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Effect of pawpaw (*Carica papaya* Linn) leaf meal on performance and carcass quality of broiler chickens

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***Target Audience:** Feed Millers, Poultry Farmers, Animal Scientists, Consumers of Chicken Meat*

Abstract

One hundred and fifty (150) broiler chickens of ROSS 308 strain at day-old were used to study the effect of pawpaw (Carica papaya) leaf meal (PLM) on performance and carcass indices. The birds were weighed on arrival and divided into five dietary groups. Each group comprised of thirty (30) birds which were subdivided into three replicates of ten (10) birds per replicate in a completely randomized design. Five experimental diets comprising T_1 (control diet) 0.0 % pawpaw leaf meal (PLM), T_2 (0.2 % fresh dried PLM), T_3 (0.4 % fresh dried PLM), T_4 (0.2 % in situ dried PLM) and T_5 (0.4 % in situ dried PLM) were formulated and fed to the birds at the starter period of 0 – 28 days and finisher period of 28 – 56 days. Results at the starter phase showed that daily feed intake was significantly ($P < 0.05$) reduced by dietary inclusion of fresh dried PLM at the 0.4 % level. Average total feed intake and cost of total feed intake were significantly ($P < 0.05$) affected at the finisher phase with the costs corresponding to the intakes, and the 0.2 % in situ dried PLM group having higher values. At the overall trial period (starter – finisher period) daily feed intake was significantly higher ($P < 0.05$) in the 0.2 % in situ dried PLM group. Carcass and organ indices were not affected ($P > 0.05$) by dietary inclusion of PLM. It was concluded that higher total feed intake with its corresponding higher cost of total feed intake and without appreciable weight gain cancels the advantage of feeding the 0.2 % in situ dried PLM. All diets were, therefore, equal in terms of performance.

***Keywords:** Pawpaw leaf meals, performance, carcass indices, broiler chickens*

Description of Problem

The use of herbal supplements in poultry production as a replacement for synthetic growth promoters is now being considered (1, 2). The antimicrobial, anti-stress, antioxidant and immunomodulatory properties of these phytogenic feed additives (PFAs) have been reported by many researchers and have positioned them well as growth promoters in livestock and poultry. Supplementation of chicken diet with herbal additives have been advocated to boost performance, increase immunity, stabilize physiological condition and improve antioxidant activity in birds (3). This will help to achieve food security and self-sufficiency in animal protein supply in a rapidly growing nation such as Nigeria, as a result of increased production of poultry meat which is currently at subsistence production level.

Medicinal plants have been used in poultry production because of their functions which include stimulation of appetite and feed intake, enhancement of secretion of endogenous digestive enzymes, stimulation of immune responses and antibacterial, antiviral, and antioxidant actions (4, 5). Pawpaw (*Carica papaya*) leaf has been employed in ethnomedicine to treat several ailments in Nigeria (6). Pawpaw plant is the most natural source of papain, which is an

effective natural digestive aid that breaks down protein and cleanses the digestive tract (7). Saponin in pawpaw leaves is responsible for the bitter taste (8). Pawpaw is a large tree-like plant with a single stem (sparsely branched stem) growing from 5 to 10 meters (16 to 33 feet) tall with the leaves spirally arranged and confined to the tree top (9).

Pawpaw leaf meal (PLM) has crude protein value of 30.12 % (6) which suggests that it is a suitable protein supplement. Crude protein values of pawpaw leaf meal have also been reported to be 28.20 % and 25.30 % (10 and 11) respectively. Reports of (6) and (12) showed that inclusion of pawpaw leaf meal in the diet of finishing and starter broilers improved performance, feed intake, weight gain, feed conversion ratio, carcass and organoleptic indices, respectively. There is scanty information on effect of *in situ* dried pawpaw leaf meal on performance and carcass quality of broiler chickens. This study, therefore, investigated the effect of air-dried fresh pawpaw leaf meal (PLM) and *in situ* dried pawpaw leaf meal (PLM) on performance at starter, finisher and starter – finisher periods as well as carcass characteristics of broiler chickens.

Materials and Method

Project site

This research was conducted at the poultry unit of Teaching and Research Farm, Federal University of Technology, Owerri, Imo State, in South-eastern Nigeria. Owerri has an altitude of about 100 m above sea level. Federal University of Technology, Owerri lies within latitudes 5^{o} 24' and 5^{o} 30' N, and longitudes 6^{o} 58' and 7^{o} 30' E and has minimum land area of ten thousand (10,000) acres or 4,048 hectares (13). Average annual temperature and rainfall of Owerri are 26.4 ^{o}C and 2219 mm respectively (14).

Collection and processing of pawpaw leaves

Fresh pawpaw leaves were harvested and *in situ* dried pawpaw leaves (pawpaw leaves which dried on the tree and fell down) were picked up from farms in Eziobodo, Owerri West Local Government Area of Imo State, Nigeria. The fresh leaves were chopped into tiny pieces and air-dried to a constant weight. This took about seven days to accomplish. The *in situ* dried leaves were also chopped into tiny pieces and air-dried for seven days for proper drying and to remove any adhering moisture. The chopped fresh air-dried and *in situ* dried leaves were milled differently into fine portions using a local milling machine. They were then stored in separate air-tight plastic containers at room temperature until needed for feed formulation.

Experimental birds, design, diets and management

One hundred and fifty (150) broiler chicks of ROSS 308 strain at day old were used. Birds were divided into five dietary groups each comprising thirty birds which was subdivided into three replicates of ten birds each and housed in a pen measuring 1 m x 1 m in a completely randomized design (RCD).

Five experimental broiler diets containing pawpaw leaf meal (PLM) at 0.0 % (control), 0.2 % fresh dried PLM, 0.4 % fresh dried PLM, 0.2 % *in situ* dried PLM and 0.4 % *in situ* dried PLM representing T_1, T_2, T_3, T_4 and T_5, respectively, were formulated and fed to the birds at the starter phase of 0 – 28 days and finisher phase of 28 – 56 days of age. The ingredient and calculated nutrient compositions of the broiler starter diets formulated to provide 22.59 % crude protein and 2865.06 kcal/kg metabolizable energy and broiler finisher diets of 19.90 % crude protein and 2895.12

kcal/kg metabolizable energy are shown in Tables 1 and 2, respectively. The birds were managed on deep litter where feed and water were provided *ad-libitum*. They were brooded according to guidelines of university farm. Necessary vaccinations and multivitamins were administered.

Table 1: Ingredient and calculated nutrient composition of experimental broiler starter diets

Ingredients	Control	Fresh dried PLM		*In situ* dried PLM	
	T1 (0.0 %)	T2 (0.2 %)	T3 (0.4 %)	T4 (0.2 %)	T5 (0.4 %)
Maize	49.0	49.0	49.0	49.0	49.0
Palm kernel cake	14.0	14.0	14.0	14.0	14.0
Soybean meal	20.0	20.0	20.0	20.0	20.0
Fish meal	9.50	9.50	9.50	9.50	9.50
Pawpaw leaf meal	0.00	0.20	0.40	0.20	0.40
Wheat offal	3.50	3.30	3.10	3.30	3.10
Bone meal	3.00	3.00	3.00	3.00	3.00
Vitamin/mineral Premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.0	100.0	100.0	100.0	100.0
Calculated nutrient composition					
Crude protein (%)	22.6	22.6	22.6	22.6	22.6
Crude fibre (%)	1.45	1.45	1.45	1.45	1.45
Calcium (%)	1.10	1.10	1.10	1.10	1.10
Phosphorus (%)	4.64	4.64	4.64	4.64	4.64
Metabolizable energy (kcal/kg)	2865.1	2865.1	2865.1	2865.1	2865.1

PLM = Pawpaw leaf meal

Table 2: Ingredient and calculated nutrient composition of experimental broiler finisher diets

Ingredients	Control	Fresh dried PLM		*In situ* dried PLM	
	T1 (0.0 %)	T2 (0.2 %)	T3 (0.4 %)	T4 (0.2 %)	T5 (0.4 %)
Maize	57.0	57.0	57.0	57.0	57.0
Palm kernel cake	8.00	8.00	8.00	8.00	8.00
Soybean meal	17.0	17.0	17.0	17.0	17.0
Fish meal	7.50	7.50	7.50	7.50	7.50
Pawpaw leaf meal	0.00	0.20	0.40	0.20	0.40
Wheat offal	4.50	4.30	4.10	4.30	4.10
Bone meal	5.00	5.00	5.00	5.00	5.00
Vitamin/mineral Premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.0	100.0	100.0	100.0	100.0
Calculated nutrient composition					
Crude protein (%)	19.9	19.9	19.9	19.9	19.9
Crude fibre (%)	4.07	4.07	4.07	4.07	4.07
Calcium (%)	2.10	2.10	2.10	2.10	2.10
Phosphorus (%)	1.37	1.37	1.37	1.37	1.37
Metabolizable energy (kcal/kg)	2895.1	2895.1	2895.1	2895.1	2895.1

PLM = Pawpaw leaf meal

Data collection

Performance parameters

Birds were weighed on arrival and weekly thereafter until the 56th day when the feeding trial was terminated. Weight gain was calculated as the difference between the final and initial weights. Feed intake was calculated daily as the difference between feed offered and the left-over feed obtained the next day by the group, which was divided by the number of birds. Average total feed intake was calculated as the sum of feed consumed per bird during the period. This was divided by the number of days to get average daily feed intake. Feed conversion ratio was calculated as average daily feed intake divided by average daily weight gain. Cost of total feed intake was calculated by multiplying the total feed intake by the unit price of the feed. Feed cost per kilogram weight gain was calculated as the cost of feed consumed to achieve 1 kilogram weight gain.

Carcass characteristics

At the end of the feeding trial one broiler chicken (weight range 2468 – 2741 g) was selected from each replicate and used for carcass analysis. The legs of each broiler were shackled by tying with a string and then hanging the bird with its head pointing downwards. This was done to restrain the birds and allow for proper exsanguination. The broilers were then slaughtered by severing their jugular veins with a sharp kitchen knife. After 3.5 minutes of blood drainage (15), carcasses were removed from the shackles. Thereafter, they were sub-scalded by immersing them in hot water (60 ^{o}C) for 30 seconds according to (16). They were then defeathered. The heads, necks and shanks were cut off, followed by gentle removal of the crop. The carcasses were then eviscerated by cutting open the abdominal cavity and pulling out the viscera. The dressed carcasses were weighed and cut according to standard practice procedures of United States Department of Agriculture (USDA) and Agricultural Marketing Service in which the more expensive broiler meat cuts (breast, thighs, drumsticks) have their complete parts (17).

Data analysis

Data collected were subjected to analysis of variance (ANOVA) for the completely randomized design as described by (18). Significant differences in treatment means were separated by Duncan's New Multiple Range Test (19).

Results and Discussion

Performance of broiler chickens

The performance of broiler chickens fed pawpaw leaf meals at the starter phase is shown in Table 3, performance at the finisher phase is shown in Table 4 while performance in whole trial period is shown in Table 5. Performance at starter level showed that daily feed intake was statistically reduced ($P < 0.05$) by inclusion of fresh dried pawpaw leaf meal in the diet at 0.4 % with other treatments remaining similar. Other parameters measured were not affected by pawpaw leaf meal. Weight gain was, however, numerically higher in the group fed 0.2 % *in situ* dried pawpaw leaf meal. The bitter taste of pawpaw noted by (8) could be responsible for the reduced feed intake at the 0.4 % level of fresh dried pawpaw leaf meal dietary inclusion. Higher saponin concentration at this higher level of inclusion could impart greater bitterness to the feed and, therefore, reduce its acceptability by the young birds.

Improved feed intake, weight gain, feed conversion ratio, carcass and organoleptic indices, had been reported with inclusion of pawpaw leaf meal in the diet of finishing and starter broilers, respectively (6, 12). Feed

intake, feed conversion ratio, dressing percentage and carcass indices of weaned rabbits fed diets supplemented with pawpaw leaf meal were not affected (20).

Table 3: Performance and cost implication of starter broiler chickens on graded levels of pawpaw leaf meal (PLM)

Parameters	Control	Fresh dried PLM		*In situ* dried PLM		SEM
	T_1 (0.0 %)	T_2 (0.2 %)	T_3 (0.4 %)	T_4 (0.2 %)	T_5 (0.4 %)	
Av. Initial liveweight (g)	45.63	44.77	45.30	45.20	43.00	3.08
Av. Final liveweight (g)	882.07	846.10	845.20	958.12	865.00	44.30
Av. Total weight gain (g)	836.43	807.33	799.87	912.92	812.13	26.64
Av. Daily weight gain (g)	29.87	28.62	28.57	32.61	29.36	1.58
Av. Total feed intake (g)	1663.03	1611.71	1523.90	1688.47	1676.57	17.67
Av. Daily feed intake (g)	59.40^{a}	57.57^{a}	54.47^{b}	60.33^{a}	59.90^{a}	1.25
Cost of total feed intake (₦)	289.77	268.53	268.22	277.57	297.79	4.39
Feed cost (₦)/kg gain	354.72	335.70	337.36	303.94	362.45	11.85
Feed conversion ratio	2.17	2.01	1.91	1.85	2.04	0.14

$^{a, b}$ Means in the same row with different superscripts are statistically different ($P < 0.05$).
Av. Average
SEM = Standard error of means
PLM = Pawpaw Leaf Meal

Table 4: Performance and cost implication of finisher broiler chickens on graded levels of pawpaw leaf meal (PLM)

Parameters	Control	Fresh dried PLM		*In situ* dried PLM		SEM
	T_1 (0.0 %)	T_2 (0.2 %)	T_3 (0.4 %)	T_4 (0.2 %)	T_5 (0.4 %)	
Av. Initial liveweight (g)	882.07	846.10	845.20	958.12	865.00	44.30
Av. Final liveweight (g)	2799.36	2613.84	2863.63	2846.33	2697.80	74.80
Av. Total weight gain (g)	1917.29	1767.74	2017.47	1888.20	1832.80	82.11
Av. Daily weight gain (g)	68.47	63.13	72.05	67.44	65.46	2.93
Av. Total feed intake (g)	3973.20^{c}	4087.60^{bc}	4213.80^{ab}	4323.80^{a}	3964.40^{c}	69.48
Av. Daily feed intake (g)	141.93	146.00	150.50	154.43	141.57	9.13
Cost of total feed intake (₦)	1189.22^{c}	1223.34^{bc}	1261.25^{ab}	1294.07^{a}	1186.62^{c}	20.96
Feed cost (₦)/kg gain	623.07	693.30	626.13	692.73	648.63	33.40
Feed conversion ratio	2.08	2.32	2.09	2.31	2.19	0.12

$^{a, b, c}$ Means in the same row with different superscripts are statistically different ($P < 0.05$).
Av. Average
SEM = Standard error of means
PLM = Pawpaw Leaf Meal

Performance at the finisher level indicated significant differences ($P < 0.05$) in total feed intake and cost of total feed intake. The feed intake correspondingly affected the cost of total feed intake at the different levels of pawpaw leaf meal inclusion with the 0.2 % *in situ* dried pawpaw leaf meal group having the highest values. This was followed by the group on 0.4 % fresh dried PLM with the control group and the 0.4 % *in situ* dried PLM having the least values. Though non-significant ($P > 0.05$), weight gain was numerically higher in the 0.4 % fresh dried PLM group. The correspondingly higher cost of total feed intake as a result of the high feed intake and without appreciable increase

in weight gain cancels the ultimate advantage of feeding the 0.2 % *in situ* dried PLM to the birds. In terms of performance, therefore, birds offered the different diets are equal.

Table 5: Performance and cost implication of broiler chickens fed graded levels of pawpaw leaf meal (PLM) in both starter and finisher periods

Parameters	Control	Fresh dried PLM		*In situ* dried PLM		SEM
	T_1 (0.0 %)	T_2 (0.2 %)	T_3 (0.4 %)	T_4 (0.2 %)	T_5 (0.4 %)	
Av. Initial liveweight (g)	45.63	44.77	45.30	45.20	43.00	3.08
Av. Final liveweight (g)	2799.36	2613.84	2863.63	2846.33	2697.80	74.80
Av. Total weight gain (g)	2753.73	2569.07	2817.33	2801.13	2654.80	74.79
Av. Daily weight gain (g)	49.17	45.88	50.31	50.02	47.41	1.34
Av. Total feed intake (g)	5632.20	5699.30	5737.73	6012.20	5642.00	90.80
Av. Daily feed intake (g)	100.67^{b}	101.76^{b}	102.47^{ab}	107.33^{a}	100.33^{b}	1.63
Cost of total feed intake (₦)	1479.19	1491.87	1529.47	1571.65	1484.41	21.72
Feed cost (₦)/kg gain	537.45	580.96	543.02	563.67	559.68	16.17
Feed conversion ratio	2.05	2.22	2.04	2.15	2.13	0.07

[a, b] Means in the same row with different superscripts are statistically different ($P < 0.05$).
Av. Average
SEM = Standard error of means
PLM = Pawpaw Leaf Meal

Performance of broilers at the overall period also shows that average daily feed intake was significantly higher ($P < 0.05$) in the 0.2 % *in situ* dried PLM group as in the starter phase. This was followed by the 0.4 % fresh dried PLM group, with the control group, 0.2 % fresh dried PLM and the 0.4 % *in situ* dried PLM groups being statistically lower ($P < 0.05$). Other parameters measured were not affected ($P > 0.05$) in the overall trial period. Inclusion of pawpaw leaf meal in the diet of finishing and starter broilers improved feed intake, weight gain, feed conversion ratio, carcass and organoleptic indices, respectively (6, 12).

Carcass characteristics

Effect of dietary inclusion of pawpaw leaf meal (PLM) on carcass characteristics and organ weights of broilers is shown in Table 6. There was no significant effect ($P > 0.05$) of pawpaw leaf meals on any of the carcass and organ parameters measured. This means that all diets were equally tolerated by the birds and the pawpaw leaves did not have effect on carcass and organs of the birds. This result agrees with (21) who found no significant differences in carcass and organ characteristics of broiler chickens fed *Carica papaya* leaf meal except the life weight of the birds. When pawpaw leaf extract was added to the drinking water of broiler chickens, there were also no significant effect on carcass and organ weights of the birds (3). The comparable values in our result are in agreement with the views of (22, 23, 24, 25, 26 and 27) that carcass values of animals may not be significantly affected by enzymes in a balanced and quality diet. Carcass and organoleptic indices were, however, improved with inclusion of pawpaw leaf meal in the diet of finishing and starter broilers, as reported by (6) and (12), respectively.

Table 6: Effect of dietary inclusion of pawpaw leaf meal (PLM) on carcass and organ weights of broilers

Parameters	Control	Fresh Dried PLM		*In situ* Dried PLM		SEM
	T_1 (0.0 %)	T_2 (0.2 %)	T_3 (0.4 %)	T_4 (0.2 %)	T_5 (0.4 %)	
Liveweight (g)	2443.33	2488.67	2390.67	2624.67	2458.00	83.35
Plucked weight (%)	92.04	93.79	93.03	93.13	92.32	3.28
Dressed weight (g)	1750.67	1802.00	1734.67	1932.00	1755.33	60.13
Dressed weight (%)	71.64	72.89	72.57	73.57	71.47	2.69
	Carcass parts (% of LW)					
Head	2.72	2.76	2.58	2.59	2.82	0.24
Neck	2.94	2.34	2.62	3.56	3.09	0.26
Wings	8.75	8.74	9.14	9.21	9.18	0.35
Breast	25.50	26.34	26.03	25.63	26.06	1.52
Thighs	13.03	13.41	13.40	12.09	12.94	0.85
Drumstick	12.02	11.31	12.11	11.11	11.84	0.60
Shanks	3.64	3.49	3.85	3.74	3.78	0.44
Legs	28.76	28.28	29.40	27.01	28.56	1.73
Back	12.41	13.25	11.96	15.59	11.58	0.92
Abdominal fat	1.18	1.75	0.83	0.61	1.16	0.35
	Organ weights (% of LW)					
Heart	0.52	0.48	0.39	0.51	0.43	0.05
Liver + gall bladder	1.86	1.85	1.89	1.47	2.00	0.14
Empty gizzard	1.73	1.99	1.78	1.81	1.93	0.17
Spleen	0.08	0.08	0.11	0.07	0.10	0.01

Means within a row without superscripts are similar ($P > 0.05$).
SEM = Standard Error of Means, LW = Liveweight, PLM = Pawpaw Leaf Meal

Conclusions and Applications

1. Feeding young broilers up to 0.4 % fresh dried pawpaw leaf meal in their diet reduces feed intake.
2. In the starter – finisher period, feed intake was significantly increased by 0.2 % *in situ* dried pawpaw leaf meal dietary inclusion but the non-appreciable increase in weight gain observed in birds in this group cancels the advantage of feeding the 0.2 % *in situ* dried pawpaw leaf meal.
3. Pawpaw leaf meal dietary inclusion did not affect any carcass or organ indices.
4. Further research is needed to determine the effect of 0.2 % fresh dried and *in situ* dried pawpaw leaf meal on performance, carcass and organ indices of poultry and also to determine the active principle in the *in situ* dried leaf meal that caused the increased feed intake at the 0.2 % inclusion level.

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