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EFFECT OF GRADED LEVELS OF GUAVA (*Psidium guajava* L.) LEAF MEAL ON PRODUCTIVE PERFORMANCE AND MEAT ORGANOLEPTIC PROPERTIES OF CHICKEN

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ABSTRACT: A study was carried out to determine the productive performance and meat organoleptic properties of finisher broiler fed diets supplemented with graded levels of dried guava leaf meal (DGLM) as a phytogenic feed additive. The study was conducted at the livestock experimental unit of National Veterinary Research Institute Vom, Nigeria. Two hundred and forty unsexed 5-weeks-old broilers of similar mean live weight were randomly assigned to 1 of 4 dietary groups with 3 replicates (0, 150g, 300g and 450g of DGLM per 100kg basal diets) over a four weeks finisher period, in completely randomized design. All the diets of iso-nitrogenous and iso-caloric and water were served to the birds *ad libitum*. The results of the finisher phase of the experiment showed that, though the average daily feed intakes of all the treatments were the same, the final body weights of birds fed T_4 diets were significantly (P<0.05) higher than those fed other diets. Feed conversion ratio (FCR), protein efficiency ratio (PER) and feed cost/weight gain followed similar trend as in body weight gain. The organoleptic properties (colour, appearance, texture, taste and aroma) of all the treatment groups revealed that DGLM had no adverse effect on broiler meat. The study concluded that the supplementation of DGLM at 300g and 450g/ 100kg enhanced utilization of nutrients in the diets resulting in impressive growth performance, reduced feed cost/weight gain, and high survivability without influencing the organoleptic properties of finisher broiler chickens.

Keywords: Broiler Chickens, Guava Leaf Meal, Herbal additive, Productive Performance, Organoleptic Properties.

INTRODUCTION

Growth promoters are getting popularity as feed additives due to their beneficial effect on gut health and immunity, and growth performance in broiler chicken. Though their mechanism of action varies, positive effect can be expressed through improved feed conversion, better appetite, stimulation of the immune system and increased vitality and regulation of the intestinal microflora (Peric et al., 2009). Antibiotics and other synthetic compounds were hitherto, used globally as feed additives (Lee et al., 2011). Although these substances achieved good performance, their potential side and residual effects both in humans and animals have become a real public health concern globally (Donoghue et al., 2003; Bacanli and Basaran, 2019). This eventually, led to the ban of the products especially in the Western World and specifically in Sweden since 1986 (Bacanli and Basaran, 2019). Some of the banned growth promoting antibiotics as indicated by (Odoemelam et al., 2013) include: avoparcin, tylosin-phosphate, virginiamycin, Zn-bacitracine, spiramycin, olaquindox and carbadox. This scenario has triggered an explosion of interest in the use of herbs and spices and their products as supplements in animal rations (Reyan Mohasesi et al., 2020; Abd El-Hack et al., 2022). Odoemelam et al. (2013) reported that up to one third of all commercial swine and chicken ration producers in Europe now use mixture of herbs and spices as feed additives.

These new class of natural feed additives are currently referred to as "phytogenics" (Singh and Gaikwad, 2020; Bajagai et al., 2022). According to (Odoemelam et al., 2013), some of the phytogenics already in use or undergoing trial are indigenous to Africa and they include: ginger (*Zingiber officinale*), garlic (*Allium sativium*), scent leaf (*Ocimum gratissimum*) bitter leaf (*Vernomnia amygdalia*) and neem leaf (*Azadirachta indica*). Kuralkar and Kuralkar (2021) indicated that the usefulness of these phytogenics lies in some important bioactive chemical constituents like alkaloids, tannins, flavonoids, saponins and phenolic compounds that produce definite physiological actions in the body of animals. Muhammad et al. (2009) posited that these phytogenic substances have been reported to enhance the performance of livestock. Guava (*Psidium guajava*) plants are widely and locally available and they have long history of nutritional and medicinal properties like the earlier mentioned phytogenics already in use. All the body parts of guava plant as well as the by-products have been used effectively and scientifically validated both for nutritional and medicinal purposes (Takeda et al., 2022) except the leaf meal (Okpara, 2006; Joseph, 2011). The determination of possible influence of any new feed additive on meat quality is an important part of the testing of new products for registration by the European Economic Council (EEC) in the annex to the directive on feed additive (Fris-Jensen, 1982). Fris-Jensen (1982) posited that

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organoleptic quality is measured or evaluated both in connection with feeding and other experiments and as a special objective in research work. This study seeks to identify and evaluate the potentialities of another prospective phytogenic plant material; guava (*Psidium guajava*) leaves as feed additive in broiler ration. The objective of this study is to determine the effects of dried guava leaf meal (DGLM) as feed additive on the productive performance and organoleptic properties of broiler chickens.

MATERIALS AND METHODS

The study location

The study was conducted at the experimental unit of Livestock Investigation Division (L.I.D); National Veterinary Research Institute (NVRI) Vom, Plateau State. Vom which is in Jos South Local Government Area of Plateau state is located between latitudes 9^0 50' and 10^0 North and longitudes 8^0 55^i and 9^0 East. Vom has a cold climatic condition due to its high altitude measuring over 1290 meters above sea level. The average rainfall is between 1,300 mm to 1500 mm and the rainy season extends from late March to early October, July and August being the wettest months. The average daily maximum temperature is 28.6^{0}C, average minimum temperature is 17^0 C while the mean relative humidity at noon varies between 14 and 17 % (Anon, 2010).

Collection and processing of guava (Psidium guajava) leaves

Fresh and matured green guava leaves used for the experiment were harvested in Vom and its environs in Jos South Local Government Area of Plateau State in the month of October, 2015. Each batch of the collection was washed and air dried. They were considered adequately dried when they became crispy to touch. They were then milled, using a hammer mill with 2 mm sieve to produce dried guava leaf meal (DGLM). The leaf meal was weighed, carefully packed in clean polythene bags, labeled and stored under room temperature until use as prescribed by Okpara (2006).

Nutrient composition of guava (*Psidium guajava* L.) leaf meal

The guava leaf meal sample was analyzed to determine the proximate constituents like moisture, protein, ether extract, ash and crude fiber according to AOAC (2000) at the Science Laboratory Technology Unit, University of Jos, Plateau State.

Experimental birds and general flock management

Two hundred and forty unsexed cobb five weeks old broiler chickens purchased from Zartech farms – Jos, Plateau State were raised in deep litter system following standard management and biosecurity practices specified for broiler chicken production as described by Oluyemi and Robert (2000). This experiment was conducted in the months of November to December and lasted for 6 weeks.

Experimental design

Birds were randomly distributed into 4 dietary treatments comprising of 60 birds per treatment. Each treatment was replicated thrice with 20 birds per replicate using a completely randomized design (CRD). The initial weight of each bird was determined with the aid of electronic weighing scale. Water and feed were made available to the birds *ad libitum* throughout the experimental period.

Experimental diets

Four experimental diets were formulated for finisher phase in accordance with the nutrient requirements of finisher broiler (NRC, 1994). The experimental diets were designed as: Treatment (T_1): 0g DGLM/100 kg basal diet as control; T_2: 150g DGLM/100 kg basal diet; T_3: 300g DGLM/100 kg basal diet; and T_4: 450g DGLM/100 kg basal diet. Ingredients and their proximate compositions are presented in Tables 1 and, 2.

Table 1 - Composition of broiler finisher's diet

Ingredients (kg)	Finisher		Calculated analysis	
Maize	49.02		ME Kcal/kg	2823.97
Wheat offal	7.35		Crude Protein (%)	20.20
Rice offal	4.90		Crude Fiber (%)	4.43
Soybean cake	33.93		Calcium (%)	1.08
Fishmeal	1.50		Phosphorus (%)	0.57
Bone ash	1.50		Feed cost ₦/kg	90.90
Lime stone	1.00			
Common salt	0.25			
Lysine	0.10			
Methionine	0.20			
Premix	0.25			
Total	100			

Bio-mix starter Premix supplied /kg: Vit A: 100000iu,Vit E : 23000mg, Vit.K_3 : 2000mg,Vit B_1: 1800mg,Vit.B_2 : 5500mg, Niacin: 27,500mg, Panthotenic Acid: 7500mg, Vit B_6: 3000mg,Vit B_{12}: 15mg, Folic Acid: 750mg, Biotin H_2: 60mg, Choline Chloride: 300000mg, Cobalt: 200mg, Copper: 3000mg, iodine: 1000mg, Iron: 20000mg, Manganese: 40000mg, Zinc: 300000mg, Selenium: 200mg, Anti-oxidant: 1250mg

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Table 2 - Percentage composition of broiler finisher diets supplemented with graded levels of DGLM

Parameters \ Treatment levels	T_1	T_2	T_3	T_4
Moisture	7.67	7.64	7.62	7.66
Crude protein	20.00	20.04	20.20	20.30
Crude fibre	6.40	6.45	6.57	6.58
Crude Fat	3.85	3.87	4.05	4.06
Ash	6.57	6.45	6.57	6.06
NFE	55.51	55.55	54.99	54.8
ME Kcal/kg	3026	3030	3031	3029

DGLM=dried guava leaf meal. Treatment (T_1): 0g DGLM/100 kg basal diet as control; T_2: 150g DGLM/100 kg basal diet; T_3: 300g DGLM/100 kg basal diet; and T_4: 450g DGLM/100 kg basal diet. NFE: Nitrogen free extract, ME: Metabolizable energy, calculated using the formula 37 × % CP + 81.8 × % EE + 35.5 × NFE (Pauzengua, 1985).

Data collection

Average daily feed intake (ADFI)

The experimental birds were provided feed and water liberally in the course of the experiments. Left over feed was collected and weighed daily. This was then subtracted from the quantity of feed served daily to obtain the daily feed intake. To obtain the average weekly feed intake per bird (AWFI / bird), feed consumed daily was multiplied by 7 (seven) and divided by the number of birds/replicate.

Average daily weight gain (ADWG)

Body weights of birds were taken at the on-set of the study and then weekly until the expiration of the study. The difference between the initial weight and the final weight showed the weight gain/bird. ADWG was obtained by dividing the final weight gain/bird/replicate by the number of days the study lasted.

Feed conversion ratio (FCR)

The records of feed consumed and that of the weight gain by birds in each treatment group were used to compute FCR according to the following formula.

$$FCR = \frac{\text{Feed intake}}{\text{Body weight gain}}$$

Protein efficiency ratio (PER)

This was obtained as $PER = \frac{\text{Weight gain}}{\text{Protein intake}}$

Mortality

This was determined by dividing the total number of dead birds by the total number of birds brought at the beginning of the study and expressed as a percentage.

$$\text{Mortality} = \frac{\text{Number of dead birds} \times 100}{\text{Number of birds housed}}$$

Economics of production

The prevailing market prices of the ingredients at the time of experiment were used to calculate the cost of feed per kilogram (₦), total cost of feed consumed (₦) and cost of feed per kilogram weight gain (₦).

Organoleptic Test

Upon completion of the feeding trial, twelve birds (one per replicate) with the mean weight of the various replicates were slaughtered and processed as described by Aduku and Olukosi (2000). Sensory evaluation was done using breast muscle samples from the processed broiler chickens. The prepared meat was cooked in separate pots to a temperature of 100^{0}C for 20 minutes by braising method without spicing or salting. Hereafter, the cooked meat samples were coded and served at room temperature (27^{0}C) to each member of a 7- man panel comprising of relevant fields; like Food Science, Animal Science, Microbiology and Catering (Zakaria et al., 2010). For the evaluation of the meat quality indices, the Hedonic scale rating of sensory evaluation method was employed as earlier described by FAO (2010); Zakaria et al. (2010). Each of the meat quality parameter was characterized and rated 1-5. While "1" represents 8 points, "5"represents 0 point in that order and without the panelists' fore knowledge. Thereafter, all the points against each parameter by each panelist were subjected to analysis of variance. This was done to determine any differences or similarities in the panelists' opinion and to determine if the test additive had any effect on the natural organoleptic meat quality indices of broiler chickens.

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Statistical analysis

The experimental design was a one-way classification in a Completely Randomized Design (CRD) with the following model: Yij=μ + ai + eij; Where Yij is the observed value of each of the response variables (performance characteristics) arising as a result of μ=the overall population mean; ai=observed effect of the i^{th} dietary treatment; eij=random or residual error due to the experimentation. All data collected were subjected to analysis of variance (Steel and Torrrie, 1980) SPSS 17 Software. Means showing significant differences were separated using the Duncan's Multiple Range Test (Duncan, 1985).

RESULTS

The result of performance indices (Table 3) revealed that mean final body weight and mean daily body weight gain increased with corresponding increase in the level of dietary supplementation with DGLM up to 450 g/100 kg of basal diet. This clearly indicated that DGLM had growth promoting effect on the animals and, that the stated level was well tolerated by the birds. Feed intake did not differ among all the treatment groups (P>0.05) which implies that DGLM was palatable to the birds. This finding was in consonance with the reports of Mahmoud et al. (2013) and Rahman et al. (2013) who reported that feed intake was statistically the same (P >0.05) among treatment groups. For feed conversion ratio (FCR) and protein efficiency ratio (PER), the trend of response observed was that the FCR and PER improved significantly (P<0.05) as the dietary supplementation level of DGLM was increased. This suggests that DGLM enhanced feed and protein conversion efficiency in the basal diets of the experimental birds. According to Anon (2011), FCR is a measure of how well a flock converts feed intake into live weight and any factor which reduces feed intake, growth or health of the broiler will worsen flock FCR. Feed cost per kilogram weight gain improved significantly (P<0.05) following the same trend of FCR and PER whereby a corresponding increase in dietary supplementation of DGLM in broiler diet improved the aforementioned parameters. Low mortality percentages which ranged from 0 to 3.33% were observed in this study. The mortality could not be attributed to any detrimental effect of the test ingredient because the mortality incidence did not follow any definite pattern. This further implies that the broiler chicken tolerated DGLM, up to 450g/100kg basal diet without any deleterious effect. Besides good management practice, DGLM according to Pandey and Shweta (2011) contains anti-inflammatory and antimicrobial properties that could induce positive effects in broiler gut health. Hascik et al. (2015) further posited that positive effects of dietary supplementation of DGLM in broiler diet may boost broiler immunity which could be attributed to the presence of flavonoids which have anti-microbial and anti-oxidative activities. The negligible mortality percentage recorded in this study (0% to 3.33% range) contradicts the reports of Mahmoud et al. (2013) and El-Deek et al. (2009) who recorded significant levels of mortality while testing the effects of DGLM and guava wastes products on broiler chickens. These differences could be attributed to the levels of bio-sanitary and bio-security measures adhered.

Table 3 - Productive performance of finisher broiler chickens fed diets supplemented with DGLM.

Performance indices \ Treatment levels	T_1	T_2	T_3	T_4	SEM	P-value
Initial body weight (g/b)	673.17	676.33	676.83	677.33	2.276	ns
Final body weight (g/b)	3,355.00^c	3,381.67^c	3,468.33^b	3,555.00^a	16.915	*
Average daily weight gain (g/b)	63.85^c	64.42^c	66.46^b	68.52^a	0.406	*
Average daily feed intake (g/b)	97.47	97.42	97.47	97.45	0.015	ns
Feed conversion ratio	1.53^a	1.51^{ab}	1.47^c	1.42^d	0.013	*
Protein efficiency ratio	3.27^b	3.30^b	3.41^a	3.51^a	0.239	*
Cost of feed consumed (₦/b)	372.14	371.93	372.12	372.04	NA	ns
Cost of guava leaf/kg(₦)	0	1.50	3.00	4.50	NA	ns
Feed Cost/Kg (₦)	90.90	90.90	90.90	90.90	NA	ns
Feed Cost ₦/kg weight gain	138.70^a	137.30^a	133.60^b	129.70^c	0.66	*
Mortality (%)	3.33	1.67	0.00	1.67	NA	ns
Initial body weight (g/b)	673.17	676.33	676.83	677.33	2.276	ns

DGLM=dried guava leaf meal. Treatment (T_1): 0g DGLM/100 kg basal diet as control; T_2: 150g DGLM/100 kg basal diet; T_3: 300g DGLM/100 kg basal diet; and T_4: 450g DGLM/100 kg basal diet. ^{a,b,c}: Means in the same row with different superscripts are significantly (P<0.05) different; NS: not significant (P > 0.05); *=P value <0.05; SEM: Standard error of mean, g/b: Gram per bird; NA: not analyzed, ₦/b: Naira per bird

Sensory evaluation of organoleptic meat quality indices of broiler chickens fed diets supplemented with dried guava leaf meal

Result of organoleptic indices is shown in Table 4. It was observed that all the organoleptic properties (colour, appearance, texture, taste and flavour) of all the treatment groups evaluated using Hedonic scale rating of sensory method compared favourably (P>0.05) across treatments. This implies that the test additive (DGLM) did not impact any

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negative influence on the broiler meat. Fris-Jensen (1982) had earlier reported that robenidine; an anti-coccidial additive, imparted an off-flavour influence on broiler meat after its administration. Mellen et al. (2014) observed significant differences among experimental groups of cobb 500 chicken with regards to meat quality after administering agolin, agolin tannin, agolin acid and bio-strong additives in their nutrition. Similarly, Wasker et al. (2009) experimented on the effect of phyto-additive methiorep (synthetic methionine) on carcass and cooked meat quality attributes in chicken and reported that the additive had no negative influence on the meat. Pandey and Shweta (2011) reported that bee pollen extract caused a significant increase in the redness value of broiler chicken meat evaluated after use as feed additive in their diet. These findings are indications that additives could influence both the performance of the livestock and the quality of its products. The slightly numerical higher rating (7.4 each) observed in T_3 and T_4 in relation to colour and 6.86 in T_4 in relation to appearance could be attributed to the presence of some oxygenated carotenoids (xanthophils or lutein) in the guava leaf according to Joseph (2011). This may add more market and nutritional value to broiler chicken fed DGLM at the rate of 450g/100kg diet.

Table 4 - Sensory evaluation of organoleptic properties of meat quality of finisher broiler chickens fed diets supplemented with graded levels of dried guava leaf meal.

Treatment levels / Sensory traits	T_1	T_2	T_3	T_4	SEM	P-value
Colour	6.67	6.29	7.14	714	0.680	ns
Appearance	6.29	6.00	6.00	6.86	0.691	ns
Texture	5.71	5.43	4.86	6.57	1.100	ns
Taste	6.00	5.71	5.71	6.29	0.639	ns
Aroma	5.71	6.29	6.29	6.29	0.595	ns

Numbers in the table represent means of 0-8 point ratings by 7 panelists using Hedonic method of sensory evaluation described by El-Deek et al. (2009). ns: not significant (P> 0.05)

CONCLUSION

The study concluded that the supplementation of dried guava (*Psidium guajava* L.) leaf meal at 300g and 450g/ 100kg enhanced utilization of nutrients in the diets resulting in impressive growth performance, reduced feed cost/weight gain (₦/kg), and high survivability without influencing the organoleptic properties of finisher broiler chickens.

DECLARATIONS

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Authors' contribution

F. B. P. Abang performed conceptualization, writing, original draft preparation, review and editing. I. E. Echeonwu performed conceptualization and evaluation of manuscript before submission. M. U. Amu performed conceptualization and evaluation of manuscript before submission.

Ethical approval

The University Committee on Ethical Matters Examined and Approved all the Experiments.

Conflict of interests

The authors declare that there is no conflict of interest.

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