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EFFECTS OF FERMENTED PAWPAW SEEDS ON PERFORMANCE, ORGAN AND CARCASS CHARACTERISTICS OF BROILER CHICKEN

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ABSTRACT

Pawpaw (*Carica papaya*) seed is often seen as the waste product of pawpaw fruit noted for being discarded after every peel of pawpaw fruit. However, studies have shown that it has enormous nutritional and medicinal properties, which formed the basis for this investigative studies. The study was designed to investigate the effect of fermented dried pawpaw seed fed at varying level of inclusion in the diets of broiler chicken at finisher stage on their general performance, carcass and organs characteristics. Two hundred day old chicks were used for the experiment and were exposed to the same management procedure throughout the starter phase (0–4 weeks). One hundred and fifty birds were then selected randomly and divided into 5 treatments of 30 birds per treatment and replicated three times with 10 birds per replicate. The pulverized fermented dried pawpaw seed was added into the broiler finisher diet in the proportion of 0 %, 5 %, 10 %, 15 %, 20 % and were allotted to treatments 1, 2, 3, 4 and 5 respectively. Initial weight, feed intake, daily feed intake, and the feed conversion ratio was measured and calculated. Significant differences across all the treatments for the carcass weight was noticed ($P < 0.05$). However, the result also showed that there was no significant difference in the organs across all treatments except for the kidney and the proventriculus. However, de-feathered weight at 15 % level of inclusion was the highest, meaning the birds could still tolerate the test ingredient up to that level, however, the birds were at best on 10 % inclusion level as they recorded the highest weight gain next to the control. A case of depressed appetite was noticed in treatment 5 (20 %), which brought about the poor weight gained recorded, compared to other treatments. The result of this study showed that the use of the fermented dried pawpaw seed flour can be tolerated up to about 10 % inclusion as it gave the lowest FCR (feed conversion ratio) which could bring about high profitability, hence, encourage more people to go into Poultry business.

Key words: pawpaw seed, broiler, carcass and organ

INTRODUCTION

The poultry sub-sector is the most commercialized of all the Nigeria's agricultural sub-sectors. The livestock sector is vital to the social economic development of Nigeria. It contributes about 9–10 % of agricultural GDP (FAO, 2016). Broilers are the most efficient in converting raw feed stuffs and by-products into high protein food, which is urgently needed to improve the nutritional standards of the human (Onyimonyi and Onu, 2009). However, the cost of this transformation is high as 80 % of the cost of production is spent on feed (Onyimonyi and Onu, 2009). In the past decades, studies have been carried out to identify alternative and non-conventional feed resources, which are cheap and easily available for poultry production (Aduku, 1993; Esonu *et al*., 2003; Ekenyem, 2007). Attention has been given to some tropical fruits that are of economic importance (Glombitza *et al*., 1993; Gous, 2005), among which Pawpaw (*Carica papaya*)

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is one. *Carica papaya* (Pawpaw) is an invaluable plant that is prevalent throughout tropical Africa. It belongs to the *Caricaceae* family. It is popular in the tropics and subtropics, because it is easy to cultivate and has rapid economic potential, which brings about quick economic returns and adaptation to different types of soils and climates (Harkness, 1967; Campbell, 1984).

Nigeria is the sixth largest producer of pawpaw globally, and the level of production has been estimated to be 836, 702 metric tons, after India, Brazil, Mexico, Indonesia and Dominican Republic (FAO, 2016; Pariona, 2017). The different parts of the pawpaw plant, including leaves, seeds and fruit, have been shown to have excellent nutritional and medicinal values (Krishna *et al*., 2008; Afolabi *et al*., (2011); feed accounts for 65–75 % of all the cost of production of non-ruminant animals. The escalating cost of the conventional feedstuffs motivated the nutritionists to search for alternative feedstuffs (Haasbroek, 2016). This has led to sourcing of locally available and cheap plant materials to formulate a balanced ration for monogastric animals (Manyelo *et al*., 2020).

The increased demand for animal protein due to rapid population growth in the developing countries like Nigeria has placed a higher demand on animal protein. The shortage of animal protein among average Nigerians demands a logical solution such as an increase in the production and consumption of poultry products (Abeke *et al*., 2013) It is estimated on the average that Nigeri-ans consumed about 7 g of protein per day instead of 28 g/head/day recommended by FAO (de Vries-Ten Have *et al*., 2020). Recently, attention has been drawn to pawpaw seeds, as alternative protein source for livestock feed (Ebenebe *et al*., 2011; Onyimonyi and Onu, 2009; Adewolu, 2008; Antia *et al*., 2006). However, there have been very little literature on the use of pawpaw seed as addictive in feed diet of broiler chickens. Therefore, evaluating the characteristics of organ and carcass of broiler chicken fed diets supplemented with fermented pawpaw seed (*Carica papaya*) could be a main way towards reducing the cost of feed production, thereby encouraging more people to engage in poultry business as a way of reducing unemployment in the society.

MATERIAL AND METHODS

Experimental site

The study was conducted at the Poultry Unit of the Teaching and Research Farm of College of Agriculture, Ejigbo Campus, Osun State University, Osun State, Nigeria. The farm is located on latitude 7 54 N and longitude 4 18 E and 4 54 E at an altitude of 426 m above the sea level.

Sourcing for research materials

200-day-old broiler chickens were purchased from a reputable farm in Osun State. Pawpaw fruits were purchased from the local markets in Ejigbo and other neighbouring towns after which the seeds were hygienically extracted.

Pawpaw seed processing

The purchased pawpaw fruit were cut open using knives. The seeds were then separated for further processing. The seeds were fermented, air-dried for 48 hours and then were exposed to ade-quate sunlight to allow quick drying and to ensure it was done evenly. The seeds were weighed before and after drying to record for moisture content and loss. Complete moisture loss is shown by constant weight of the dried seeds on weighing. After drying, the seeds were pulverized using an electric grinder till a fine texture is achieved and were kept in an airtight container to prevent oxidation. The milled pawpaw seeds were then added to the broiler feeds at the varying inclusion levels, as designed by the experiment.

Housing and management of experimental birds

Preparation of pen before arrival

Standard brooding procedures were adopted based on the standard of Osun State University, Osogbo. The day-old chicks were then brought in, unboxed and counted. Weak or sick birds were checked for and isolated from the brooder pen. Adequate heat (0 to 4 weeks, 35 °C to 26 °C), humidity range (55–68 %) drugs and vaccine were provided for the birds during the starter phase. The chicks were brooded and kept in a deep litter system using high wattage electricity bulb and coal pots. From 0–4 weeks, the chicks were group-fed for acclimatization and the development of the GIT prior to inclusion of the dried fermented pawpaw seed, which was the starter phase (29 days) without any inclusion of the additive (pawpaw seed) i.e., fed only with the broiler starter. Feeding trial commenced after the starter phase which lasted from the day 29 to day 56. After the first four weeks the birds were randomly assigned to five treatments

(accounting for 30 birds per treatment) and replicated three times (10 birds allocated to each replicate).

Routine and occasional management practices were carried out during the experiment.

Vaccination and Medication Program

During the experiment, the birds were given Gumboro (1st and 2nd shots), Lasota (1st and 2nd shots) and vitamins serving as anti-stress, antibiotics and coccidiostat all before the onset of the feeding trial. Coccidiostat was administered during the experiment.

Experimental treatment diet

The 200 experimental birds (Arbor acres) were in the group fed with broiler starter for 4 weeks i.e., 1 to 28 days (starter phase), after which the feeding trial commenced. The pulverized paw-paw seed was compounded with the finisher diet at varying levels of inclusion at a reputable feed mill in Osun State, where all bio-security measures were performed. The birds were then grouped and assigned to treatments and replicated with a control treatment of 0 % inclusion of the Pawpaw seed.

Treatment 1 – Control (0 % of Dried Fermented Pawpaw seed)
Treatment 2 – (5 % of Dried Fermented Pawpaw seed)
Treatment 3 – (10 % of Dried Fermented Pawpaw seed)
Treatment 4 – (15 % of Dried Fermented Pawpaw seed)
Treatment 5 – (20 % of Dried Fermented Pawpaw seed)

General performance data collection

Initial weights were taken and recorded on the onset of the trial and the average weight deduced using a sensitive weighing scale.

$$\textit{Daily weight gained} = \frac{\text{average weekly weight gain}}{\text{7 days}}$$

Feed intake: This was recorded daily via weigh-back mechanism by subtracting left-over feed from feed served i.e., Amount of feed given (g) minus leftover feed (g).

Final weight gained: at the end of the 56th day, the final weights were taken and recorded.

Feed Conversion Ratio (FCR): This was obtained by dividing the average total feed intake by the average total body weight gain i.e., $\frac{\text{Average Total Feed Intake}}{\text{Weight gain}}$

At the end of the experiment, two birds were randomly selected from each replicate. The select-ed birds were humanely slaughtered via the jugular vein, allowed to bleed for two minutes and dipped in hot water before being de-feathered. After dressing, the carcass and organ weight were taken.

Collection of carcass characteristics data

The dressed weight of the birds was taken after the dressing. The carcasses were then cut into its various body parts while the organs were carefully removed. The body parts were weighed, they include eviscerated weight, belly fat, thigh, shanks, neck, breast, wings, back, head and the drumsticks. Dressing percentage was calculated according to Steven *et al*., (1981).

Collection of organ characteristics data

The weighed organs include the lungs, kidney, heart, spleen, liver, pancreas, proventriculus and the gizzard (closed and open).

Statistical Analysis

Data obtained were subjected to one-way analysis of variance (ANOVA) using the statistical Analysis system (SAS version 9.1, 2008). Where significant differences were found, the means were separated using the Duncan's multiple range test of the same statistical package.

Table 1. Vaccination and medication regime of broiler chicken

Administration period	Vaccination	Medication
Day 1	NDV-1/10 (HATCHERY)	Anti-stress, glucose
Day 2	1st Gumboro Vaccine	Vitamin
2nd week	NDV (lasota strain)	Antibiotics
3rd week	2nd Gumboro vaccine	Anti-coccidiosis
4th week	NDV (lasota strain)	Anti-coccidiosis
6th week		Wormazine

Table 2. Feed formulation for the experimental diets

Ingredients	0 %	5 %	10 %	15 %	20 %	STARTER
Maize	50.00	45.00	45.00	43.00	38.00	50.00
Wheat Offal	10.50	12.00	10.50	10.00	14.00	3.90
BDG	10.00	10.00	10.00	12.50	12.00	5.00
GNC	12.00	11.00	10.00	8.00	7.00	10.00
SBM	13.00	12.00	10.00	7.00	4.50	24.50
Fish Meal	0.00	0.00	0.00	0.00	0.00	3.00
Oyster Shell	0.20	0.20	0.20	0.20	0.20	0.20
Bone Meal	3.00	3.00	3.00	3.00	3.00	2.50
Methionine	0.35	0.35	0.35	0.35	0.35	0.25
Lysine	0.30	0.30	0.30	0.30	0.30	0.00
Broiler Premix	0.30	0.30	0.30	0.30	0.30	0.25
Salt	0.40	0.40	0.40	0.40	0.40	0.40
FDPS	0.00	5.00	10.00	15.00	20.00	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

RESULTS

Effect of fermented dried pawpaw seed on the performance of broilers (kg)

Table 3 shows significant ($P < 0.05$) differences in all the parameters, except the initial body weight. The final body weight was significantly highest in T1 (14.50 ± 0.86) and the lowest in T5 (10.16 ± 0.16). Total weight gain was significantly higher in T1 (7.53 ± 0.88), T2 (6.63 ± 0.72) and T3 (7.33 ± 0.66) compared with T4 (4.41 ± 0.66) and T5 (3.03 ± 0.26), respectively, while the daily weight gain and the daily feed intake took a similar trend as total weight gain. The treatment 5 had the significantly higher feed conversion ratio (6.92 ± 0.61) compared with T1 (3.42 ± 0.33), T2 (3.86 ± 0.48), T3 (3.43 ± 0.36) and T4 (5.07 ± 0.75), respectively.

Effect of fermented dried pawpaw seed on the carcass of broiers

Table 4 shows significant differences ($P < 0.05$) in all the parameters measured. The slaughtered weight ranged from 1.64 to 1.19 kg in T5. De-feathered weight was significantly highest (1.59 ± 0.15 kg) in T4 and lowest (1.15 ± 0.10 kg) in T5. The dressed weight, head weight, neck, wings, shanks, thigh A, thigh B, drumstick weight and breast muscle weight followed the same trend as de-feathered weight. T1 had significantly higher neck weight (0.71 ± 0.04 kg) compared with T2 (0.05 ± 0.01 kg), T3 (0.05 ± 0.01 kg), T4 (0.05 ± 0.01 kg) and T5 (0.05 ± 0.01 kg), respectively.

Table 3. Effect of fermented dried pawpaw seed on performance characteristics of broiler chicken (kg)

Treatments	Initial live-weight	Final live-weight	Total weight gained	Total feed intake	Daily weight gained	Daily feed intake
1 (0 %)	7.967 ± 0.1667	14.500 ± 0.8660^{a}	7.533 ± 0.8819^{a}	25.203 ± 0.4812^{a}	0.270 ± 0.3215^{a}	0.900 ± 0.0153^{a}
2 (5 %)	7.033 ± 0.1453	13.667 ± 0.8333^{ab}	6.633 ± 0.7219^{a}	24.913 ± 0.1073^{a}	0.240 ± 0.0252^{a}	0.890 ± 0.0058^{a}
3 (10 %)	7.467 ± 0.2906	13.800 ± 0.4163^{ab}	7.333 ± 0.6667^{a}	24.650 ± 0.1422^{a}	0.263 ± 0.0267^{a}	0.880 ± 0.0058^{a}
4 (15 %)	7.600 ± 0.3055	12.000 ± 0.5000^{bc}	4.410 ± 0.6667^{b}	21.320 ± 0.3182^{b}	0.157 ± 0.0260^{b}	0.760 ± 0.0116^{b}
5 (20 %)	7.133 ± 0.1333	10.167 ± 0.1667^{c}	3.033 ± 0.2603^{b}	20.670 ± 0.0872^{b}	0.110 ± 0.0116^{b}	0.737 ± 0.0033^{b}

^{abc} Means within the same column with different superscripts are significantly ($P < 0.05$) difference

Table 4. Effect of fermented dried pawpaw seed on the carcass of broilers (kg)

Treatments	1 (0 %)	2 (5 %)	3 (10 %)	4 (15 %)	5 (20 %)
Slaughtered weight	1.57 ± 0.120^{a}	1.47 ± 0.088^{ab}	1.40 ± 0.058^{ab}	1.65 ± 0.127^{a}	1.19 ± 0.096^{b}
De-feathered weight	1.50 ± 0.123^{ab}	1.42 ± 0.082^{ab}	1.39 ± 0.058^{ab}	1.59 ± 0.155^{a}	1.15 ± 0.104^{b}
Dressed weight	1.11 ± 0.061^{ab}	1.08 ± 0.069^{ab}	1.07 ± 0.033^{ab}	1.28 ± 0.122^{a}	0.86 ± 0.069^{b}
Head	0.05 ± 0.001^{a}	10.04 ± 0.002^{ab}	0.04 ± 0.001^{ab}	0.05 ± 0.003^{a}	0.04 ± 0.02^{b}
Neck	0.71 ± 0.005^{a}	0.056 ± 0.004^{b}	0.06 ± 0.002^{b}	0.06 ± 0.005^{ab}	0.05 ± 0.05^{b}
Wings	0.15 ± 0.009^{a}	0.14 ± 0.011^{ab}	0.13 ± 0.004^{ab}	0.15 ± 0.015^{a}	0.11 ± 0.009^{b}
Back	0.20 ± 0.009^{b}	0.27 ± 0.0039^{b}	0.22 ± 0.009^{b}	0.31 ± 0.076^{a}	0.17 ± 0.004^{c}
Shank	0.09 ± 0.008^{ab}	0.07 ± 0.008^{ab}	0.08 ± 0.001^{ab}	0.09 ± 0.006^{a}	0.07 ± 0.006^{b}
Thigh A	0.08 ± 0.006^{ab}	0.08 ± 0.008^{ab}	0.08 ± 0.008^{ab}	1.00 ± 0.009^{a}	0.06 ± 0.008^{b}
Thigh B	0.09 ± 0.04^{a}	0.08 ± 0.008^{ab}	0.08 ± 0.001^{ab}	1.00 ± 0.008^{a}	0.06 ± 0.009^{b}
Drum stick	0.17 ± 0.012^{ab}	0.15 ± 0.009^{b}	0.16 ± 0.004^{b}	0.20 ± 0.013^{a}	0.14 ± 0.011^{b}
Breast muscles	0.22 ± 0.0118^{a}	0.19 ± 0.004^{ab}	0.2 ± 0.021^{a}	0.23 ± 0.016^{a}	0.16 ± 0.021^{b}

^{abc} Means within the same column with different superscripts are significantly (P < 0.05) difference

Table 5. Effect of fermented dried pawpaw seed on the organs of broilers (kg)

Treatments	Kidney	Liver	Spleen	Heart	Proventriculus	Pancreas	Lungs	Intestine
1 (0 %)	0.007 ± 0.001^{a}	0.031 ± 0.001	0.001 ± 0.000	0.007 ± 0.001	0.012 ± 0.000^{ab}	0.004 ± 0.001	0.007 ± 0.000	0.132 ± 0.036
2 (5 %)	0.004 ± 0.001^{bc}	0.026 ± 0.002	0.001 ± 0.000	0.007 ± 0.001	0.015 ± 0.003^{ab}	0.003 ± 0.0000	0.008 ± 0.001	0.127 ± 0.009
3 (10 %)	0.006 ± 0.003^{ab}	0.032 ± 0.003	0.001 ± 0.000	0.001 ± 0.001	0.014 ± 0.001^{ab}	0.003 ± 0.001	0.007 ± 0.001	0.115 ± 0.005
4 (15 %)	0.003 ± 0.001^{c}	0.031 ± 0.002	0.001 ± 0.000	0.008 ± 0.002	0.016 ± 0.002^{a}	0.005 ± 0.000	0.007 ± 0.001	0.113 ± 0.003
5 (20 %)	0.004 ± 0.001^{c}	0.026 ± 0.002	0.001 ± 0.000	0.004 ± 0.009	0.009 ± 0.003^{b}	0.004 ± 0.001	0.007 ± 0.001	0.111 ± 0.018

^{abc} Means within the same column with different superscripts are significantly (P < 0.05) difference

Effect of fermented dried pawpaw seed on the organs of broiers

Table 5 shows significant difference in the kidney and proventriculus weight across the dietary treatments. T1 has the highest (0.007 ± 0.0009 kg), while T4 (0.003 ± 0.0006 kg) and T5 (0.004 ± 0.0009 kg), respectively, had the significantly lowest kidney weight. While T4 had the significantly highest proventriculus weight (0.016 ± 0.00015 kg) compared with T1 (0.012 ± 0.0003 kg), T2 (0.015 ± 0.0028 kg), T3 (0.014 ± 0.0013 kg) and T5 (0.009 ± 0.0031 kg), respectively. However, there were no significant difference (P > 0.05) in liver, spleen, heart, pancreas, lungs, intestine, gizzard open and gizzard closed weight across the dietary treatments.

DISCUSSION

The effect of adding fermented dried pawpaw seed into the diet of broiler chicken on their performance was evaluated with standard performance characteristics model. There were significant differences within the parameters across all treatments, i.e., up to 10 % of FDPS could be added into the broiler diet without any deleterious effects on the organs (Sugiharto *et al*., 2021). Bolu *et al*. (2009) observed that the broilers fed diet with non-fermented dried pawpaw seeds of 15 % inclusion has the lowest weight gain. This finding is in concert with this study, where 15 % and 20 % inclusion of FDPS had the least weight gains. However, 10 % inclusion of FDPS resulted in weight gain very similar to the control, which indicates that the fermented dried pawpaw seed is preferable compared to the non-fermented pawpaw seed. From

an economic point of view, feed-ing FDPS up to 10 % in the diet, however, exhibited no (P > 0.05) economic implications as measured by feed cost per kg live body weight gain and income over feed cost, as reported by Sugharto *et al*. (2021). The average feed conversion ratio (FCR) of diets T1, T2, T3, T4 and T5 were 3.42, 3.86, 3.43, 5.07 and 6.92, respectively, which implied that 15 % and 20 % inclusion of FDPS compromised FCR of broiler Chicken as the average cumulative FCR was highest using the diet T5 (having 20 % FDPS). Average value of feed conversion ratio for growing chicks varies from 2.03 to 2.28, as reported by Raman *et al*. (2010). In this experiment, average value of FCR ranged from 3.42 to 6.92, what is higher than reported in the above-mentioned study. Several other factors may be responsible for this, such as particle size of the feed ingredients, age of the birds and the genetic makeup of the chicks.

CONCLUSION

The study revealed that 10 % inclusion level of FDPS gave an impressive weight gain compared to studies carried out by several other authors. This could have been because of the fermentation procedure performed on the test ingredients. The FDPS seems to be preferable to the non-fermented pawpaw seed as the birds were able to consume more feed and gained more weight. Inclusion at a higher percentage of FDPS (15 % and above) could inhibit growth, as it was confirmed in 20 % inclusion level, where the decrease in feed intake was observed. The highest FCR, which means low profitability for broiler farmers, was also recorded at 20 % of FDPS inclusion.

AUTHOR'S CONTRIBUTIONS

Conceptualization: Akinduro, V. O.

Methodology: Akinduro, V. O., Oloruntola, O. D., Asaniyan, E. K., Osunkeye, O.J., Oyebisi, M. A.

Investigation: Akinduro, V. O., Oloruntola, O. D., Asaniyan, E. K., Osunkeye, O. J., Oyebisi, M. A.

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Writing-original draft preparation: Akinduro, V. O.

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Project administration: Akinduro, V. O.

All authors have read and agreed to the published version of the final manuscript.

DATA AVAILABILITY STATEMENT

Data presented in this study are available on request from the corresponding author.

CONFLICT OF INTEREST

There is no conflict of interest.

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