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Nutritional evaluation of *Picralima nitida* seed powder in diets of broiler chickens

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Abstract
Resistance of microbes to synthetic drugs necessitates the use of phyto-additives as organic-based medications in poultry diets. A natural alternative is Picralima nitida with antimicrobial and antioxidant activities that can be exploited in poultry nutrition. This study, therefore, evaluated the response of broiler chickens to Picralima nitida seed powder (PnSP). A total of 150-day-old Arbor Acre chicks were divided into 5 dietary treatments with 3 replicates of ten birds each. In a completely randomized design, the starter (21 days) and finisher (28 days) diets for the chickens were 0, 0.05, 0.1, 0.15, and 0.2% PnSP-based. Average Daily Gain (ADG), Average Daily Feed Intake (ADFI), Feed to Gain Ratio (FGR), Performance Efficiency Index (PEI), carcass (cut-up parts), selected organs and intestinal morphometry were evaluated. Data collected were subjected to a one-way analysis of variance and treatment means separated using Duncan Multiple Range Test. At the starter phase, ADG increased (p=0.04) with the use of PnSP, and the optimal value was obtained at 0.15%, and the best (p=0.04) PEI 171.91 was obtained in chickens subjected to 0.1% PnSP. Abdominal fat (p<0.001) decreased in broilers fed PnSP-supplemented diets while the highest (p=0.01) thigh weight was obtained from chickens fed 0.1% PnSP supplemented diet. In conclusion, supplementing 0.2%PnSP in broiler diet had no adverse effect on the performance and carcass characteristics of broilers, however, 0.1% PnSP gave the optimum inclusion level.

Keywords: *Abdominal fat, carcass, efficiency index, performance, Picralima nitida*

Introduction

The sub-therapeutic use of synthetic antibiotic growth promoters in animal feed to improve growth and avoid infectious intestinal disorders has produced a problem of drug residues in finished animal products due to the rising use of antibiotics in both veterinary and human circumstances, which has resulted in the emergence of new antibiotic-resistant bacteria and posed a severe threat to public health (Shittu *et al*., 2022). This has made it possible to incorporate phyto-additives, as organic remedies into the diets of poultry. Through the use of phytoadditives in animal diets, as anti-oxidant and antimicrobials, performance metrics are enhanced and disease is averted without affecting the health of consumers as elucidated in different researches (Puvaca *et al*., 2013; Burt, 2004; Ruberto *et al*., 2002).

A growing number of additives are being used in the production of broilers due to their impact on animal growth (Vera *et al*., 2021); to achieve the projected growth rate as quickly as possible and cut production costs in light of the world's expanding population in both developed and developing nations. *Picralima nitida* (K. Schum) Hallier

(Olufunmilayo *et al*., 2015), *Morinda lucida* (Lala *et al*., 2017), and turmeric (Odunsi *et al*., 2017) are a few examples of such additives. This study's focus plant, *P. nitida*, was frequently alluded to as *Hunteria umbellata. Picralima nitida* plant parts, particularly the leaves, roots, seeds and barks are highly prized in African folk medicine for the treatment of a variety of animal and human ailments. For instance, the plant's stem and root decoction are thought to have antihelminthic properties and be used to cure swellings (Gill, 1992). Traditional midwives in West Africa use both the plant's leaves and seeds to cure conditions connected to pregnancy as well as to hasten or speed up labor at term (Falodun *et al*., 2006). According to reports, *P. nitida* lowers blood sugar levels, treats diabetes and lowers blood pressure and cholesterol levels while also easing joint and muscle pain (Akinsola, 2016).

There is a paucity of information on its use in the livestock industry except for a study on the rabbit by Ibeh *et al.* (2007) in which it was reported that 0.5 ml and 1.0 ml dosage of *Hunteria umbellata* seed extract did not exhibit any marked toxicity in the animals. Olufunmilayo *et al*. (2015) also reported that infusion of 100 mg ethanol extract of *H. umbellata* per body weight of albino rats did not elicit any hematotoxicity effect, had a hypoglycemic effect and may also reduce oxidative stress but could cause hepatic damage if a high dose is consumed for a long time. The anti-inflammatory activity of *P. nitida* could be attributed to its alkaloid content (Adeneye *et al.,* 2013). According to preliminary studies on *P. nitida* (Haruna and Odunsi, 2022), it included significant concentrations of secondary metabolites, minerals and other nutrients, suggesting that it might be a possible source of the nutrition required to breed healthy birds. Therefore, this research intended to determine how graded levels of *P. nitida* seed powder (PnSP) affected the performance and carcass traits of broiler chickens.

Materials and Methods

Description of the experimental site

The study was conducted at the Teaching and Research Farm (Broiler Unit), Ladoke Akintola University of Technology, Ogbomoso. Ogbomoso is situated in the derived savannah at latitude 8^{o} 10^{1} north of the equator and longitude 4^{o} 10^{1} east of the Greenwich meridian. The altitude varies from 300 to 600 meters above sea level, and the average annual temperature and rainfall are both 27^{o} C and 1247 mm, respectively (Google Earth, 2018).

Procurement and Processing of *Picralima nitida* seed

Picralima nitida pods were sourced from Ago Owu Farm Settlement, Ikoyi, Osun State, Nigeria. The pod and leaves of the plant were taken to the Forestry Research Institute of Nigeria (FRIN) for identification and authentication in the herbarium, taxonomy section and a herbarium number FHI-113021 was obtained. The pods were broken to remove the seed and processed to powder form as described (Adeneye *et al.,* 2013; Haruna and Odunsi, 2022) in the Animal Biosciences Unit of the Department of Animal Nutrition and Biotechnology, LAUTECH, Ogbomoso. The seeds were cleaned with distilled water, de-hulled and diced into small sizes with a stainless knife to facilitate air-drying at room temperature for 4 days when constant weights were obtained. The dried seeds were screened to remove undesirable materials such as stones and other extraneous matter and thereafter, were milled with Super Master (SMB-2977) electric blender into powder form termed *Picralima nitida* Seed Powder (PnSP) and stored in an air-tight container and kept in a cool place until needed for animal trial. The samples of the starter and finisher diet were analyzed for proximate contents using AOAC (2007). Pictures taken while processing were presented in Plates 1a-d.

Plate 1a: *Picralima nitida* pod

Plate 1b: *Picralima nitida* seed

Plate 1c: *Diced Picralima* nitida seed

Plate 1d: *Picralima nitida* Seed Powder (PnSP)

Experimental birds, diets and management

One hundred and fifty (150) day-old broiler chicks (Arbor Acre) from a reputable hatchery in Nigeria were used for the study. On arrival, the birds were randomly allotted to five dietary treatments of 3 replicates of ten birds each after the initial weight has been taken using Camry (Emperors) digital weighing scale. The model number of the scale is El-02HS with a weighing capacity of 3000 g and to the nearest 0.5 g. The birds were offered diets and water mixed with vitamins and glucose to minimize transportation stress. The birds were subjected to standard poultry routine practices such as brooding, medication and vaccination at appropriate ages in the course of the experiment. The birds were offered feed and drinkable water *ad-libitum* on daily basis throughout the experiment which lasted for seven (7) weeks. Broiler starter diets were offered from 0-3 weeks while broiler finisher diets were offered from 4-7 weeks. Five iso-nitrogenous and iso-caloric broiler starter and finisher diets were formulated such that PnSP was included at five levels (0, 0.05, 0.1, 0.15 and 0.2%) in diets, A, B, C, D and E respectively, at starter and finisher phases and their control diets are presented in Table 1**.**

Table 1: Gross and analysed composition of starter (0-3 weeks) and finisher (4-7 weeks) diets (DM %)

Ingredients (%)	Starter	Finisher
Maize	52.10	57.00
Soya bean meal	27.00	23.00
Groundnut cake	8.00	4.00
Wheat offal	5.00	8.60
Fish meal (72% CP)	3.00	2.50
Di-calcium phosphate	3.00	3.00
Limestone	1.00	1.00
Lysine	0.20	0.20
Methionine	0.25	0.25
Broiler premix*	0.25	0.25
Salt	0.20	0.20
PnSP	-	-
Total	**100**	**100**
Analyzed composition (%)		
Crude protein	23.05	19.91
Ether extract	5.05	4.66
Crude fibre	4.31	5.09
Ash	7.10	6.90
Dry matter	93.11	93.55
NFE**	53.60	56.99
ME (kcal/Kg)+	2875.67	2903.66

*100 kilogram of diet contained the following vitamins and minerals: Vitamin A = 12IU, Vitamin D_3 = 2500IU, Vitamin E = 30mg, Vitamin K = 2mg, Vitamin B_1 = 2.25mg, Vitamin B_2 = 6mg, Vitamin B_{12} = 0.015mg, Niacin = 40mg, Pantothenic Acid = 15mg, Folic Acid = 0.05mg, Biotin = 300mg, Chloride = 80mg, Manganese = 50mg, Zinc = 20mg, Iron = 5mg, Copper = 5mg, Iodine = 1mg, Selenium = 0.2mg, Cobalt = 0.5mg and Antioxidant = 125(IU)
** Nitrogen Free Extract, + Calculated from ingredient analysis table

Data collection

Zootechnical performance

Data were collected daily on Feed Intake (DFI) and Average Daily Gain (ADG) while Feed to Gain Ratio (FGR) and survivability were computed using the appropriate formula. Performance Efficiency Index (PEI) was computed using the formula described by Martins *et al.* (2015), whereby, live weight was multiplied by % survivability and divided by the multiplication of age at slaughter and FGR, the result was then multiplied by 100.

Carcass and organ evaluation

Two birds that had similar body weights and were quite close to the average weight of each replicate were chosen for slaughter on day 49. They were properly bled by hanging upside down and then scalded using water at the temperature of 60°C. They were de-feathered, eviscerated and dressed. The weights were recorded at each stage. The weight of the cut-up parts (thigh, breast, neck, wings, drumsticks and back); abdominal fats, organs (heart, kidney, lungs, liver, spleen, cleaned gizzard, crop and proventriculus) and offal (small intestine, large intestine and caecum) were recorded and expressed to live weight basis. Lengths of offal were also measured and expressed to the live weight of sacrificed birds (i.e cm/kg).

Ethical approval

The general instructions of institutional rules for the care and use of laboratory animals were strictly followed in the execution of this investigation. Chickens were treated humanely following the established ethical norms (World Medical Association Declaration of Helsinki, 2013).

Statistical analysis

The data collected were subjected to a one-way analysis of variance (ANOVA) using the procedure of SAS (2003). Significant mean differences were determined using Duncan's Multiple Range Test of the same package at a 5% probability level. In addition, orthogonal contrast (linear, quadratic and cubic) was determined for growth performance parameters.

Model for one way:

Y ij = μ + α i + G!H!I!

Where,

Yij = jth observation of the ith treatment

μ = Population mean

α i = Effect of ith PnSP (i=0, 0.05, 0.1, 0.15 and 0.2)

G!ij= Experimental Error

Results and Discussion

Growth performance

The effects of *P. nitida* seed powder on growth performance throughout the starter (1-21 days), finisher (22-49 days) and pooled phases (1-49 days) are shown in Table 2. All of the parameters examined at the starter phase were not significantly affected (p>0.05), except for the final live weight (FLW) and ADG, which showed significant changes (p<0.05). Broiler chicks fed (0.15% PnSP) had the highest FLW and ADG values (p=0.07), whereas birds fed (0.1 PnSP) had the least value. Graded quantities of PnSP did not have a substantial impact on the ADFI, FGR and survival percentage. Furthermore, orthogonal contrast had no discernible influence on all evaluated growth indices. Weight gain during the starter phase was greatest when 0.15% PnSP was added to broiler diets. The therapeutic effects of *P. nitida*, which increased endogenous digestive enzyme secretion, reduced the growth of harmful bacteria and stimulated immunological responses, may be responsible for the outcome (Ajayi and Ojelere, 2013; Olufunmilayo *et al*., 2015; Akinsola, 2016). The findings corroborated prior studies on turmeric (Odunsi *et al*., 2015), *Morinda lucida* (Lala *et al*., 2017), garlic (Diya, 2018; Ali *et al*., 2019), ginger (Ali *et al*., 2019) and *Polyalthia longifolia* (Shittu *et al*., 2022) that phytoadditives improved growth performance in broiler chickens during the starter phase.

The performance of broiler chickens was observed to be significantly improved by the application of turmeric up to 10 g/kg (Mondal *et al*. 2015 and Choudhury *et al*., 2018). Garlic (*Allium sativum*), according to Diya (2018) and Ali *et al*. (2019), was found to promote broiler chicken growth. The current finding corroborated the claims stated above but contradicted Namagirilakshmi (2005) that the inclusion of turmeric at levels up to 1% did not have a significant impact on the body weight gain of broiler chickens; the fluctuation was likely caused by the different species and chemical makeup of the spices. The report of Spernakova *et al*. (2007) was supported by the decrease in body weight of birds fed 0.2% PnSP. Five phytoadditives (thyme, oregano, marjoram, rosemary and yarrow) and their corresponding essential oils were supplied to female Ross broiler chickens at rates of 10 g/kg and 1 g/kg, respectively. It was discovered that the BWG of the birds fed oregano herb and oil was much lower. The relationship between FI and BWG is described by the feed-to-gain ratio. More specifically, it establishes how effective the animal was overall at converting feed mass into body mass over a certain time frame. The results of Hernandez *et al*. (2004) using two commercial, three-component combinations (oregano, cinnamon and pepper) and (sage, thyme and rosemary) were supported by the insignificant difference in the FGR of the birds. However, according to Raghdad and Al-Jaleel (2012), the addition of turmeric to a mixture of *Allium sativum* (garlic), *Thymus vulgaris* (thyme) and *Echinacea purpurea* (cornflower) enhanced FGR in broiler chicks.

Except for % survivability, where birds in the control treatment had the lowest value of 83.33% and those on 0.15% PnSP had 96.67%, growth performance during the finisher phase (22-49 d) exhibited no significant (p>0.05) influence on any parameters. Orthogonal contrast also had no noticeable impact on the growth indicators that were monitored. Performance at the finisher and combined phases followed a similar pattern, with no notable differences seen for any of the parameters assessed except survivability, which was improved by the application of PnSP. According to Adeneye and Crooks (2015), the phytoadditive characteristics of alkaloids can boost the birds' immune, which may account for the increased survivorship with the usage of PnSP. The outcome is consistent with Onunkwo and George's (2015) findings that Moringa oleifera leaf meal did not affect broiler finisher chicken performance, but it differs from those reported by Morakinyo *et al*. (2017), Odunsi *et al*. (2017) and Mondal *et al*. (2015), who found that turmeric had a significant impact on the growth performance of broiler finisher chickens.

Although the parameters for the pooled phase (1-49d) did not differ significantly (p>0.05), however, the FLW and FGR of the birds given the diet containing 0.1% PnSP were higher (p=0.29) and better (p=0.57), respectively. The PEI (%) was significantly greater (p=0.04) in birds-fed diets supplemented with PnSP, while the lowest PEI (128.89%) was found in birds fed the control diet. None of the parameters differed significantly (p>0.01) in the orthogonal contrast. When compared to birds on a PnSP-free diet, the weights of the birds on levels over 0.1% PnSP numerically increased; but, when compared to birds on 0.05% and 0.1%, their weights dropped. This, however, corroborated reports from some earlier studies that found some phytoadditives to be growth stimulants at low doses and growth retardants at high doses. Examples of these include crude pawpaw (*Carica papaya*) latex (Haruna and Odunsi, 2018), rosemary leaf meal (Ghazalah and Ali, 2008) and safflower seed meal (Ghazalah and Ali, 2018). The findings of this study demonstrated that PnSP, depending on its amount of inclusion in the diet and the age of the chickens, can both stimulate and suppress development in broiler chickens. The PEI found in birds fed 0.05% (170%) and 0.1% (171%) PnSP revealed that the birds performed better at those levels of PnSP, demonstrating the effectiveness of the secondary metabolites (alkaloids and flavonoids) in PnSP (Adeneye and Crooks, 2015).

Carcass and organ measurements

The effects of PnSP on the carcass, organ and intestine weights of broiler chickens are displayed in Tables 3 and 4. The majority of the parameters evaluated showed no significant variations (p>0.05), excluding the wings (p<0.001), thighs (p=0.01) and abdominal fat (p<0.001). Broilers fed PnSP-supplemented diets considerably reduced their abdominal fat compared to broilers fed a PnSP-free diet, and the least (p<0.001) significant value (0.52%) was recorded in birds fed 0.1%

PnSP. Birds fed 0.1% PnSP had the highest (p=0.01) thigh (12.69%) and those on 0.15% PnSP had the lowest (p=0.01) value of 10.41%. The reduction in abdominal fat caused by the use of PnSP demonstrated that PnSP regulates the activity of fat-metabolizing enzymes, hence modifying blood lipid metabolism (Zhong-ze *et al*., 2007). According to Adeneye and Crooks (2015), the PnSP's high alkaloid content could potentially be responsible for the reduction, supporting the claim that spices and their extracts have lipotropic effects (Cross *et al*, 2007). Some naturally occurring elements in spices regulate lipid metabolism through fatty acid transport, improving lipid efficiency and reducing the build-up of abdominal fat (Cross *et al*, 2007).

Asai and Miyazawa (2001) found that dietary curcuminoids had a greater impact on fatty acid catabolism in the liver than on de novo fatty acid synthesis in broiler chickens' lipid metabolism. Alkaloid fraction of *Hunteria umbellata* has been demonstrated to exhibit anti-hyperlipidemic, cardioprotective actions and to considerably reduce the histological lesions of fatty hepatic degradation in hyperlipidemic Wistar rats, supporting the reduction in abdominal fat levels with the administration of PnSP (Adeneye and Crooks, 2015). Three studies using phytoadditive sources (turmeric, rosemary, garlic and neem leave) in broiler diets (Chou *et al*. (2010); Milošević *et al*. (2013) and Mondal *et al*. (2015) reported a substantial reduction in the birds' abdominal fat.

Conclusion and Recommendation

Based on the results of this study, it could be concluded that adding 0.15% PnSP to the diet resulted in the best weight increase during the starter phase, while the birds were able to tolerate up to 0.2% PnSP during the finisher phase without experiencing any negative effects. PnSP usage enhanced the PEI at 0.1% PnSP. The highest and lowest values for thigh and abdominal fat were obtained from birds fed 0.1% PnSP; whereas, there was no obvious difference in the proportion of organs and offal to live weight.

Table 2: Effect of PnSP on growth performance of broiler chickens

Diet / Parameters(g)	Control	0.05% PnSP	0.10% PnSP	0.15% PnSP	0.20% PnSP	SEM	P. Value	Orthogonal Contrast			
								Linear	Quadratic	Cubic	Quartic
Starter phase											
Initial live weight (g)	44.29	44.27	44.31	44.13	44.45	0.16	0.98	NS	NS	NS	NS
Final live weight (g)	650.0^{b}	665.0^{ab}	644.6^{b}	732.1^{a}	696.7^{ab}	11.3	0.04	NS	NS	NS	NS
Av. daily gain (g)	28.84^{b}	29.55^{ab}	28.58^{b}	32.75^{a}	31.06^{ab}	0.54	0.04	NS	NS	NS	NS
Av. daily feed intake (g)	45.62	52.56	45.06	45.50	45.39	1.51	0.49	NS	NS	NS	NS
Feed: Gain	1.58	1.78	1.58	1.40	1.46	0.08	0.43	NS	NS	NS	NS
%Survivability	100	100	100	100	100	-	-	NS	NS	NS	NS
Finisher phase											
Final live weight (g)	2011.9	2176.7	2198.3	2180.8	2079.2	32.3	0.29	NS	NS	NS	NS
Av. daily gain (g)	48.64	53.98	55.49	51.74	49.64	1.11	0.24	NS	NS	NS	NS
Av. daily feed intake (g)	129.74	134.14	135.16	132.76	132.21	1.30	0.76	NS	NS	NS	NS
Feed: Gain	2.69	2.48	2.43	2.57	2.66	0.05	0.54	NS	NS	NS	NS
%Survivability	83.33^{b}	93.33^{ab}	93.33^{ab}	96.67^{a}	93.33^{ab}	1.82	0.05	NS	NS	NS	NS
Pooled											
Initial live weight (g)	44.29	44.27	44.31	44.13	44.45	0.16	0.98	NS	NS	NS	NS
Final live weight (g)	2011.9	2176.7	2198.3	2180.8	2079.2	32.3	0.29	NS	NS	NS	NS
Av. daily gain (g)	40.16	43.51	42.96	43.61	41.52	0.66	0.29	NS	NS	NS	NS
Av. daily feed intake (g)	93.69	99.18	96.54	95.36	95.00	1.03	0.55	NS	NS	NS	NS
Feed: Gain	2.33	2.30	2.25	2.19	2.29	0.03	0.57	NS	NS	NS	NS
%Survivability	83.33^{b}	93.33^{ab}	93.33^{ab}	96.67^{a}	93.33^{ab}	1.82	0.05	NS	NS	NS	NS
PEI (%)	128.89^{b}	170.45^{a}	171.91^{a}	167.46^{ab}	149.12^{ab}	6.16	0.04	NS	NS	NS	NS

^{ab}: Treatment values on the same row with different superscripts are significantly different ($p<0.05$). SEM = Standard Error Mean, PnSP= *Picralima nitida* Seed Powder, NS = No Significant Difference, PEI = performance efficiency index, Av. = Average

Table 3: Effect of PnSP on carcass characteristics and dressed percentage of broiler chickens

Diets / Parameters	Control	0.05% PnSP	0.10% PnSP	0.15% PnSP	0.20% PnSP	SEM	P. Value
Dressed (% LW)	73.27	71.29	73.54	69.41	68.48	0.80	0.16
Cut parts (% LW):							
Neck	5.46	4.89	5.05	5.09	5.35	0.09	0.33
Breast	22.57	23.80	24.65	22.30	22.58	0.54	0.66
Wing	8.41[a]	7.57[ab]	7.73[b]	7.22[b]	7.58[ab]	0.11	<0.001
Thigh	11.56[ab]	10.47[b]	12.69[a]	10.41[b]	11.22[b]	0.27	0.01
Drumstick	11.03	10.77	11.03	10.98	11.57	0.19	0.80
Back	11.92	13.41	12.14	13.33	11.33	0.30	0.11
Abdominal fat	1.16[a]	0.77[b]	0.52[c]	0.69[b]	0.67[b]	0.06	<0.001

[ab]: Treatment values on the same row with different superscripts are significantly different ($p<0.05$). LW= Live weight, PnSP= *Picralima nitida* Seed Powder

Table 4: Effect of PnSP on organ characteristics and intestinal morphometrics of broiler chickens

Diets / Parameters	Control	0.05% PnSP	0.10% PnSP	0.15% PnSP	0.20% PnSP	SEM	P. Value
Organs (% LW):							
Kidney	0.54	0.36	0.54	0.44	0.40	0.03	0.38
Lungs	0.52	0.55	0.59	0.48	0.44	0.02	0.52
Heart	0.43	0.36	0.44	0.42	0.44	0.02	0.79
Spleen	0.10	0.09	0.08	0.09	0.07	0.01	0.66
Cleaned gizzard	1.86	1.84	1.61	1.67	1.92	0.05	0.28
Liver	1.90	1.90	1.99	1.91	1.87	0.06	0.99
Crop	0.50	0.60	0.57	0.47	0.50	0.04	0.81
Proventriculus	0.44	0.50	0.38	0.43	0.43	0.02	0.36
Pancreas	0.23	0.25	0.24	0.24	0.24	0.01	0.97
Bursa	0.05	0.05	0.06	0.06	0.07	0.00	0.76
Offals:							
Small intestine (%)	3.92	4.24	4.14	4.83	4.90	0.25	0.75
Small intestine (cm/kg)	0.11	0.10	0.10	0.12	0.11	0.00	0.42
Large intestine (%)	0.15	0.15	0.13	0.14	0.16	0.01	0.96
Large intestine (cm/kg)	0.01	0.00	0.00	0.00	0.01	0.00	0.33
Caecum (%)	0.60	0.80	0.77	0.80	0.73	0.06	0.88
Caecum (cm/kg)	0.01	0.02	0.01	0.01	0.01	0.00	0.55

PnSP= *Picralima nitida* Seed Powder

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