonium mucunoides* improved growth at all the levels of fortification. Therefore, it is concluded that up to 50% of *C. mucunoides* could be used to fortify PKC for broiler diets. Additional investigations using levels of *C. mucunoides* above 50% to fortify palm kernel cake should be carried out to determine the optimum level.

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