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Growth performance, nutrients digestibility and economy of feed conversion of broiler chickens fed diets containing cowpea milling waste and plantain peel meal mixture

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Abstract

A total of 144, one-day-old Arbor Acre chicks were used to investigate the effect of feeding diets containing cowpea milling waste and plantain peel meal mixture (CMWPPM) on the growth performance, nutrients digestibility and economy of feed conversion of broiler chickens. The birds were randomly allotted to four dietary treatments in a completely randomized design model, and consisted of 0, 10, 20 and 30 % dietary inclusion levels of CMWPPM. Each treatment was replicated three times with 12 chicks per replicate, making a total of 36 chicks per treatment. The experiment lasted for seven weeks. Nutrients digestibility studies were carried out at the 3rd and 7th week of the experiment using specially-designed metabolism cages. Results showed that at the starter phase, birds on CMWPPM 0 % had significantly (P<0.05) higher feed intake, while birds on CMMPPM 20 % had significantly (P<0.05) lower feed intake than birds on the other treatments. The cost of feed and total cost of feed intake were significantly (P<0.05) higher for CMWPPM 30 % and significantly lower for CMWPPM 20 % than for the other treatments; while feed cost per kg weight gain had no significant difference across the treatments. At the finisher phase, there were no significant differences in all the growth performance parameters measured across the treatment groups. However, total cost of feed intake was significantly (P<0.05) higher for CMWPPM 10 % and significantly (P<0.05) lower for CMWPPM 20 %. The feed cost per kg weight gain was significantly (P<0.05) higher for CMWPPM 10 % and significantly (P<0.05) lower for CMWPPM 20 % and 30 % diets. Results of nutrients digestibility at the starter phase show that though dry matter, crude protein, crude fibre and nitrogen free extract digestibility were significantly (P<0.05) different across the treatments, there were no significant (P>0.05) difference in the overall total digestible nutrient across the diets. For the finisher phase, as the level of CMWPPM increased in the diets, the CP, CF, ash, lipid, NFE and TDN decreased across the treatments Therefore, it is concluded that the inclusion level of CMWPPM in the diet of broiler chickens should not exceed 20 % for optimum economy of feed conversion at the finisher phase; whereas birds can be fed diets containing 30 % dietary inclusion level of CMWPPM with good economy of feed conversion at the starter phase.

Keywords: *Cowpea milling waste, plantain peel meal, growth performance, broiler chickens*.

La Performance de croissance, digestibilité des nutriments et économie de la conversion alimentaire des poulets de chair nourris avec des aliments contenant des déchets de 'cowpea' et un mélange de repas defarine d'écorce de 'plantain'

Résumé

Un total de 144 poussins de 'Arbor Acre' âgés d'un jour a été utilisés pour étudier l'effet des régimes alimentaires contenant des déchets de 'cowpea' et du mélange de repas defarine *d'écorce de 'plantain'. (Le 'CMWPPM') sur les performances de croissance, la digestibilité des nutriments et l'économie de la conversion alimentaire des poulets de chair. Les oiseaux ont été attribués au hasard à quatre traitements diététiques dans un modèle de conception complètement aléatoire, et consistaient en des niveaux d'inclusion alimentaire de 0, 10, 20 et 30% de 'CMWPPM'. Chaque traitement a été répété trois fois avec 12 poussins par répétition, soit un total de 36 poussins par traitement. L'expérience a duré sept semaines. Des études de digestibilité des nutriments ont été réalisées à la 3ème et 7ème semaine de l'expérience en utilisant des cages de métabolisme spécialement conçues. Les résultats ont montré qu'à la phase de démarrage, les oiseaux sous 'CMWPPM' 0% avaient une ingestion alimentaire significativement (P <0,05) plus élevée, tandis que les oiseaux sous 'CMMPPM' 20% avaient une ingestion alimentaire significativement (P <0,05) inférieure à celle des oiseaux sur les autres traitements. Le coût de l'alimentation et le coût total de la prise alimentaire étaient significativement (P <0,05) plus élevés pour CMWPPM 30% et significativement plus faibles pour CMWPPM 20% que pour les autres traitements ; tandis que le coût de l'alimentation par kg de gain de poids n'avait pas de différence significative entre les traitements. Lors de la phase de finition, il n'y avait pas de différences significatives dans tous les paramètres de performance de croissance mesurés dans les groupes de traitement. Cependant, le coût total de l'ingestion alimentaire était significativement (P <0,05) plus élevé pour CMWPPM 10% et significativement (P <0,05) inférieur pour CMWPPM 20%. Le coût de l'alimentation par kg de gain de poids était significativement (P <0,05) plus élevé pour le CMWPPM 10% et significativement (P <0,05) inférieur pour les régimes CMWPPM 20% et 30%. Les résultats de la digestibilité des nutriments à la phase de démarrage montrent que bien que la digestibilité de la matière sèche, des protéines brutes, des fibres brutes et de l'extrait sans azote soient significativement différentes (P <0,05) d'un traitement à l'autre, il n'y avait pas de différence significative (P> 0,05) dans le total de nutriments digestibles à travers les régimes. Pour la phase de finition, au fur et à mesure que le niveau de 'CMWPPM' augmentait dans les régimes alimentaires, le 'CP', les 'FC', les cendres, les lipides, l'NFE et le TDN diminuaient au fil des traitements. Par conséquent, il est conclu que le niveau d'inclusion de 'CMWPPM' dans l'alimentation des poulets de chair dépasse 20% pour une économie optimale de la conversion des aliments lors de la phase de finition ; tandis que les oiseaux peuvent être nourris avec des aliments contenant 30% de taux d'inclusion alimentaire de 'CMWPPM' avec une bonne économie de conversion alimentaire lors de la phase de démarrage.*

Mots clés : déchets de 'cowpea', farine d'écorce de plantain, performances de croissance, poulets de chair.

Introduction

The poultry industry has not been a very lucrative enterprise because of high cost of conventional feedstuffs, which most times are competed for by both human beings and the livestock industry (Ironkwe and Oruwari, 2012). Nigeria, like many other developing countries of the world, is currently faced with shortage and high cost of conventional feedstuffs for poultry production (Duwa *et al*., 2014). This high cost and low availability of conventional poultry feedstuffs frequently demand consideration of by-products, even if efficiency of utilization is low, for poultry feeding (Negesse *et al*., 2009). It is important to utilize inexpensive materials not only to sustain the market of animal products but also to search for new sources of animal feed by recycling underutilized wastes (Ulloa *et al*., 2004). It is therefore necessary now for animal nutritionists to look for non-conventional feedstuffs that are readily available and cheaper in order to cut down on the feed cost, which constitute about 65-70 % of the total cost of production. Reports have shown that there are large numbers of feedstuffs with enormous potentials in Nigeria, and among which are plantain peel meal and cowpea milling waste.

Plantain (*Musa paradisiaca*) peels are mostly regarded as wastes which constitute environmental pollution especially in urban areas where goats and sheep are not allowed to roam about (Ajasin *et al*., 2004; Ighodaro, 2012). Plantain peel is reported to have some nutritional values. It is a source of energy which compares favourably with maize, except for its crude fibre and ether extract content. Plantain peel is a good source of energy containing 12 % crude protein, 6 % crude fibre and 2700 Kcal/kg metabolizable energy on dry matter basis (Omole *et al*., 2008). It also contains higher levels of minerals such as calcium, iron and phosphorous (Nsa *et al*., 2010). Cowpea milling waste is a by-product obtained from cowpea (*Vigna unguiculata*). It contains 24 % crude protein and its nutrients can easily be utilized by livestock (Maidala and Bello, 2016). Research have shown that cowpea milling waste meal can be fed to cockerel chicks up to 40 % inclusion level with no adverse effect on their growth performance (Raheem, 2016); while plantain peel meal can replace maize in broiler diets up to 75 % (Agubosi *et al*., 2019) or constitute as much as 50 % of a broiler diet (Nsa *et al.,* 2010).

Although, cowpea milling waste and plantain peel meal have been used individually for feeding livestock, however, there are no reports on the use of cowpea milling waste and plantain peel mixture for feeding broiler chickens in Nigeria. Hence, this research study was designed to evaluate the growth performance, nutrients digestibility and economy of feed conversion of broiler chickens fed diets containing cowpea milling waste and plantain peel meal mixture.

Materials and methods

Study location

This research study was carried out at the Poultry Unit of the Department of Animal Production Teaching and Research Farm, Federal University of Technology, Minna, Niger State. This lies within the Guinea Savannah zone of Nigeria (latitude 9˚37' North and longitude 6˚33' East).

Test ingredient and preparation of the experimental diets

Cowpea milling waste and plantain peel meal mixture (50 %: 50 % ratio) were obtained as a composite ready-to-use industrial by-product from Kitchen Friendly, an agro–industrial company located in Gurara area of Minna. It was obtained as a by-product of cowpea and plantain processing, and used to compound four treatment diets as follows: T_1 (without cowpea milling waste and plantain peel meal), T_2 (with 10 % cowpea milling waste and plantain peel meal), T_3 (with 20 % cowpea milling waste and plantain peel meal) and T_4 (with 30 % cowpea milling waste and plantain peel meal) for the starter and finisher phases respectively (Tables 1).

Experimental design and management of the experimental birds

A total of one hundred and forty-four (144) day-old Arbor Acre broiler chicks were purchased from Damas Farm, Ibadan, Oyo State, Nigeria. Before the arrivals of the birds, the walls and floors of the pens were sanitized using Germicide (Izal®) solution, after thoroughly washing with detergent and water. The pens were then allowed to dry completely and litter materials made of wood shavings were spread on the floor of the pen. Newspapers were spread on the floor for the first one week of the experiment. Germ free feeders and drinkers were also made available with proper label of treatment and replicates for easy identification. Local pots and charcoal were made available during the brooding process to produce warmth for the chicks. The day old chicks upon arrival were made to acclimatize for one week after which the experimental diets were introduced to them. The birds were randomly allotted to four treatments in a completely randomized design (CRD) lay-out. Each of the treatment had three replicates made up of 12 birds per replicate. The experiment was carried out under an intensive management system with feed and water supplied *ad-libitum*. After one week adjustment period, the starter phase was from day 8 to day 28 (21 days) while the finisher phase was from day 29 to day 56 (28 days). Vaccines were administered to the birds based on the recommendations of the Nigerian Institute of Animal Science (NIAS) for the region.

Data collection

Data were collected on feed intake, weekly weight gain and feed conversion ratio. Economy of feed conversion was determined based on the following parameters: feed cost per kg (–), total cost of feed intake per bird (–), and feed cost per kg body weight gain (–/kg). At the beginning of the 3^{rd} and 7^{th} week of the experiment, two birds per replicate were randomly selected and moved to specially constructed metabolism cages for nutrient digestibility studies, using the total collection method. After three days adjustment period, faecal samples were collected for four days. Upon collection in specially-prepared aluminum foils, they were immediately treated with boric acid granules to prevent degradation, and then oven-dried at 80^{0}C for 24 hours and stored until needed for proximate analysis. Dry matter, crude protein, crude fibre, ether extract, nitrogen free extract and ash content of the experimental diets and collected faecal samples were determined using the procedures of AOAC (2000), and hence the coefficients of digestibility were calculated.

Statistical analysis

Data collected were subjected to one-way analysis of variance using SPSS (version 16.0; 2007). Where means were significant ($P<0.05$), they were separated using the Duncan Multiple Range Test.

Results and discussion

The proximate composition of cowpea milling waste and plantain peel meal mixture (CMWPPM) is presented in Table 2. Dry matter, crude protein, ether extract, ash, crude fibre, and nitrogen free extract contents were 83.40, 19.25, 9.50, 6.00, 9.00, and 39.65 % respectively. These results show that cowpea milling waste and plantain peel meal mixture has high crude protein and low crude fibre content, hence, the mixture can serve as a non-conventional protein feedstuff for broiler chicken.

At the starter phase, birds on CMWPPM 0 % had significantly ($P<0.05$) higher feed intake, while birds on CMMPPM 20 % had significantly ($P<0.05$) lower feed intake than birds on the other treatments (Table 3). This result contradicts the findings of Abdon *et al.* (2013) who reported that different dietary levels of cowpea seed had no significant ($P>0.05$) effect on feed intake in broiler chicken. The observed difference in feed intake in this study might be due to plantain peel meal inclusion in the diets which increased the crude fibre content of the diet and hence affected feed palatability and acceptability, and hence reduced feed intake. The high mortality recorded in Treatment 1 and 2 at the starter phase was due to rodent attack at the early phase which was competently tackled. There were no significant differences in all the growth

Table 1: **Ingredient composition of the experimental diets at both the starter and finisher phases**

	Starter Phase				Finisher Phase			
Ingredient	**CMWPPM 0 %**	**CMWPPM 10 %**	**CMWPPM 20 %**	**CMWPPM 30 %**	**CMWPPM 0 %**	**CMWPPM 10 %**	**CMWPPM 20 %**	**CMWPPM 30 %**
Maize	50.00	45.00	37.00	32.00	62.00	55.00	48.50	41.50
Maize offal	5.00	3.00	4.00	2.00	20.25	17.25	13.75	10.75
CMWPPM	0.00	10.00	20.00	30.00	0.00	10.00	20.00	30.00
Soybean cake (45 %.CP)	26.00	23.00	20.00	17.00	10.00	10.00	10.00	10.00
Full fat soya	10.00	10.00	10.00	10.00	3.00	3.00	3.00	3.00
Fishmeal (66 %.CP)	3.00	3.00	3.00	3.00	1.00	1.00	1.00	1.00
Limestone	1.00	1.00	1.00	1.00	2.50	2.50	2.50	2.50
Bone meal	3.50	3.50	3.50	3.50	0.25	0.25	0.25	0.25
Lysine	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.25
Methionine	0.50	0.50	0.50	0.50	0.25	0.25	0.25	0.25
*Vitamins and minerals								
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
TOTAL	100	100	100	100	100	100	100	100
CALCULATED ANALYSIS								
Crude protein (%)	23.17	23.01	23.10	23.02	19.84	19.94	19.87	20.01
ME (Kcal /kg)	2896	2883	2852	2839	2975	2962	2951	2930
Crude fibre (%)	4.45	4.75	5.35	5.64	3.80	3.78	3.72	3.68
Ether extract (%)	5.88	6.35	6.84	7.31	5.31	5.44	5.60	5.76
Calcium (%)	1.86	1.85	1.85	1.84	1.48	1.40	1.83	1.33
Available phosphorus (%)	0.78	0.79	0.78	0.78	0.74	0.78	0.77	0.78
Lysine (%)	1.20	1.21	1.40	1.46	1.25	1.28	1.30	1.33
Methionine (%)	1.15	1.15	1.10	1.07	0.60	0.60	0.61	0.62

*0.25kg of the premix contained: Vitamin A 1,000,00 IU, Vitamin D_3 200,000 IU, Vitamin E 2300 mg, Vitamin K_3 200.00 mg, Vitamin B_1 180 mg, Vitamin B_2 550 mg, Niacin 2,750 mg, Pantothenic acid 750 mg, Vitamin B_6, Vitamin B_{12} 1.5 mg, Folic acid 75 mg, Biotin 6mg, Choline chloride 30,000 mg, Cobalt 20 mg, Copper 300 mg, Iodine 100 mg, Iron 2000 mg, Manganese 4,000 mg, Selenium 20 mg, Zinc 3000 mg, Antioxidant 125 mg..

CMWPPM = Cowpea milling waste and plantain peel meal mixture, ME = Metabolizable energy

Table 2: Proximate composition and energy value of cowpea milling waste and plantain peel meal mixture

Parameters (%)	Percentage composition (%)
Dry matter	83.40
Crude protein	19.25
Crude fibre	9.00
Ash	6.00
Ether extract	9.50
Nitrogen free extract	39.65
Metabolizable energy (kcal/kg)	2879

performance parameters of the birds fed different dietary levels of CMWPPM at the finisher phase. This differs from the findings of Akanji *et al.* (2015) who reported that cowpea based diets had effect on broiler performance because feed consumed and growth response were extremely ($P<0.05$) declined in chicks fed unprocessed cowpea and dehulled cowpea diets, respectively.

The results of the economy of feed conversion at the starter phase showed that as the level of cowpea milling waste and plantain peel meal mixture increased, cost of feed per kg decreased (which was not the case at the finisher phase). This is similar to the findings of Adama *et al.* (2007) when they fed sorghum dried brewers' grain to broiler chicken and reported that feed cost was significantly ($P<0.05$) lower when fed at 40 % dietary inclusion level. At the finisher phase, feed cost per kg weight gain was significantly ($P<0.05$) higher for CMWPPM 10 % and significantly ($P<0.05$) lower for CMWPPM 20 % and 30 % diets; whereas, there were no significant differences in feed cost per kg weight gain among the birds fed the different dietary treatments at the starter phase.

The result of the nutrient digestibility at the starter phase is presented in Table 4. The results showed that dry matter, crude protein, crude fibre and nitrogen free extract digestibilities were significantly ($p<0.05$) different across the treatments. The DM, CF, CP and NFE were significantly higher for CMWPPM 0 % than for the other treatments and least in CMWPPM 30 %. Ash, lipid and total digestible nutrient (TDN) were not significantly ($P>0.05$) different across the treatments. For the finisher phase (Table 5), results show that all parameters measured were significantly ($P<0.05$) different except for dry matter digestibility. As the level of CMWPPM increased in the diets, the CP, CF, ash, lipid, NFE and TDN decreased across the treatments. TDN values for the test diets were significantly ($P<0.05$) lower than that of the control diet except for the diet containing 10 % CMWPPM. This result is in agreement with the result of Abel *et al.* (2014) who fed broiler chicken with treated banana peel meal. The significantly better performance obtained from the control may be attributed to the increasing level of banana peel in the diet which increased its fibre content (Atapattu and Senevirathne, 2012).

Table 3: Growth performance and economy of feed conversion of broiler chickens fed diets containing cowpea milling waste and plantain peel meal mixture

Parameter	Starter Phase (21 days)						Finisher Phase (28 days)					
	CMWPP M 0 %	CMWPP M 10 %	CMWPP M 20 %	CMWPP M 30 %	SEM	P-VALUE	CMWPP M 0 %	CMWPP M 10 %	CMWPP M 20 %	CMWPP M 30 %	SEM	P-VALUE
GROWTH PERFORMANCE												
INI WT(g)	64.93	65.30	64.96	64.69	0.50	0.94	459.70	440.73	430.56	463.33	22.40	0.80
FIN WT(g)	459.70	440.73	430.56	463.33	17.40	0.80	1013.3	966.80	975.00	975.26	22.58	0.92
TFI(g)	1023.70[a]	838.40[b]	750.56[c]	834.63[b]	43.05	0.13	1524.03	1545.43	1205.76	1218.76	69.45	0.13
AFI(g)	48.75[a]	39.92[b]	35.74[c]	39.74[b]	1.53	0.13	54.42	55.18	43.06	43.52	2.48	0.13
TBWG(g)	394.76	375.43	365.60	398.66	17.30	0.84	553.63	526.06	544.43	511.93	28.77	0.89
ABWG(g)	18.80	17.88	17.40	18.98	1.30	0.24	19.77	18.78	19.44	18.28	1.67	0.89
FCR	2.60	2.25	2.05	2.09	0.15	0.22	2.82	2.94	2.24	2.38	0.14	0.30
MOR %	8.33[b]	19.00[a]	0.00[c]	0.00[c]	3.01	0.05	13.90[a]	19.64[a]	0.00[b]	0.00[b]	3.07	0.02
ECONOMY OF FEED CONVERSION												
	181.45[a]	151.45[ab]	121.17[c]	155.94[ab]	8.44	0.06	254.58	262.79	208.05	213.95	11.30	0.18
TCOF intake												
(−)	192.49[a]	127.23[b]	91.26[c]	130.20[b]	16.00	0.15	330.48[ab]	409.24[a]	251.06[c]	260.76[c]	24.05	0.037
COF/kgWG										510.80[c]	46.44	0.057
(−)	493.55	343.81	248.80	334.14	42.60	0.25	616.04[ab]	775.36[a]	468.62[c]			

[abc]Means in the same row with different superscripts were significantly ($p<0.05$) different.

CMWPPM = Cowpea milling waste and plantain peel meal mixture

SEM = Standard error of mean P-value = Probability value

INI WT = Initial body weight FIN WT = Final body weight TFI = Total feed intake

AFI = Average feed intake TBWG = Total body weight gain ABWG = Average body weight gain

FCR = Feed conversion ratio MOR % = Percentage mortality COF = Cost of feed

TCOF = Total cost of feed intake COF/kgWG = Cost of feed per kg weight gain

Table 4 : Effects of cowpea milling waste and plantain peel meal on the nutrient digestibility of broiler chickens at the starter phase

Parameters (%)	CMWPPM 0 %	CMWPPM 10 %	CMWPPM 20 %	CMWPPM 30 %	SEM	p-value
Dry matter	81.26[a]	79.45[ab]	80.55[ab]	70.66[b]	1.80	0.011
Crude protein	68.46[a]	50.33[ab]	62.53[ab]	45.68[b]	3.77	0.091
Crude fibre	69.03[a]	50.62[ab]	59.39[ab]	46.97[b]	3.52	0.092
Ash	75.38	70.75	66.14	74.67	1.93	0.332
Ether extract	89.14	84.81	90.01	81.02	1.55	0.126
NFE	87.81[a]	90.80[a]	87.27[a]	80.97[b]	1.33	0.029
TDN	73.74	72.34	74.13	65.83	1.48	0.150

Table 5: Effects of cowpea milling waste and plantain peel meal on the nutrient digestibility of broiler chickens at the finisher phase

Parameters (%)	CMWPPM 0 %	CMWPPM 10 %	CMWPPM 20 %	CMWPPM 30 %	SEM	p-value
Dry matter	89.26	80.43	81.55	71.94	2.9	0.221
Crude protein	77.08[a]	62.72[ab]	42.02[b]	41.47[b]	5.45	0.021
Crude fibre	76.81[a]	62.64[a]	61.82[a]	40.17[b]	4.84	0.026
Ash	81.68[a]	48.86[b]	34.21[b]	23.38[b]	6.4	0.045
Ether extract	94.83[a]	85.08[b]	77.38[b]	77.00[b]	2.5	0.007
NFE	94.20[a]	89.14[ab]	86.60[b]	84.67[b]	1.42	0.063
TDN	84.66[a]	75.60[ab]	67.48[b]	67.42[b]	2.5	0.011

CMWPPM = Cowpea milling waste and plantain peel meal mixture
NFE = Nitrogen free extract TDN = Total digestible nutrient.
SEM: Standard error of mean. P-value = Probability value.

Conclusion and recommendations

From the results of this research study, it is concluded that the inclusion of CMWPPM in the diets of broiler chickens should not exceed 20 % for optimum economy of feed conversion at the finisher phase; whereas birds can be fed diets containing 30 % dietary inclusion level of CMWPPM with good economy of feed conversion at the starter phase.

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