Nig. J. Anim. Prod. 2026, 53(1): 81 - 93 https://doi.org/10.51791/njap.v53i1.9152 Nigerian Journal of Animal Production

Growth performance indices and internal organs characteristics of broiler chickens administered velvet tamarind (*Dialium guineense* willd) leaf extracts

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Abstract

Residual effects of synthetic antibiotic growth promoters use in poultry production has resulted in the utilization of non-synthetic plant materials that elicit similar physiological activity. However, the fibrous nature of these plant materials, have limited their dietary use in broiler production, especially when used as leaf meals. Using the extracts of Dialium guineense leaves allows for greater utilization and enhances the animal's response. This study was conducted in the quest to explore non-synthetic alternatives to synthetic drug use in poultry production. A total of 200 Ross 308 broiler chickens were used in a completely randomized design (CRD) experiment to evaluate the growth performance and internal organs characteristics of broiler chickens administered Dialium guineense leaf extracts (DGLE). The birds were divided into four experimental groups of 50 birds each and replicated five times to contain 10 birds per replicate. One of the groups served as the control ($DGLE_0$) without DGLE, while the treatment groups comprised administration of DGLE at 0.5 ($DGLE_{0.5}$), 1.0 ($DGLE_{1.0}$), and 1.5 ($DGLE_{1.5}$) g/L of drinking water. Feed intake (FI), body weight gain (BWG), feed conversion ratio (FCR), carcass analysis, and internal organ histology of the birds were evaluated. The study lasted for 42 days. Feed intake of the birds was similar (P>0.05) between the experimental groups, while body weight gain was significantly (P<0.05) higher in $DGLE_{1.0}$ than in $DGLE_0$ and $DGLE_{1.5}$, but similar (P>0.05) to $DGLE_{0.5}$. Feed conversion ratio was similar (P>0.05) between $DGLE_0$, $DGLE_{0.5}$, and $DGLE_{1.5}$, but significantly (P<0.05) higher in $DGLE_0$ than in $DGLE_{1.0}$ which was similar (P>0.05) to $DGLE_{0.5}$ and $DGLE_{1.5}$. The percentage weights of the neck, breast, gizzard, and lungs of the birds were significantly (P<0.05) higher in $DGLE_0$ and $DGLE_{1.5}$ than in $DGLE_{1.0}$, but similar (P>0.05) to $DGLE_{0.5}$ which is similar (P>0.05) to $DGLE_{1.0}$. Percentage weights of the wings and kidneys were significantly (P<0.05) higher in $DGLE_0$ and $DGLE_{1.5}$ than in $DGLE_{0.5}$ and $DGLE_{1.0}$ which were similar (P>0.05). Percentage weights of the drumstick, shank, and intestine were similar (P>0.05) between $DGLE_0$ and $DGLE_{1.5}$ which were significantly (P<0.05) higher than those obtained for birds on $DGLE_{1.0}$ which were similar (P>0.05) to those of birds on $DGLE_{0.5}$; and those of birds on $DGLE_{0.5}$ similar (P>0.05) to those of birds on $DGLE_{1.5}$. The percentage weights of the abdominal fat and the liver were significantly (P<0.05) higher in $DGLE_0$ than in other treatments, and those of $DGLE_{0.5}$ were significantly (P<0.05) higher than those of $DGLE_{1.0}$ and $DGLE_{1.5}$, which were similar (P>0.05). The percentage dressed weight and that of the head, thighs, heart, and spleen were similar (P>0.05) between the experimental groups. The histological assessment of the internal organs of the birds revealed increased volume of alveolar sacs in the lungs of $DGLE_{1.0}$ and $DGLE_{1.5}$ birds, while the intestines of the same $DGLE_{1.0}$ and $DGLE_{1.5}$ birds showed increased mucosal and villi mass. The results of this study demonstrates that DGLE could serve as an alternative non-synthetic materials for improving weight gain in broiler chickens without any untoward effect on the lungs, liver, spleen, and intestine.

Keywords: Broiler, plant extracts, weight gain, histology

Indices de croissance et caractéristiques des organes internes de poulets de chair ayant reçu des extraits de feuilles de tamarin velouté (Dialium guineense Willd)

Résumé

Les effets résiduels liés à l'utilisation d'antibiotiques de croissance synthétiques dans la production avicole ont conduit à l'utilisation de matières végétales non synthétiques présentant une activité physiologique similaire. Cependant, la nature fibreuse de ces matières végétales a limité leur utilisation alimentaire dans la production de poulets de chair, en particulier lorsqu'elles sont utilisées sous forme de farines de feuilles. L'utilisation d'extraits de feuilles de Dialium guineense permet une meilleure utilisation et améliore la réponse des animaux. Cette étude a été menée dans le but d'explorer des alternatives non synthétiques à l'utilisation de médicaments synthétiques dans la production avicole. Au total, 200 poulets de chair Ross 308 ont été utilisés dans le cadre d'une expérience en plan complètement randomisé (CRD) afin d'évaluer les performances de croissance et les caractéristiques des organes internes des poulets de chair ayant reçu des extraits de feuilles de Dialium guineense (DGLE). Les oiseaux ont été répartis en quatre groupes expérimentaux de 50 oiseaux chacun et répliqués cinq fois pour contenir 10 oiseaux par réplique. L'un des groupes a servi de groupe témoin (DGLE0) sans DGLE, tandis que les groupes de traitement comprenaient l'administration de DGLE à des doses de 0,5 (DGLE0,5), 1,0 (DGLE1,0) et 1,5 (DGLE1,5) g/L d'eau de boisson. La consommation alimentaire (FI), le gain de poids corporel (BWG), l'indice de conversion alimentaire (FCR), l'analyse des carcasses et l'histologie des organes internes des oiseaux ont été évalués. L'étude a duré 42 jours. La consommation alimentaire des volailles était similaire (P > 0,05) entre les groupes expérimentaux, tandis que le gain de poids corporel était significativement (P < 0,05) plus élevé dans le groupe DGLE1,0 que dans les groupes DGLE0 et DGLE1,5, mais similaire (P > 0,05) à celui du groupe DGLE0,5. L'indice de conversion alimentaire était similaire (P > 0,05) entre les groupes DGLE0, DGLE0,5 et DGLE1,5, mais significativement (P < 0,05) plus élevé dans le groupe DGLE0 que dans le groupe DGLE1,0, qui était similaire (P > 0,05) aux groupes DGLE0,5 et DGLE1,5. Les pourcentages de poids du cou, de la poitrine, du gésier et des poumons des volailles étaient significativement (P < 0,05) plus élevés chez les groupes DGLE0 et DGLE1,5 que chez le groupe DGLE1,0, mais similaires (P > 0,05) à ceux du groupe DGLE0,5, qui est lui-même similaire (P > 0,05) au groupe DGLE1,0. Les pourcentages de poids des ailes et des reins étaient significativement (P < 0,05) plus élevés dans les groupes DGLE0 et DGLE1,5 que dans les groupes DGLE0,5 et DGLE1,0, qui étaient similaires (P > 0,05). Les pourcentages de poids des pilons, des cuisses et des intestins étaient similaires (P > 0,05) entre les groupes DGLE0 et DGLE1,5, qui étaient significativement (P < 0,05) plus élevés que ceux obtenus pour les oiseaux du groupe DGLE1,0, lesquels étaient similaires (P > 0,05) à ceux des oiseaux du groupe DGLE0,5 ; et à ceux des oiseaux sous DGLE0,5, qui étaient similaires (P > 0,05) à ceux des oiseaux sous DGLE1,5. Les pourcentages de poids de la graisse abdominale et du foie étaient significativement (P < 0,05) plus élevés dans le groupe DGLE0 que dans les autres traitements, et ceux du groupe DGLE0,5 étaient significativement (P < 0,05) plus élevés que ceux des groupes DGLE1,0 et DGLE1,5, qui étaient similaires (P > 0,05). Le pourcentage du poids en poids paré ainsi que celui de la tête, des cuisses, du cœur et de la rate étaient similaires (P > 0,05) entre les groupes expérimentaux. L'examen histologique des organes internes des volailles a révélé une augmentation du volume des alvéoles pulmonaires chez les volailles des groupes DGLE1.0 et DGLE1.5, tandis que les intestins de ces mêmes volailles présentaient une augmentation de la masse de la muqueuse et des villosités. Les résultats de cette étude démontrent que le DGLE *pourrait servir de matériau non synthétique alternatif pour améliorer la prise de poids chez les poulets de chair sans effet indésirable sur les poumons, le foie, la rate et l'intestin.*

Mots-clés: Poulet de chair, extraits végétaux, prise de poids, histologie

Introduction

Chicken production is a cornerstone of global food security, contributing 37% of meat and 80% of egg supplies worldwide (FAO, 2023). High performance and productivity are the needs of the poultry industry which has led to the use of synthetic drugs and feed additives for various purposes (Selaledi *et al*., 2020). Scientists, particularly in developing countries, are concerned about the residual effects of the synthetic drugs and feed additives used in poultry production to improve productivity (Chowdhury *et al*., 2021). The continued use of antibiotic growth promoters (AGPs) and other synthetic drugs in livestock production have raised global concerns about synthetic drugs and antibiotic use in livestock due to their adverse effects on human health, food safety, and the environment. As a result, actions have been taken to restrict or ban the use of synthetic material use in livestock production (Gadde *et al*., 2017; Wani *et al*., 2022).

Given the global concern to eliminate synthetic materials use in livestock production there has been increasing number of studies on the use of non-synthetic or natural alternatives of plant origin that possess numerous bio-active compounds called phytochemicals (Reda *et al*., 2020; Sheiha *et al*., 2020). These plant materials are sometimes used as phytogenic feed additives in poultry diets which exert various biological effects on the birds (Pliego *et al*., 2022).

Phytogenic feed additives are herbs or plant-derived products added to livestock feeds to achieve better growth, immunity and reduced stress responses through improvement in digestibility, nutrient uptake, product quality and antimicrobial activity (Mpofu *et al*., 2016). According to Mandey and Sompie (2021), the incorporation of phytogenic feed additives in poultry feed leads to improve in production by improving nutrient availability and reducing pathogenic bacteria in the gastrointestinal tract. Phytogenic feed additives have also been reported to be relatively safe, effective and cheaper (Mnisi *et al*., 2022).

Several plants have been explored as phytogenics in animal production, of which *Dialium guineense* is one of them. It is commonly known as black velvet tamarind. *Dialium guineense* is a tropical fruit-bearing tree in the flowering plant family, Fabaceae and sub-family, Caesalpinioideae which grows well in the rainforest zones of West Africa (Ajiboye *et al*., 2015; Besong *et al*., 2016). *Dialium guineense* can be found in West African countries such as Ghana where it is known as Yoyi, Sierra Leone, Senegal, and Nigeria where it is known as Awin in Yoruba, Icheku in Igbo and Tsamiyar kurm in Hausa (Ajiboye *et al*., 2015; Besong *et al*., 2016). The plant is rich in essential nutrients and phytochemicals (Ogbuewu *et al*., 2023). The pharmacological properties of *D. guineense* are linked to its constituent of several bioactive phytochemical compounds such as phenols, flavonoids, saponins, and tannins, which makes it useful in traditional medicine (Abu *et al*., 2020). Oloruntola *et al*. (2016) recorded positive results when medicinal plants were supplemented in the diets of broiler chickens. Also, various leaf meals have been used as alternative feed resources to reduce feed cost or elicit improved physiological functions and status in poultry (Sugiharto *et al*., 2019). Utilization of *Dialium guineense* leaf meal in rabbit bucks diet at 30 % inclusion level have been reported to improve total spermatozoa count per ejaculate, spermatozoa concentration, libido score and reduction in percentage abnormal spermatozoa, and support body weight gain (Iwuji *et al*., 2020 and 2025). Also, black velvet tamarind (*Dialium guineense*) stem bark as an alternative to AGPs in chicken production has been reported to promote antimicrobial activity *in vitro* (Ogbuewu *et al*., 2023).

The use of leaf meals in poultry nutrition is limited by their high fibre content and some anti-nutritional factors, thereby limiting their level of inclusion in the diets (Fawolu and Igbasan, 2019; Sugiharto *et al*., 2019). Hence, in order to increase the utilization of leaf meals in non-ruminant animal production, researches have devised means of increasing the level of administration and reduction of anti-nutritional contents through processing (Mareto, 2023), of which ethanol extraction is one of them (Mareto, 2023). The ethanol extraction of *Dialium guineense* leaf meal gets rid of the fibre content, while concentrating the bioactive phytochemicals, thereby facilitating utilization at higher levels without the limiting fibre content factor and some anti-nutritional components. The roles of *Dialium guineense* leaf extracts on broiler chicken physiology is unknown, therefore, this study is designed to evaluate the effects of ethanol extracts of *Dialium guineense* leaves on the growth performance indices and internal organs characteristics of broiler chickens.

Materials and methods

Study Location and Duration

The study was carried out at the Poultry Unit, Teaching and Research Farm, Federal University of Technology Owerri, Imo State, Nigeria. Owerri is located in the South-Eastern agro-ecological zone of Nigeria, with geographical coordinates approximately at 5.4763°N latitude and 7.0259°E longitude. The mean annual rainfall in Owerri is approximately 2,412 mm, with an average annual temperature of 25.9°C and relative humidity ranging between 70% and 80%, and characterized by a rainy season from April to October and a dry season from November to March (Okon *et al*., 2021). The research lasted for a period of 42 days.

Preparation of ethanol extracts of Dialium guineense leaves

Fresh leaves of *Dialium guineense* were identified and harvested from the trees located in the environs of Federal University of Technology Owerri. After harvesting, the leaves were thoroughly washed with water to remove dust, soil particles, and any other potential contaminants. Once cleaned, the leaves were laid out in a well-ventilated, shaded area to air-dry naturally for about 7 days. After complete drying, the leaves were ground into a meal using a hammer mill with mesh size of 2 mm, after which it was subjected to a cold maceration process for extraction, using ethanol as the solvent (Abu and Onoagbe, 2021). The process lasted for 48 hours, during which the mixture was intermittently agitated to enhance the extraction of the bioactive compounds. The resulting solution was filtered using Whatman No. 1 filter paper to remove the fibre residue, and the filtrate was concentrated using a rotary evaporator set at 40°C under reduced pressure. The powdered extract obtained was stored in air-tight, light-resistant container at 4°C until when need for incorporation into the drinking water of the birds.

Experimental animals and their management

A total of 200 one-day-old Ross 308 broiler chickens was used for the experiment which lasted for 42 days. The birds were divided into four experimental groups, each consisting of 50 birds and replicated 5 times to contain 10 birds per replicate. Each of the experimental groups was randomly assigned to one of four treatments in a completely randomized design (CRD). The treatments consist of *Dialium guineense* leaf extracts (DGLE) administered at 0 ($DGLE_0$), 0.5 ($DGLE_{0.5}$), 1.0 ($DGLE_{1.0}$), and 1.5 ($DGLE_{1.5}$) grams of DGLE per liter of drinking water, respectively. The birds were reared on deep litter system using wood shavings as the litter material. Standard broiler chickens' starter and finisher diets (Table 1), and management practices as outlined by Aviagen (2022 and 2025) were strictly followed, and water was freely provided for the birds.

Table 1 Starter and finisher diets of the experimental broiler chickens

Ingredients (%)	Starter diet	Finisher diet
Maize	55.00	58.00
Soyabean meal	32.00	29.00
Palm kernel cake	4.00	5.00
Fish meal	4.00	3.00
Bone meal	3.00	2.00
Oyster shell	1.00	2.00
Common salt	0.25	0.25
Lysine	0.25	0.25
Methionine	0.25	0.25
Vitamin-mineral premix*	0.25	0.25
Total	**100.00**	**100.00**
Calculated nutrient composition		
Crude protein	22.55	20.41
Crude fibre	4.11	4.67
Ether extract	4.26	3.50
Lysine	1.17	1.22
Methionine	0.62	0.72
Methabolizable energy (kcal/kg)	2946.50	3108.20

Formulated according to Ross 308 nutrition specifications (Aviagen, 2022).

**To provide the following per kilogram feed: vitamin A 12100 IU, vitamin D3 2500 IU, vitamin E 8 mg, vitamin K 2 mg, vitamin B_1 3 mg, vitamin B_2 5 mg, niacin 15 mg, pantothenic acid 6 mg, folic acid 4 mg, manganese 8 mg, zinc 0.05 mg, iron 29 mg, copper 3 mg, iodine 1.2 mg, selenium 0.16 mg and cobalt 2 mg. CP = crude protein.*

Growth performance

The average initial body weight of the chicks at the start of the experiment was measured using an electronic scale of 0.01 sensitivity. Feed intake was recorded daily by subtracting the weight of leftover feed from the total feed offered to the birds. At the end of 42 days, the average final body weight of the birds was measured and recorded. Total body weight gain was calculated as the difference between the final and initial body weights. Average daily feed intake and average daily weight gain were calculated by dividing total feed intake and total weight gain by 42 days, respectively. Feed conversion ratio (FCR) was calculated by dividing the total feed intake by the total weight gain. Mortality was monitored daily and recorded.

Carcass evaluation and internal organs weight

At the end of the experiment, two birds from each replicate were randomly selected and denied feed for 12 hours while allowing them access to water before slaughter. The birds were slaughtered by cervical dislocation, a method endorsed by the American Veterinary Medical Association (AVMA, 2020) for poultry euthanasia. The live weight of the birds was measured, while the dressed weight, cut parts weight, and internal organs weight were measured with a digital scale and expressed as percentages of the live weight. The internal organs such as the lungs, liver, heart, gizzard, spleen, kidney, and intestines were excised, blotted dry, and weighed individually.

Internal organs histology

The organs (lungs, liver, spleen, and small intestine) were carefully excised, blotted dry, and subjected to histological examination. Tissue samples of the lungs, liver, spleen, and small intestine were fixed in 10% neutral buffered formalin for 48 hours. After fixation, the tissues were processed through dehydration in ascending grades of ethanol, cleared in xylene, and embedded in paraffin wax. Sections of 5 µm thickness were cut using a microtome and mounted on glass slides. The sections were stained with hematoxylin and eosin (H&E) and examined under a light microscope for any histopathological changes at 400x magnification (Slaoui and Fiette, 2011). The histological results of the internal organs were presented as photomicrographs.

Experimental design and data analysis

The experiment was conducted in a completely randomized design (CRD) and the data collected were subjected to analysis of variance (ANOVA) using IBM SPSS statistics (Version 26) predictive analytics software. Differences among treatment means were done using Tukey HSD test of the same software at a significance level of $p < 0.05$.

Results

Growth performance indices

The growth performance indicators of the experimental broiler chickens are presented in Table 1. The initial body weight, total and daily feed intakes of the birds were similar (P>0.05) between the treatment groups, while the final body weight recorded significant (P<0.05) differences between the treatment means. The final body weight, total and daily body weight gains were similar (P>0.05) between $DGLE_{0.5}$ and $DGLE_{1.0}$ birds, but significantly (P<0.05) higher in birds on $DGLE_{1.0}$ than in birds on $DGEL_0$ and $DGLE_{1.5}$ which were similar (P>0.05) with birds on $DGLE_{0.5}$. Feed conversion ratio (FCR) was similar (P>0.05) between $DGLE_0$, $DGLE_{0.5}$, and $DGLE_{1.5}$; and between $DGLE_{0.5}$, $DGLE_{1.0}$, and $DGLE_{1.5}$, but significantly (P<0.05) higher in $DGLE_0$ than in $DGLE_{1.0}$ birds.

Table 2 Growth performance indices of broiler chickens administered *Dialium guineense* leaf extracts

Parameters (g/bird)	Treatments $DGLE_0$	$DGLE_{0.5}$	$DGLE_{1.0}$	$DGLE_{1.5}$	SEM	*p*-value
Initial body weight	47.22	48.36	46.92	47.76	0.91	0.434
Final body weight	2470.48^b	2588.50^{ab}	2674.82^a	2504.19^b	42.31	0.001
Total body weight gain	2423.26^b	2540.14^{ab}	2627.90^a	2456.43^b	42.48	0.001
Daily body weight gain	57.70^b	60.48^{ab}	62.57^a	58.49^b	1.01	0.001
Total feed intake	5786.61	5329.08	4789.02	5079.88	398.56	0.122
Daily feed intake	137.78	126.88	121.62	120.95	9.92	0.331
Feed conversion ratio	2.39^a	2.10^{ab}	1.83^b	2.07^{ab}	0.16	0.028
Mortality (count)	0	1	0	0	-	-

[ab] Means on the same row with different superscripts are significantly (p<0.05) different.

Carcass and internal organs evaluation

The relative weights of the cut parts and the internal organs of the experimental birds to their live weights are presented in Table 3. The live weight of the birds selected for carcass and internal organs evaluation was similar (P>0.05) between $DGLE_{0.5}$ and $DGLE_{1.0}$ which were significantly (P<0.05) higher than the live weight of birds on $DGLE_0$ and $DGLE_{1.5}$ which were similar (P>0.05). The percentage weights of the neck, breast, gizzard, and lungs of the birds were significantly (P<0.05) higher in $DGLE_0$ and $DGLE_{1.5}$ than in $DGLE_{1.0}$, but similar (P>0.05) to $DGLE_{0.5}$ which is similar (P>0.05) to $DGLE_{1.0.}$ Percentage weights of the wings and kidneys were significantly (P<0.05) higher in $DGLE_0$ and $DGLE_{1.5}$ than in $DGLE_{0.5}$ and $DGLE_{1.0}$ which were similar (P>0.05). Percentage weights of the drumstick, shank, and intestine were similar (P>0.05) between $DGLE_0$ and $DGLE_{1.5}$ which were significantly (P<0.05) higher than those obtained for birds on $DGLE_{1.0}$ which were similar (P>0.05) to those of birds on $DGLE_{0.5}$; and those of birds on $DGLE_{0.5}$ similar (P>0.05) to those of birds on $DGLE_{1.5}$. The percentage weights of the abdominal fat and the liver were significantly (P<0.05) higher in $DGLE_0$ than in other treatments, and those of $DGLE_{0.5}$ were significantly (P<0.05) higher than those of $DGLE_{1.0}$ and $DGLE_{1.5}$, which were similar (P>0.05). The percentage dressed weight and that of the head, thighs, heart, and spleen were similar (P>0.05) between the experimental groups

Table 3 Carcass and internal organs evaluation of the broiler chickens administered *Dialium guineense* leaf extracts

Parameters (%)	Treatments				SEM	*p*-value
	$DGLE_0$	**$DGLE_{0.5}$**	**$DGLE_{1.0}$**	**$DGLE_{1.5}$**		
Live weight (g)	2493.42^b	2604.70^a	2709.63^a	2497.22^b	36.77	<0.001
Dressed weight	76.24	76.46	77.43	76.09	0.66	0.215
Head	2.10	2.10	2.08	2.08	0.02	0.796
Neck	4.85^a	4.64^{ab}	4.46^b	4.82^a	0.06	<0.001
Wings	7.78^a	7.43^b	7.14^b	7.74^a	0.10	<0.001
Breast	23.09^a	22.53^{ab}	21.98^b	23.08^a	0.35	0.016
Thighs	18.53	18.24	18.02	18.66	0.26	0.133
Drumsticks	17.04^a	15.97^{bc}	15.57^c	16.65^{ab}	0.37	0.005
Shank	3.72^a	3.55^{bc}	3.47^c	3.70^{ab}	0.05	0.001
Abdominal fat	1.90^a	1.78^b	1.65^c	1.59^c	0.02	<0.001
Heart	0.54	0.52	0.50	0.54	0.01	0.043
Gizzard (empty)	1.85^a	1.82^{ab}	1.76^b	1.85^a	0.03	0.007
Lungs	0.61^a	0.60^{ab}	0.56^b	0.61^a	0.01	0.008
Liver	2.72^a	2.56^b	2.10^c	2.23^c	0.05	<0.001
Spleen	0.14	0.14	0.14	0.14	0.005	0.538
Kidney	0.38^a	0.35^b	0.35^b	0.37^a	0.01	<0.001
Intestine (empty)	3.41^a	3.26^{bc}	3.14^c	3.38^{ab}	0.05	<0.001

^{abc} Means with different superscripts are significantly (P<0.05) different.

Internal organs histology

Lung

(a) (b) (c) (d)

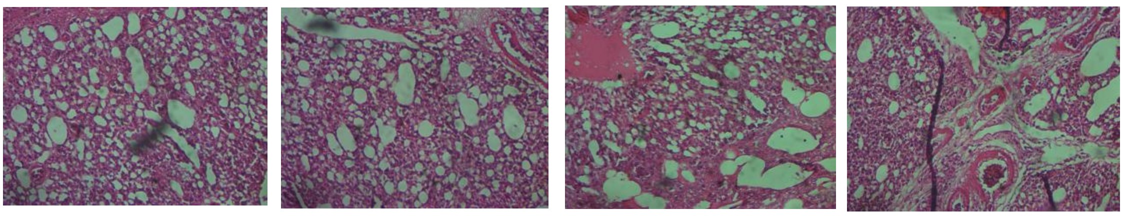

Figure 1. Photomicrographs of the lungs of the experimental birds showing increase in volume of alveolar sacs of birds on $DGLE_{1.0}$ and $DGLE_{1.5}$.

Liver

(a) (b) (c) (d)

Splee

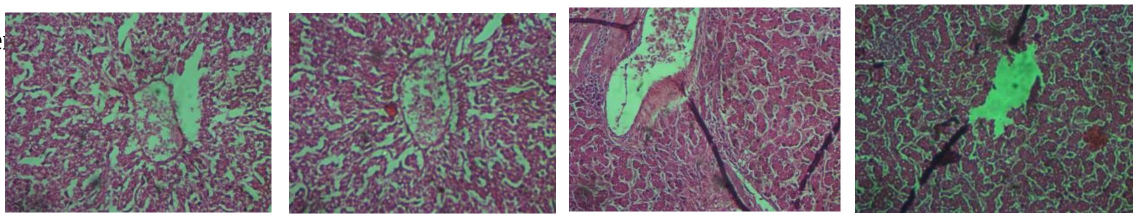

Figure 2. Photomicrographs of the livers of the experimental birds showing normal tissue architecture in all the experimental groups.

Spleen

(a) (b) (c) (d)

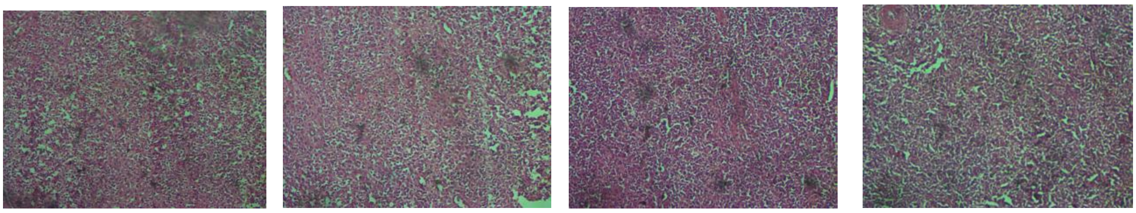

Figure 3. Photomicrographs of the spleens of the experimental birds showing normal tissue architecture in all the experimental groups.

Intestine

(a) (b) (c) (d)

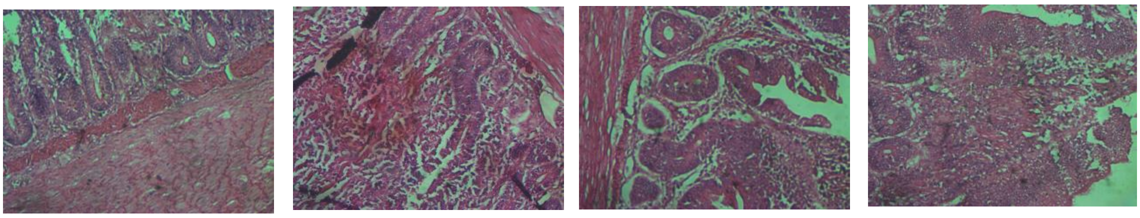

Figure 4. Photomicrographs of the intestines of the experimental birds showing increased mucosal and villi mass in $DGLE_{1.0}$ and $DGLE_{1.5}$ birds.

Legend:

(a) = $DGLE_0$ (Control, without DGLE)
(b) = $DGLE_{0.5}$ (0.5 g/L of DGLE)
(c) = $DGLE_{1.0}$ (1.0 g/L of DGLE)
(d) = $DGLE_{1.5}$ (1.5 g/L of DGLE)

Discussion

Growth performance indices

The feed intake, weight gain, and feed conversion ratio (FCR) were used as growth performance indicators to evaluate the growth performance of the broiler chickens administered *Dialium guineense* leaf extracts (DGLE). Ethanol extracts of *Dialium guineense* leaves administered via drinking water mediated a progressive increase in body weight of the broiler chickens with increasing level of administration, which became significant at 1 g/L ($DGLE_{1.0}$) administration. This is evidenced in Table 2 as recorded in the daily body weight gain (DBWG), total body weight gain (TBWG), and final body weight (FBW) of the experimental birds. However, the progressive increase in body weight of the birds as the level of administration of the extracts increases declined at 1.5 g/L ($DGLE_{1.5}$) administration of the extracts. The similar feed intake (daily and total feed intake) recorded in this study while significant differences were recorded in the weight gains and FCR indicates that DGLE plays growth regulatory role in broiler chickens. This role can be attributed to the phytochemical constituents of the extracts, especially phenol, which has been reported to promote growth through prevention of oxidative stress and halting damage to cellular and extracellular macro molecules (Mahfuz *et al*. 2021). Also, phytochemicals which are constituents of *Dialium guineense* leaves (Ogbuewu *et al*., 2023) have been reported to have a complex beneficial effect on the gut health of poultry, facilitating nutrient availability and better feed utilization (Oni and Oke, 2025). The decline in the body weight gains of the birds on $DGLE_{1.5}$ indicates that DGLE also contains factors that may hinder growth in the birds, and their actions are likely dependent on their levels of administration to the birds. Unfortunately, *Dialium guineense* leaves also contains some antinutritional factors like tannins and saponins (Onah *et al*., 2022) which may hinder nutrient availability and utilization (Mareto, 2023), and the ethanol extraction of the leaf meal may not have eliminated all of them. It is therefore possible that at 1.5 g/L ($DGLE_{1.5}$) administration of DGLE to the birds, the tolerance level was exceeded which resulted in the decline in their body weight gain. The significantly lower FCR obtained for birds on $DGLE_{1.0}$ than in birds on the $DGLE_0$ (control, no administration of the extracts) corroborates the growth-promoting ability of DGLE and indicates that 1.0 g/L administration is the best level of administration among the treatments. This growth-promoting ability of DGLE recorded in this study is also in agreement with the report on the ability of *Dialium guineense* leaf meal to increase body weight of rabbit bucks at 30 % dietary inclusion (Iwuji *et al*., 2025).

Carcass and internal organs evaluation

Evaluation of the cut parts and internal organs weight of the experimental birds (Table 3) gives insight into the growth patterns of the different parts and organs of the birds as affected by *Dialium guineense* leaf extracts (DGLE). This is based on the principle of allometric and isometric growth patterns (Lawrence and Fowler, 2002). The animal's body has a mechanism regulating the growth of different parts and organs relative to the live weight or size of the animal, resulting in each part of the body contributing a certain percentage to the whole size or live weight of the animal. The live weight of the birds selected for the carcass and internal organs evaluation indicates that birds on $DGLE_{0.5}$ and $DGLE_{1.0}$ were significantly heavier than birds on the control ($DGLE_0$) and $DGLE_{1.5}$. The similar percentage dressed weight between the treatments indicates that normal growth pattern based on the principle of allometric and isometric growth was upheld by the treatments in the parts/organs that do not constitute the dressed weight. In this study, the drained blood, feathers, head, shanks, and all the internal organs were not part of the dressed weight. It has been reported (Iwuji *et al*., 2022) that body parts that are small or contribute small percentages to the live weight of animals are usually tightly regulated in accordance to the principle of allometric and isometric growth than body parts that are big or contribute large percentages to the live weight of the animals. The significant differences obtained in the percentage weights of these parts even when the direct weights do not widely differ were as a result of the significant differences in their live weights. This explains why birds with higher live weights ($DGLE_{0.5}$ and $DGLE_{1.0}$) recorded significantly lower percentage weights in body parts that followed normal allometric and isometric growth pattern, than birds with lower live weights ($DGLE_{0}$ and $DGLE_{1.5}$). Likewise, the lower percentage breast and drumsticks weights recorded in $DGLE_{1.0}$ birds were as a result of the higher live weight recorded in them. Interestingly, the percentage weight of the abdominal fat significantly decreased with increasing dose of the extracts, and the direct weights also decreased with increasing dose of the extracts. This clearly indicates that *Dialium guineense* leaf extracts mediates reduction of abdominal fat deposition in broiler chickens, which can be attributed to the actions of some phytochemicals like phenols, flavonoids, and saponins present in the leaves of *Dialium guineense* (Onah *et al*., 2022). The liver also recorded similar weights and pattern of percentage weights between the experimental groups. Considering the functions of the liver in the body, excess lipid in the blood may accumulate in the liver as fat (Beitz, 2004), but due to the activities of the phytochemicals (phenols, flavonoids, saponins, etc), which may have exerted a reduction effect in blood lipids (Islam *et al*., 2021), the accumulation of fat in the liver may have been prevented in the treated birds, resulting in the reduction of their liver weights and their percentages to their live weights. The results of the carcass and internal organs weight evaluation of the broiler chickens indicates that besides the abdominal fat and liver growth of the birds, DGLE did not affected allometric and isometric growth pattern of the evaluated parts.

Internal organs histology

The histological assessment of the internal organs of the birds revealed increased volume of alveolar sacs in the lungs of $DGLE_{1.0}$ and $DGLE_{1.5}$ birds, while the intestines of the same $DGLE_{1.0}$ and $DGLE_{1.5}$ birds showed increased mucosal and villi mass. Since the size (length and width) of the villi affects nutrient absorption (Wang *et al*., 2025), it could mean that *Dialium guineense* leaf extracts (DGLE) mediated better nutrient absorption in $DGLE_{1.0}$ and $DGLE_{1.5}$ birds through increased villi size. It was also observed that there were no pathological changes in the tissues of all the organs evaluated, implying that the extracts did not negatively affect the organs and there were no toxicity at the levels of administration.

Conclusion

The ethanol extracts of velvet tamarind (*Dialium guineense* Willd) has demonstrated regulatory roles in feed utilization and growth performance of broiler chickens, without adversely affecting the tissue architecture of their lungs, liver, spleen, and intestine. It therefore could serve as a non-synthetic alternative for improving the growth performance of broiler chickens. Although up to 1.5 g/L administration through drinking water was tolerated by the birds, the best growth performance result was achieved at 1.0 g/L administration.

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Date received:17th December, 2025

Date accepted: 20th April, 2026