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Carcass, internal organs, duodenal digesta bacteria and economics of broilers fed dryAfrican porridge (*Tetraptera tetrapluera*) pod meal

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Abstract

A study was conducted to ascertain the potential of African Porridge pod meal as natural feed additive to improve broiler performance. Its effect on carcass, internal organs, duodenal bacteria and economic benefits were examined. One hundred and twenty (120) 1-day old mixed sex Ross chicks were randomly allotted to 4 dietary treatments (T1 – T4) containing 0.0, 0.25, 0.5 and 0.75%dry African porridge pod meal respectively. Each treatment was replicated three times with 10 birds per replicate in a complete randomized design (CRD). Feed and water were given ad libitum for 8 weeks. Dressed percentage was significantly reduced (P<0.05) by African porridge pod meal which posted 68.96 - 71.93% as against 76.96% by the control. The cut-parts were not improved significantly. Abdominal fat deposition, bile secretion were increased and pancreas enlarged (P<0.05)by 0.50 and 0.75% levels of African porridge pod meal. Feeding of African porridge pod meal did not alter the nutritional value and pH of the meat. The spice showed antibacterial activity against salmonella and E. coli in the duodenum. The economic benefit was not improved, but the same as the control. In conclusion, in terms of carcass yield use of African porridge pod meal could not be advocated, but considering its antibacterial effect it could be used at 0.25% to modulate the gut of broilers.

Keywords: African porridge pod meal, broiler, carcass, duodenal bacteria, economic benefit, internal organs

Introduction

In recent years there have been advances in poultry nutrition which have resulted to great improvement in productivity of poultry species especially chickens. The major areas ascribed to this success are the use of enzymes, anti-microbial, anti-mycotoxin and antioxidation products as feed additives for broiler chickens. In broiler nutrition, recently attention has been shifted from not only feed quality but to what happens in the gastro intestinal tract. Positive interaction and relationship has been established between feed and the gastro intestinal tract when it is modulated with natural bioactive substances leading to better growth (Ndelekwute *et al*., 2017a). The use of spices and other phytogenic substances such as lime juice and other citrus products has been favoured in this aspect (Khan *et al*., 2015; Ndelekwute *et al*., 2017b). This is due to the fact that not only do they improve growth but the issue of residue accumulation in meat has not been established (Windisch *et al*., 2008). According to Windisch *et al.* (2008) components of spices such as essential oils are well metabolized by the liver giving no room for residue accumulation. To portray this fact several spices such as black pepper, *Xylopia aethiopica*, ginger, moringa and garlic products have been recommended to be included in feeds for broilers (Platel and Srinivasan, 2004; Khalaji *et al*., 2011; Nkukwana *et al*., 2015).

In broiler production, the major parameter used to measure productivity is the live weight but recently some authors have published otherwise. According to

Ndelekwute *et al*. (2016a) though the poultry farmer may optimize the growth of broilers through application of feed additives, the live weight achieved should be replicated in the carcass yield. They also maintained that any choice of feed additive should be one that would not impact negatively on the gastro intestinal tract (GIT) and other internal organs. These assertions are important because the live weight of broilers include the intestine, other internal organs and the feathers which are not part of the meat. Hence the carcass weight is affected by the non-meat portion of broilers. The weight of the carcass seems to be a better parameter to really measure the productivity of broiler chickens in modern broiler market.

There have been some reports on positive effect of some spices on carcass yield of broilers (Khalaji *et al*., 2011; Nkukwana *et al*., 2015; Ndelekwute *et al.*, 2015). However, there have been conflicting reports on effect of African porridge pod meal on live weight of broilers. According to Nweze *et al.* (2011) African porridge pod meal significantly improved weight gain of broilers. Later Ndelekwute *et al.* (2016b) reported in the contrary. Therefore the objective of this study was to ascertain the effect of African porridge pod meal included in broiler diets on carcass yield, meat quality, internal organs, *duodenal* bacterial load and the economic benefit.

Materials and methods

The research was carried out at the Research and Teaching Poultry Unit of the Department of Animal Science, University of Uyo, Nigeria. Dry pods of African porridge were procured from the market. The pods were sliced into pieces and ground.

Experiment design

The experiment was conducted with one hundred and twenty (120) 1- day old broiler chicks of Ross strain. There were four treatments of 30 birds each and replicated three times in each treatment. Ten birds were assigned to each replicate and arranged on completely randomized design (CRD). Four diets each for starter and finisher phases were formulated which represented the four treatments (T). The control group (T1) did not contain African porridge pod meal. Treatments 2 – 4 contained 0.25, 0.5 and 0.75% of African porridge pod meal respectively (Tables 1 and 2). Heat was supplied to the birds for the first three weeks. The starter and finisher diets and drinking water were provided *ad libitum* for the first four weeks and the last four weeks, respectively. Vaccines were administered and other health management practices were observed according to recommendations of a Veterinary officer

Carcass and internal organ analysis

The carcass analysis was done according to Scott *et al.* (1969). Twenty four (24) birds, two from each replicate of a treatment were used for carcass analysis. The birds were fasted for 18 hours. Slaughtering was observed by severing the jugular vein with a sharp knife. Hot water was used to loosen the feathers by immersing in hot water for 30 seconds at the temperature of 60^{o}C followed by de-feathering. The abdomen was cut open and viscera pulled out. The abdominal fat was removed and the carcass cut into parts. Weights of the cut-parts, abdominal fat and internal organs were determined.

Dressed carcass weight, internal organs and abdominal fat were expressed as percentage live weight while weights of different carcass parts were expressed as percentage of dressed carcass weight according to Abaza *et al*. (2008).

Determination of carcass nutritional value

The proximate composition and pH of the

Table 1: Composition of experimental starter diets

Ingredients %	T_1(0.0)	T_2(2.5)	T_3(5.0)	T_4(7.5)
Maize	51.0	51.0	51.0	51.0
Soybean meal	30.0	30.0	30.0	30.0
African pod meal	0.00	0.25	0.50	0.75
Palm kernel cake	10.2	9.95	9.70	9.45
Fish meal	4.00	4.00	4.00	4.00
Bone meal	4.00	4.00	4.00	4.00
Common salt	0.25	0.25	0.25	0.25
Lysine	0.20	0.20	0.20	0.20
Methionine	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated nutrient composition				
Crude protein	23.21	23.18	23.15	23.12
Crude fibre	4.38	4.37	4.35	4.34
Ether extract	3.57	3.57	3.57	3.56
Ash	1.08	1.08	1.08	1.08
Lysine	1.59	1.59	1.59	1.59
Methionine	0.50	0.50	0.50	0.50
Calcium	1.41	1.41	1.41	1.41
Phosphorus	0.94	0.94	0.94	0.94
Energy (kcalME/kg)	2856	2852	2848	2845

***Starter premix supplied per kg diet: vitamin A 15000I.U, vitamin D_3 13000I.U, thiamin 2mg, riboflavin 6mg, pyridoxine 4mg, Niacin 40mg, cobalamine 0.05g, Biotin 0.08mg, Choline chloride 0.05g, Manganese 0.096g, Zinc 0.06g, Iron 0.024g, Copper 0.006g, Iodine 0.014g, Selenium 0.24mg, Cobalt 0.024mg and Antioxidant 0.125g**

Table 2: Composition of experimental finisher diets

Ingredients %	T_1(0.0)	T_2(2.5)	T_3(5.0)	T_4(7.5)
Maize	51.0	51.0	51.0	51.0
Soybean meal	28.0	28.0	28.0	28.0
African pod meal	0.00	0.25	0.5	0.75
Palm kernel cake	15.0	14.78	14.5	14.3
Fish meal	2.00	2.00	2.00	2.0
Bone meal	3.00	3.00	3.00	3.0
Common salt	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10
Methionine	0.10	0.10	0.10	0.10
Premix*	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated nutrient composition				
Crude protein	20.89	20.87	20.86	20.85
Crude fibre	4.93	4.91	4.90	4.89
Ether extract	3.81	3.81	3.81	3.80
Ash	0.81	0.81	0.81	0.81
Lysine	1.43	1.43	1.43	1.43
Methionine	0.47	0.47	0.47	0.47
Calcium	1.05	1.05	1.05	1.05
Phosphorus	0.79	0.79	0.79	0.76
Energy (kcalME/kg	2851	2846	2842	2838

***Finisher Premix supplied per kg diet: vitamin A 10,000 I.U., Vitamin D. 12,000 I. U., Vitamin E 20 I.U., Vitamin K 2.5mg. Thiamine 20mg. Riboflavin 3.0mg, Pyridoxine 4.0mg, Niacin 20mg, Cobalamin 0.05mg, Pantothenic acid 5.0mg, Folic acid 0.5mg, Biotin 0.08mg, Choline chlorine 0.2mg, Manganese 0.006g, Zinc 0.03g, Copper 0.006g, iodine 0.0014g, Selenium 0.24g, Cobalt 0.25g and Antioxidant 0.125g**

meat were determined according to AOAC (1995). One bird from each replicate was slaughtered and the feathers removed without using hot water in order not to exaggerate the moisture content of the meat. The meat from the breast, thigh and drumstick were used. Skin of each used cut parts was removed and 20g of meat from each was removed and all homogenized together. The meat pH was determined by mixing 10g of the homogenized meat with 90ml of deionized water. The electrode of a pH meter (Havana Microcomputer pH meter, model H18424, made in Romania) was then dipped into the mixture and the pH value taken.

Duodenal digesta microbiological analysis

At the end of the experiment digesta was collected from the *duodenum* of one bird from each replicate. Each bird was first slaughtered and its abdomen opened. Thereafter, all the digesta in the *duodenal* fold was collected. Serial dilution technique after incubation of the digesta according to Fawole and Oso (1988) was used to determine the bacteria load.

Economic analysis

Economic analysis was done according to the following procedures as reported by Ndelekwute *et al*. (2014).

Cost/kg feed = Summation of price per kg of feed ingredients x their proportions in the feed formula ÷ 100

Average Cost/kg feed = $\frac{\text{Cost/kg feed (Starter phase) + Cost/kg feed (Finisher phase).}}{2}$

Feed cost/bird = average cost/kg feed x quantity of feed consume.

Feed cost/bird (dressed weight) = feed cost/bird (starter phase) + Feed cost/bird (finisher phase)

Revenue/dressed bird = Price/kg dressed weight x dressed carcass weight/bird.

Goss margin = Revenue/bird feed cost/bird.

Data transformation and statistical analysis

Data collected which were expressed as percentages were transformed using Arc Sine as outlined by Preston (1996). All data were then subjected to analysis of variance (ANOVA). Significant means were separated using Duncan New Multiple Range Text (DNMRT) according to Steel and Torrie (1980).

Results and discussion

The antibacterial effect of African porridge pod mealin the *duodenum* is shown in Fig. 1. The result showed that African porridge pod mealhad antibacterial effect in the *duodenum*. The trend showed dose dependent action on total bacterial load as the antibacterial action increased with increasing concentration. Closer look at the result also indicated that it had more antibacterial action on individual bacteria (*salmonella* and *E. coli*) than it had on the total bacterial load count indicating that there could be other bacteria in the system that were resistant to African porridge pod meal.

The effect of African porridge pod meal on carcass and abdominal fat is shown on Table 3. Dressed percentage was significantly ($P<0.05$) higher in control. There was no difference in dressed weight of the birds on different levels of African porridge pod meal. Cut-parts also did not show significant differences across treatment. Inclusion of African porridge pepper significantly ($P<0.05$) increased the abdominal fat within African porridge pod meal groups as compared to the control. Within the same groups abdominal fat deposition was similar.

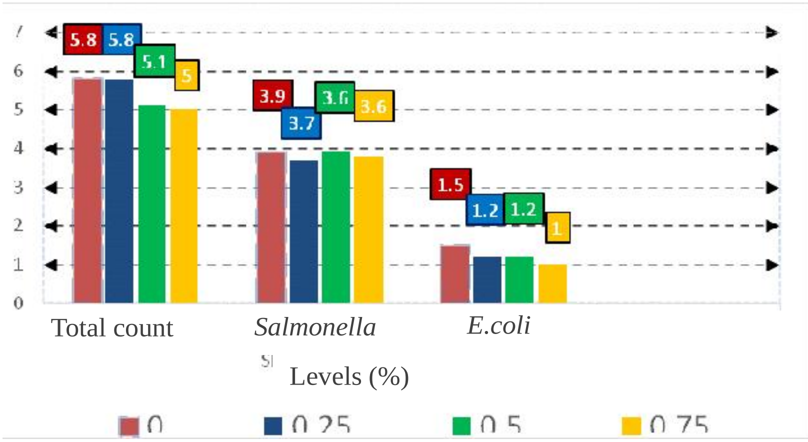

Fig. 1: Effect of African porridge pod meal on microbial entity (10^3cfu/g) of the *duodenum*.

Table 3: Effect of African porridge pod meal (%) on carcass and abdominal fat of broiler chickens

Parameters	T1(0.00)	T2 (0.25)	T3(0.5)	T4 (0.75)	SEM
Dressed weight (%)	76.73^{a}	71.93^{b}	70.52^{b}	68.96^{b}	5.05
Breast weight (%)	35.94	34.44	34.98	31.95	2.04
Back cut (%)	23.11	24.87	25.64	23.18	2.01
Wings (%)	10.63	10.35	10.96	11.92	1.89
Drumstick (%)	14.66	13.32	13.84	15.88	1.91
Thigh (%)	14.76	14.02	14.58	14.78	1.77
Abdominal fat (%)	0.97^{b}	1.39^{a}	1.45^{a}	1.67^{a}	0.38

abc means along the same row with different superscripts are significantly (P<0.05) different.

African porridge pod meal was unable to improve carcass yield rather the dressed percentage was negatively affected, thus indicative of the fact that it could have acted negatively on protein accretion and muscle development. This could not be unconnected with the report of Ndelekwute *et al*. (2016b) that African porridge pod meal did not improve the final live weight of broilers. It was went further report that as the level of African porridge pod meal increased final live weight decreased, perhaps due to the anti-nutritional content of African porridge pod meal and thus could have direct bearing on the dressed weight. The result of carcass yield contradicted Nweze *et al.* (2011) on improvement in carcass yield in birds treated African porridge with pod meal. Increase in abdominal fat deposition due to intake of African porridge pod meal could have been that probably the spice supported lipogenesis in the body indicating that the reported anti-nutritional factors did not impart negatively on fat metabolism. This underscores the report of Chunmei *et al.* (2010) that trypsin inhibitor and lectin did not disrupt fat metabolism in rat rather fat metabolism was increased.

Table 4 indicates the effect of African porridge pod meal on internal organs of the broiler chickens. The spice did not impart negatively on the gizzard, liver, kidney, spleen and *caecum*. Nevertheless significant (P<0.05) differences were observed in pancreas, intestine and bile volume. The results of pancreas and bile show that above 0.25%, the pancreas was enlarged and bile volume increased. This condition could negatively affect the secretory functions of pancreas which include secretion of enzymes such as trypsin, lipase and carbohydrase which could hamper digestion.

Table 4: Effect of African porridge pod meal (%) on internal organs and bile of broiler chickens

Parameter	T1(0)	T2(0.25)	T3(0.50)	T4(0.75)	SEM
Gizzard (%)	2.34	2.44	2.25	2.65	0.50
Liver (%)	1.45	1.46	1.48	1.53	0.21
Pancreas (%)	0.31^{b}	0.27^{b}	0.57^{a}	0.64^{a}	0.06
Kidney (%)	0.25	0.24	0.26	0.28	0.05
Spleen (%)	0.09	0.13	0.11	0.12	0.05
Bile volume (%)	0.01^{b}	0.04^{b}	0.09^{a}	0.09^{a}	0.05
Small intestine (%)	3.02^{a}	3.03^{a}	2.65^{b}	2.66^{b}	0.30

ab Means along the same row with different superscripts are significantly (P<0.05) different

Rada *et al.* (2017) had indicated that presence of anti-nutritional factors in feed enlarged the pancreas and increased trypsin secretion. Earlier, Liddle *et al.* (1984) and Liener (1989) reported that inactivation of trypsin led to continuous release of cholecystokinin, which stimulated pancreatic production of digestive enzymes including trypsin and chymotrypsin, which led to an enlarged pancreas as a result of hypertrophy and hyperplasia. Increase in bile volume confirmed the reported secretory effect of spices on bile. Animal studies have shown that many spices induce higher secretion of bile acids which play a vital role in fat digestion and absorption (Platel and Srinivasan, 2004). It was further observed that the size of intestine was reduced at 0.50 and 0.75% levels of inclusion of African porridge pod meal compared to the control and 0.25% which were similar. Antibiotics and natural products such as spices, herbal products which exhibit and exert antibacterial actions have been reported to reduce the size of the intestine of chickens (Miles *et al*., 2016; Khalaji *et al*., 2011; Nkukwana *et al*., 2015) due to sizeable number of bacteria their multiplication has been inhibited resulting to little bacterial mass in the intestine and reduction in fermentation products. This is shown in the number of microbial count, number of *salmonella* and *E. coli* in the *duodenum* (Fig. 1). This is indication that African porridge pod meal could be used to modulate the gut of broiler chickens for productivity. Hence, a functional gastrointestinal tract (GIT) is essential for the digestion and absorption of nutrients required for the bird's maintenance and growth (Baurhoo *et al.*, 2009).

Effect of African porridge pod meal on nutritive value of meat of the broilers (Table 5) shows no deleterious impact. The protein, fat, ash, fibre and pH were not significantly altered removing any fear of quality compromise. Elsewhere, spice like black pepper was reported to induce no negative impact on the meat quality of broiler chickens (Ndelekwute *et al*., 2016a).

Also feeding of African porridge pod meal did not improve economic benefit significantly (P>0.05). This could be due to the fact that it did not improve the dressed weight of the birds.

Table 5: Effect of african porridge pod meal (%) on nutritive value and pH of broiler meat

Parameter	T1(0)	T2(0.25)	T3(0.50)	T4(0.75)	SEM
Crude protein (%)	24.00	24.50	24.08	24.45	5.07
Ether extract (%)	1.05	1.01	1.06	1.09	0.19
Crude fibre (%)	0.15	0.19	0.16	0.17	0.03
Ash (%)	1.09	1.06	1.08	1.06	0.17
pH	5.95	5.88	5.78	5.77	0.45

Table 6: Effect of african porridge pod meal (%) on economics of broiler chickens

Parameter	T1(0)	T2(0.25)	T3(0.50)	T4(0.75)	SEM
Cost/ kg feed	110.54	111.05	112.10	113.05	
Feed cost/ bird	507.90	510.60	513.30	515.70	55.09
Cost/gain	220.60	220.00	222.07	218.60	34.88
Revenue/bird	1554	1563.24	1544	1532	75.65
Gross margin/bird	1046.10	1052.64	1030.70	1016.30	66.76

Conclusion

Inclusion, African porridge pod meal in the diets of broiler chickens did not improve carcass yield, but did not reduce the meat quality and neither did it lead to poor economic benefit. The spice showed antibacterial action on bacteria population of *duodenal* digesta and it increased bile secretion. Therefore it could be recommended for modulation of gut of broiler chickens.

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