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EFFECTS OF PAWPAW (*Carica papaya*) LEAF MEAL ON NUTRIENT DIGESTIBILITY AND GROWTH PRFORMANCE OF JAPANESE QUAILS (*Coturnix coturnix japonica*)

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ABSTRACT

A six (6) weeks feeding trial was conducted to evaluate the effect of pawpaw (*Carica papaya*) leaf meal (PLM) on nutrient digestibility and growth performance of Japanese quails. A total of two hundred and seventy (270) Japanese quail birds were randomly allotted to five dietary treatments with three replicates of 18 birds each in a Completely Randomized Design (CRD). Five experimental diets were formulated in which diet 1 served as control (0 % PLM), while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20 % pawpaw leaf meal respectively. Water and feed were offered *ad-libitum.* Data collected on growth parameters and nutrient digestibility were subjected to analysis of variance using general linear model of SAS. The result showed that digestibility of dry matter was significantly ($p<0.05$) better (75.62%) in birds fed 5% PLM based diet when compared to other treatment groups (0, 10, 15, and 20 % PLM based diets) which were having similar percentage nutrient digestibility (70.94, 71.06, 71.14 and 70.96% respectively). Birds on 5% PLM based diet also had significantly ($p<0.05$) better final body weight (160.13 g/bird), daily weight gain (3.80 g/bird), daily feed intake (16.81 g/bird) and age at first egg (39 days) when compared to other treatment groups. However, the control group (0% PLM) had better feed conversion ratio (FCR) of 3.10 and feed cost per kg gain (₦388.12) when compared to other treatments (5, 10, 15, and 20% PLM based diet) which were having 4.04, 4.12, 4.71, 5.09 FCR and ₦461.07, ₦492.74, ₦507.60, and ₦521.33 feed cost per kg gain respectively. It was concluded that inclusion of PLM at 5% is optimal for improved nutrient utilization and growth performance of Japanese quails.

INTRODUCTION

The average African is meeting only 33% of the expected/recommended daily animal protein requirement and 66% of daily plant protein requirement (Atteh, 2003). This is attributed to the problem of feed shortage arising from skyrocketing prices of conventional protein and energy feed ingredients (such as groundnut cake, soybean, maize and sorghum) which have negatively affected animal protein supply and created a wide gap between the demand and supply of animal protein in Nigeria and many developing countries of the world (Oyawoye, 2002).

A realistic step towards enhancing animal protein supply and intake in Nigeria is the development and expansion of the poultry industry. In response to this, attention of scientists and researchers have turned to the rearing of Japanese quails (Edache *et al*., 2005). Quails are fast growing poultry species that are very economical to maintain as they require less floor space (Haruna *et al.,* 1997). They are small sized, early maturing, hardy and prolific (Robbins *et al*., 1991). They come to sexual

maturity and egg production early between 5-6 weeks of age and attain market weight of 150-180g at almost the same age. The meat and eggs are high quality protein with low body fat and cholesterol contents making it a choice product for individuals prone to cardiovascular diseases (Haruna *et al*., 1997; Olubamiwa *et al*., 1999). They have low feed requirement of 20-25g per day. In addition, they are fairly disease resistant and with proper care, quail hens can lay between 200 and 350 eggs in their first year (Oluyemi and Roberts, 2000).

The sources of protein for poultry feed are expensive and they constitute about 30-35% of their diet. The over dependence on the use of soyabeans and groundnut cake as major sources of protein in poultry feed has led to stiff competition between humans and livestock protein ingredients and consequently high-cost of poultry feeds (Abubakar *et al*., 2004; Agbede and Aletor, 2004).

A possible solution to the high cost of feeds may be a greater utilization of potential cheaper alternative feed ingredients, such as leaf meals (Odunsi *et al.,* 1999; Nworgu *et al.,* 2007; Iheukwumere *et al.,* 2008; Onyimonyi *et al.,* 2009), as replacement for the more expensive soybean cake/meal and fish meal. Leaf meals in quail diets would not only serve as a protein source, but also provide some vitamins, minerals and oxycarotenoids which may improve egg and carcass quality of the birds as observed in chickens by D'Mello *et al.* (1987) and Opara (1996).

Pawpaw (*Carica papaya*) leaves have the potential to supply dietary proteins required by birds. This is because they have a high crude protein (CP) content (30%) with low (5%) crude fibre levels (Onyimonyi *et al.,* 2009). Additionally, pawpaw leaves contain papain (5.3%), a natural enzyme that helps in the digestion of proteins (Singh *et al.,* 2011) in the digestive tract, and vitamin C (286 mg/100g), as well as vitamin E (30 mg/100 mg) (Watt and Breyer-Brandwijk, 1962). They also contain high levels of base metals (potassium, sodium, calcium, and magnesium), and appreciable levels of iron (Maisarah *et al.,* 2014). However, leaf meals are known to adversely affect nutrient utilization in monogastric animals by diluting macronutrients (Longe and Ogedengbe, 1989; Sobayo *et al.,* 2012). Despite pawpaw leaf meal's potential as a replacement for soyabean to reduce the cost of feeding quails, its impact on nutrient digestion, utilization, growth performance and carcass characteristics of birds fed on it has not been adequately and effectively evaluated. This study therefore investigated the effect of diet containing graded level of pawpaw leaf meal (PLM) on growth performance and nutrient digestibility of Japanese quails (*Cutornix cutornix japonica*).

MATERIALS AND METHODS

Experimental site

The study was conducted at the Poultry Unit of the Department of Animal Science Teaching and Research Farm, Ahmadu Bello University, Samaru, Zaria, Kaduna State. It is located within the Northern Guinea Savanna Zone of Nigeria on latitude 11°09' 01.78" N and longitude 7°39'14.79" E, 671m above sea level. The climate is characterised by well-defined dry and wet seasons with a mean annual rainfall ranging from 700-1400mm. The maximum temperature varies from 26 – 40°C depending on the season, while the relative humidity during the dry and wet seasons are 21 and 72% respectively (IAR, 2016).

Source and Processing of Pawpaw Leaf

Fresh pawpaw leaves were collected from Mallam Shehu pawpaw plantation at Hayin Gada, along Shika Road, Sabon Gari Local Government area of Kaduna State and dried in a shade to a crispy feel. It was then ground in a hammer mill to produce pawpaw leave meal (PLM).

Experimental Diets

Five experimental diets were formulated. Diet 1 served as control (0% PLM) while diets 2, 3, 4 and 5 contained 5, 10, 15 and 20% pawpaw leaf

meal respectively. The composition of the experimental diets is shown in Table 1.

Proximate and Chemical Composition of Pawpaw Leaf Meal:

The proximate composition (dry matter, crude protein, crude fibre, ether extract, ash and nitrogen free extract) of the samples of pawpaw leaf meal were determined using the standard methods described by AOAC, (1990) in the Biochemical Laboratory, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. To determine the dry mater (DM) content, weighed samples were put into an oven at 105^0C for 16 hours. The DM was then determined based on weight loss. Macro Kjeldahl method was used in determining the nitrogen (N) content of the leaf meal sample and the crude protein was calculated as N × 6.25. The ash content was determined as residue remaining after incinerating the sample at 600^0C for 3 hours in a muffle furnace. The presence of anti–nutritional factors (ANF) such as tannin, phytate, oxalate, and saponin were detected quantitatively by the standard methods described at the Biochemical Laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria.

Design and Management of the Experimental Birds

Two hundred and seventy (270) one-week old Japanese quail chicks purchased from National Veterinary Research Institute (NVRI) Vom, Jos, were used for the study. The birds were randomly allotted to five dietary treatments with three replicates of 18 birds each in a Completely Randomized Design (CRD). All routine management practices and necessary biosecurity measures were carried out. Water and feed were administered *ad-libitum* throughout the period of the experiment.

Growth Performance Parameters:

Performance parameters measured include initial body weight, final body weight, and weight gain, feed intake, age at first egg and first egg weight. Feed intake and body weight gain were taken weekly. This was used to calculate feed conversion ratio, average daily feed intake, average daily weight gain and feed cost/kg gain.

Nutrient Digestibility:

Digestibility trial was carried out at the end of the growing phase after sexing at 6 weeks of age. Three male birds from each replicate were taken to a clean, separate and disinfected metabolic cage with polythene bag attached beneath the cage to collect the excreta. They were allowed 3 days acclimatization period and thereafter the study was conducted for 5 days. A known weight of feed (100g) was given to the birds in each pen by 8:00am daily during the digestibility trial. Total faecal output for each pen was collected from the polythene bag attached beneath the metabolic cage every morning prior to feeding for a period of five (5) days, the faeces were bulked and dried. The dried faecal samples along with the feed samples were taken to the Biochemical Laboratory, Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria for determination of proximate composition using methods described by A.O.A.C (2005). The % apparent digestibility was calculated using the equation below:

$$\% \text{ Digestibility of Nutrient} = \frac{\text{nutrient intake} - \text{nutrient output}}{\text{nutrient intake}} \times 100$$

Nutrient intake (g) = feed intake X nutrient in diet

Nutrient output (g) = faecal output X nutrient in faeces

Data Analysis

Data generated were subjected to analysis of variance (ANOVA) using the general linear model procedure of Statistical Analysis System (SAS, 2008) while significant differences between treatment means were separated using Duncan Multiple Range Test in the SAS package.

Table 1: Composition of quail starter diet containing graded levels of pawpaw leaf meal

	Inclusion levels of pawpaw leaf meal (%)				
Ingredient	**0**	**5**	**10**	**15**	**20**
Maize	43.20	41.20	39.00	37.20	35.50
SBC	35.00	33.00	31.20	28.00	26.00
PLM	0.00	5.00	10.00	15.00	20.00
Groundnut Cake	18.00	17.00	16.00	16.00	15.00
Bone Meal	3.00	3.00	3.00	3.00	3.00
Common salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.30	0.30	0.30	0.30	0.30
Vit/Min. Premix**	0.25	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**	**100**
Calculated Analysis					
Metabolizable Energy (kcal/kg)	2954	2937	2920	2901	2906
Crude Protein (%)	27.09	27.11	27.21	27.11	27.15
Crude Fibre (%)	4.65	4.75	4.85	4.90	5.01
Ether Extracts (%)	6.17	6.19	6.21	6.22	6.25
Calcium (%)	1.21	1.20	1.19	1.18	1.18
Available Phosphorus (%)	0.87	0.85	0.83	0.81	0.79
Lysine (%)	1.40	1.32	1.25	1.15	1.17
Methionine (%)	0.67	0.65	0.63	0.61	0.59
Cysteine (%)	0.39	0.37	0.35	0.33	0.31
Cost per kg diet (₦)	125.10	119.44	113.97	107.74	102.29

**Vitamin-Mineral Premix provided per Kg the following: Vitamin A, 10,000iu; Vitamin D_3, 2,200,000iu; Vitamin E, 10,000mg; Vitamin K_3, 2,000mg; Vitamin B_1, 1,500mg; Vitamin B_2 5000mg; Vitamin B_6, 1,500mg; Vitamin B_{12}, 10mg; Folic acid, 500mg; Niacin, 15,00mg, Calpan, 5000mg; Biotin, 20mg; Antioxidant, 125,000mg; Cobalt, 200mg; Selenium, 200mg; iodine, 1,000mg; Iron, 40,000mg; manganese, 70,000mg; Copper, 4,000mg; Zinc, 50,000mg; choline chloride 150,000mg
SBC = Soyabean cake
PLM = Pawpaw Leaf Meal

RESULTS AND DISCUSSION

The result of proximate composition of pawpaw leaf meal is presented in Table 2. The result showed that pawpaw leaves have high in crude protein (26.78%), and low in crude fibre (10.22%), carbohydrates (49.01%) and minerals (12.93%) contents. The crude protein content obtained for pawpaw leaf is 26.78% which is lower than 30.12% reported by Onyimonyi and Onu (2009), 28.20% by Ebenebe *et al*. (2011), 29.8% by Kanyinji and Zulu (2014) and 32.6%

by Okoli *et al.* (2014). It was however comparable to the value of 25.30% reported by Unigwe *et al.* (2014), and 26.14% by Oloruntola, *et al.* (2018). The variation could be attributed to difference in geographical location, season and nutrient status of the soil. The high protein content of PLM suggests its suitability and utilization as a protein supplement in diets for the birds (Onyimonyi and Onu, 2009). The crude fibre (CF) content of 10.22% obtained in this study is high when compared to 5.60% reported by Onyimonyi and Onu (2009), 8.86% by Unigwe *et al.* (2014) but lower than 24.80, 11.40, 12.00 and 12.93% observed for *Microdesmis puberula*, cassava, neem and mucuna leaves respectively (Esonu *et al*., 2006; Iheukwumere *et al*., 2008; Onyimonyi *et al*., 2009 and Emenalom *et al*., 2009). The relatively low fibre of PLM is indicative of its potential as feedstuff for poultry birds when included at optimum level. The ash content of 12.93% obtained in this study is higher than the value of 8.88% reported by Unigwe *et al.* (2014), and 16.05% by Oloruntola *et al.* (2018). The relatively high content of ash is a reflection of its deposit of mineral elements (Antia *et al*., 2006). These various reports may arise from the natural variability of plant secondary metabolite and chemical compositions (Nahak *et al.*, 2014; Valenzuela-Grijalva *et al.*, 2017).

Table 2: Proximate Composition of Pawpaw Leaf Meal

Parameters	**Pawpaw leaf composition (%)**
Dry matter	92.65
Crude Protein	26.78
Crude Fibre	10.22
Ether Extract	1.06
Nitrogen Free Extract	49.01
Ash	12.93

The result of the anti-nutritional factor composition of pawpaw leaf meal is presented in Table 3. The result revealed that PLM contains tannin (0.07mg/100g), saponin (17.80 mg/100g), oxalate (1.62 mg/100g), phytate (0.30 mg/100g). Oloruntola *et al.* (2018) also reported that PLM contain saponin (16.90 g/kg), tannin (0.01 g/kg), phytate (20.18 g/kg), oxalate (6.11 g/kg). The presence of ANF in PLM was also reported by Oche *et al.* (2017) with the leaf having saponin (3.84 mg/100g), phytate (6.98 mg/100g), Oxalate (0.18 mg/100g), tannin (0.55 mg/100g). From this finding, pawpaw is reported to contain appreciable amount of saponin as suggested by other researchers. However, the variation in concentration could be due to the type of leaves analyzed or stage of harvesting the leaves since younger leaves are known to contain lower ANF contents compared to older leaves.

Table 3: Anti-nutrient Composition of Pawpaw Leaf Meal

Parameters	Composition (mg/100g)
Tannins	0.07
Saponins	17.80
Oxalate	1.62
Phytate	0.30

The growth and early laying performance of quail chicks fed diets containing graded levels of pawpaw leaf meal is shown in Table 4. The result showed that there were significant ($P<0.05$) differences in all the parameters measured. The significantly higher final weight and average daily weight gain observed in birds fed 5% pawpaw leaf meal-based diet could be attributed to the low fibre in their diet when compared to other treatment groups with higher inclusion of pawpaw leaf meal. Fibre is known to be poorly digested by poultry species and thus its higher percentage in the diet interferes with nutrient digestion and absorption which leads to depressed growth as suggested by Opara (1996) and Iheukwumere *et al.* (2008) because monogastric animals lack appropriate enzymes to degrade CF (Danickle *et al.,* 1999; Babalola *et al.,* 2006). Kanyinji and Zulu (2014) also reported weight gain in quails fed diets containing up to 6% PLM. However, this finding disagrees with the work of Unigwe *et al.* (2014) who reported no significant differences in weight gains of broiler chickens fed diets containing sundried pawpaw leaf meal even as the level of inclusion increased. The variation observed could be attributed to specie differences and methods of drying the leaves.

The higher feed intake in birds fed 5% pawpaw leaf meal-based diet agrees with the findings of Unigwe *et al.* (2014) who reported high feed intake in quails fed diets containing 6% PLM. This might be as a result of low energy values of the feed when compared to the control and due to high fibre content of other diets which had an energy dilution effect on these diets and a consequential increase in feed intake as suggested by Esonu *et al.* (2005), who worked on the inclusion of neem leaf meal in the diet of laying hens. It is most probable that the better FCR observed in the control group was due to lower crude fibre content of the diet compared to the rest of the birds on higher fibre supplied by the PLM, since fibrous diets are not well digested by monogastrics (Onyimonyi and Onu, 2009). In research finding reported by Unigwe *et al.* (2014) broiler birds that were not given pawpaw leaf meal-based diet gave a better FCR than those on PLM based diet. Ironkwe and Oruwari, (2012) observed that high crude fiber caused an increasing digestion rate in the gastrointestinal tract and therefore reduced digestion time and nutrient absorption by the gastrointestinal membrane. Jiménez-Moreno *et al.* (2013) also reported that increasing total fibre in the diet significantly affected nutrient retention (dry matter, organic matter, and nitrogen).

Age at first egg was significantly lower in birds fed 5% PLM based diets when compared to other treatments. This indicates that the inclusion of PLM at lower levels improved the nutritive and reproductive potentials of the birds due to the high CP content of PLM (30.12%) and low fibre (5.60%) which facilitates better digestion and utilization of nutrients as suggested by Onyimonmiyi and Onu, (2009).

Papaw also contains four identified proteolytic enzymes (papain, chymopapain A and B and papaya peptidase A (Yadava *et al*., 1990), phytosterols and antioxidants, enzymes,

flavonoids (Saeed *et al.,* 2014) which enhance productivity. This finding is similar to that of Subekti *et al*. (2008) who indicated that quails fed Katuk leaf meal (KLM) based diet laid eggs faster than the quails fed control diet (0% KLM). The result indicates that phytosterols and antioxidants contained in leaf meals enhanced the reproductive performance of quails.

Table 4: Effects of diets containing graded levels of Pawpaw Leaf Meal on growth and early laying performance of quail chicks (2 – 6 weeks)

	Inclusion levels of pawpaw leaf meal (%)					
Parameters	**0**	**5**	**10**	**15**	**20**	**SEM**
Initial Weight (g/bird)	46.1	46.03	46.03	46.04	46.03	0.04
Final Body Weight (g/bird)	145.35^{c}	160.13^{a}	156.11^{b}	134.7^{d}	132.27^{e}	0.73
Daily Weight Gain (g/bird/day)	3.30^{c}	3.80^{a}	3.66^{b}	2.95^{d}	2.87^{e}	0.02
Daily Feed Intake(g/bird/day)	10.98^{d}	16.81^{a}	15.90^{ab}	14.91^{c}	15.69^{bc}	0.50
Feed Conversion Ratio	3.10^{a}	4.04^{bc}	4.12^{c}	4.71^{d}	5.09^{e}	0.14
Age at First Egg (days)	42.00^{b}	39.00^{a}	43.66^{c}	46.33^{d}	49.00^{e}	0.67
First Egg Weight (g)	8.00^{b}	8.66^{ab}	8.33^{ab}	7.00^{c}	9.00^{a}	0.49
Feed Cost (₦)/kg gain	388.12^{a}	461.07^{b}	492.74^{bc}	507.60^{c}	521.33^{c}	17.08

^{a,b,c,d,e} = means with different superscripts on the same row are significantly different ($p<0.05$).
SEM = Standard Error of Means

The result of the effect of diets containing pawpaw leaf meal (PLM) on the digestibility of nutrients and ash retention by Japanese quail chicks is presented in Table 5. Dietary treatments had significant ($P<0.05$) effect on all the parameters measured. It was observed that percentage digestibility of dry matter was significantly ($p<0.05$) higher in birds fed diet containing 5% PLM compared to other treatment groups were statistically similar. Digestibility of crude protein was significantly ($p<0.05$) higher in birds fed 20% PLM based diets compared to other treatment groups but is comparable to those of birds on 5 and 15% PLM based diets. Crude fibre, ether extract and nitrogen free extract digestibility were all significantly higher in birds fed 5% PLM based diet followed by the control group in the same trend.

The significantly higher digestibility of dry matter observed in birds fed 5% PLM based diet may be attributed to low fibre when compared to treatments with higher PLM inclusion levels. However, when compared to the control, the presence of papain (a proteolytic enzyme that aids digestion) in diet containing 5% PLM gave the birds an edge over those in the control group. Dry matter digestibility in this study was higher than the values reported by Alu (2012) and Yonika (2014) that the digestibility of dry matter by quail layers was between 47.49-60.27%. It is however closely in agreement with the findings of Fransisca *et al.* (2017) who reported that the dry matter digestibility of quail layer ranges from 72-73%. Kanyinji and Zulu (2014) reported higher DM digestibility range of 81.4 – 88.4% in growing quails fed diets containing between 2-6% PLM. The digestibility of crude protein in this study was higher than the results reported by Alu (2012) which ranged from 55.24 to 69.21%, and the one reported by Fransica *et al.* (2017) which

was between 40.44% - 49.49%. It also varied from the values by Kanyinji and Zulu (2014) who reported percentage CP digestibility to be between 75-92% for birds fed diets containing 2–6% PLM. The variation could be attributed to diet composition and nutrient dilution effect of antinutrients present in PLM.

Higher digestibility of crude fibre, ether extract and nitrogen free extract observed in birds fed 5% PLM based diet could be attributed to the fact that pawpaw leaves may not only supply dietary proteins required by quails, but also provide herbal proteolytic enzymes to enhance digestibility of ingested feed in the tract, thereby accelerating their growth (Maisarah *et al.*, 2014). This finding agrees with the work of Kanyinji and Zulu (2014) who reported better digestibility of nutrients in birds fed diets containing 6% PLM. The lower percentage digestibly of crude fibre, ether extract and NFE observed in birds fed diets containing 10, 15 and 20% PLM could be attributed to the fact that leaf meals are known to adversely affect nutrient utilization in monogastric animals by diluting macronutrients as advanced by Longe and Ogedengbe, (1989) and Sobayo *et al.* (2012), modifying gut characteristics and intestinal morphology (Wu *et al.*, 2004; Sobayo *et al.*, 2012), as well as altering the upper and lower part of the digestive tract (Gabriel *et al.*, 2003; Hetland *et al.*, 2003; Sobayo *et al.*, 2012). Thus, it is expected that increasing PLM level in the diets would reduce digestibility of nutrients. Percentage ash digestion was higher in birds fed diets containing 20% PLM and this could be attributed to high level of base metals (calcium, sodium, potassium and magnesium) found in pawpaw leaf as suggested by Maisarah *et al.* (2014).

Table 5: Effects of diets containing graded levels of pawpaw leaf meal on apparent nutrient digestibility of Japanese quails

	Inclusion levels of pawpaw leaf meal (%)					
Parameters (%)	**0**	**5**	**10**	**15**	**20**	**SEM**
Dry matter	70.94^{b}	75.62^{a}	71.06^{b}	71.14^{b}	70.96^{b}	0.39
Crude Protein	68.16^{b}	70.71^{ab}	69.68^{b}	73.13^{ab}	75.58^{a}	5.95
Crude Fibre	44.83^{b}	63.95^{a}	45.19^{b}	38.70^{bc}	29.23^{c}	12.12
Ether Extract	67.18^{b}	76.63^{a}	72.45^{ab}	70.71^{b}	69.04^{b}	5.64
Ash	63.11^{c}	69.42^{b}	58.35^{d}	60.49^{d}	74.39^{a}	2.39
Nitrogen Free Extract	76.57^{b}	81.16^{a}	76.23^{b}	74.44^{b}	67.42^{c}	3.38

$^{a,b,c,\ ab}$ = means with different superscripts on the same row are significantly different ($p<0.05$).
SEM = Standard Error of Means

CONCLUSION

The inclusion of pawpaw leaf meal at optimum level (5%) has positive effect on growth performance and nutrient digestibility of Japanese quails. This is evident by the better performance of birds on 5% PLM based diet and poor performance of those on 20% PLM based diets as observed in this study. It was also evident from the results that birds on 5% PLM based diet were able to digest nutrients better than those in other treatment groups. This indicates that the inclusion of PLM at 5% in the diet of growing Japanese quails is optimal for better growth and digestibility of nutrients in quails.

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