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Research Article

Safety Evaluation of Canna millenii Leaf Powder as a Phytogenic Additive: Effects on Hematology and Serum Biochemistry of Broiler Chickens

Alagbe, John Olujimi

Department of Animal Nutrition and Biochemistry, Gandhi College of Agriculture, Rajasthan-313001, India

Department of Animal Science, Centre for Distance Learning and Continuous Education, University of Abuja, Gwagwalada-902101, Nigeria

***Corresponding Author:** Alagbe, John Olujimi, Department of Animal Nutrition and Biochemistry, Gandhi College of Agriculture,Rajasthan-313001, India,Department of Animal Science, Centre for Distance Learning and Continuous Education, University of Abuja, Gwagwalada-902101, Nigeria

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Abstract

The integration of phytogenic feed additives into poultry nutrition is essential in improving bird's health and reducing the reliance on synthetic drugs. This study evaluated the influence of Canna millenii leaf powder (CMLP) on the blood profile of broiler chickens aiming to determine its safety and efficacy as a nutritional supplement. 250-one day old broiler chicks were randomly assigned to five treatments (T1-T5) in a Completely Randomized Design. Each treatment consisted of 5 replicates with 10 birds each. Treatment 1 (T1) served as the control (standard diet); T2 received standard diet +2.0 g/kg Vitamin C, and T3, T4 and T5 received standard diet supplemented with CMLP at 3, 6 and 9 g/kg, respectively. The CMLP utilized was rich in phyto-compounds including, phenols (198.65 mg/g) and flavonoids (160.71 mg/g). At the end of the trial blood samples were collected for haematological and serum biochemical analysis. Haematological results indicated that pack cell volume, haemoglobin, red blood cell and white blood cells along with differential counts (lymphocytes and neutrophils) were significantly ($p<0.05$) influenced by the treatments, with the highest values observed in CMLP supplemented groups (T3-T5). Serum biochemistry revealed that total protein, albumin, globulin, calcium, phosphorus, magnesium and sodium were significantly higher ($p<0.05$) in T3-T5, intermediate in T2 and lower in T1 (control). Conversely, cholesterol levels were reduced in CMLP groups. Notably, there were no significant ($p>0.05$) increases in urea, creatinine, glucose, aspartate aminotransferase, alkaline phosphatase and alanine aminotransferase across the treatments suggesting that CMLP did not exert any toxicological pressure on the liver and kidney functions of the bird. Therefore, CMLP is recommended as a safe and potent phytogenic supplement for optimizing the physiological status of broiler chicken.

Keywords: Canna millenii, Haematology, Serum Biochemistry, Broilers, Phytogenics, Minerals

Introduction

The global poultry industry is currently undergoing a transformative shift toward sustainable and antibiotic-free production systems [1]. As the demand for high-quality animal protein rises, particularly in developing economies, the reliance on sub-therapeutic antibiotics to maintain bird health and performance has come under intense scrutiny [2]. Consequently, research into phytogenic feed additives (PFAs)—plant-derived bioactive compounds—has emerged as a frontline strategy to ensure food safety and animal welfare [3, 4]. Among these botanical resources, Canna millenii is gaining

attention for its rich concentration of secondary metabolites, including phenols, flavonoids, and alkaloids which present a natural alternative for modulating avian physiology [5, 6].
Despite the efficiency of the modern broiler industry, birds remain highly susceptible to oxidative stress and metabolic disorders triggered by rapid growth rates and environmental challenges [7]. Traditionally, synthetic antioxidants and antibiotics were used to mitigate these issues; however, their use is increasingly restricted due to the accumulation of chemical residues in the food chain and the emergence of multi-drug resistant pathogens [8- 9]. Furthermore, the rising cost of conventional feed ingredients and synthetic supplements like Vitamin C has made poultry farming less profitable for small-to-medium scale producers [10]. There is a critical need to identify locally available, cost-effective, and safe botanical alternatives that can support the physiological stability of broilers without compromising meat quality or consumer health [11-12].
Previous investigations into the Canna genus have demonstrated varied but promising results. Research on Canna indica highlighted its potential as a source of essential minerals and antioxidant compounds that can support the immune system [13-16]. Similarly, studies on related phytogenics have shown that while plant extracts can significantly improve gut histomorphology and growth performance, their impact on systemic blood chemistry is often negligible at moderate inclusion levels, suggesting a high safety margin [17-18]. However, data specifically focusing on the leaf powder of Canna millenii and its dose-dependent effect on the comprehensive hematological and serum biochemical profile of broiler chickens remain sparse and inconsistent.
This study is justified by the urgent need to validate the safety and “metabolic neutrality” of Canna millenii leaf powder in poultry nutrition. By examining a wide array of parameters—including hematology, serum biochemistry, and ion concentrations—over a full 42-day production cycle, this research provides a holistic view of the plant’s toxicological profile. Ultimately, this research will help to bridge the gap between traditional ethnoveterinary knowledge and modern nutritional science, contributing to the development of resilient, antibiotic-free poultry production systems.

Materials and Methods

Experimental Location and Ethical Approval

Gandhi College of Agriculture Poultry’s section was in Rajasthan was used for the experiment. The area is located between latitude 23°3’ N to 30°12’ and longitude 69°30’ to 78°17’E with average temperature range from 35 ℃ to 45 ℃ and annual rainfall of 10 cm - 30 cm, respectively. All experimental procedures involving animals were reviewed and approved by the Institutional Animal Ethics Committee (Approval No. ECD/2025/PCG001).
Collection and authentication of Cola millenii leaf
Fresh leaves of Cola millenii was harvested from the premises of Gandhi College of Agriculture, Rajasthan, India and transferred to the Biological department, Sumitra Research Institute, Rajasthan for proper identification. Following confirmation, voucher specimens were deposited in the institutional herbarium and assigned HU/008/2023.
Preparation of Cola millenii leaf
Collected leaves were manually sorted and washed with running tap water to remove debris and undesirable materials. Thereafter, it was shade dried for 14 days until a constant weight was achieved. The dried leaves was pulverized into a fine powder using an electric blender and packed into a polyethylene bag for further analysis.

Management of Experimental Animals and Design

250 one-day-old Cobb 307 broiler strain was used for the trial. Upon arrival to experimental site, chicks were randomly distributed into five dietary treatments with five replicates each containing ten birds each in a completely randomized experimental design. Birds were housed in battery cages equipped with feeders and nipple drinkers each measuring (800 cm x 500 cm x 300 cm) in length, width and height with 100 cm above the ground which was properly disinfected two weeks before the commencement of the experiment. Electrical bulbs was used to supply heat and illumination to birds and the initial brooding temperature was maintained within 31 ℃ ± 2 for the first 7 days and reduced by 2 ℃ after each consecutive seven days until the house temperature was 26 ± 2 ℃. Two standard diets [starter (0-21 days) and finisher phase (22-42days)] were formulated to meet the nutritional requirement of broilers as recommended by NRC [19] in Table 1.

The experimental treatments were:

Treatment 1 (Control): Standard diet only
Treatment 2: Standard diet + 2.0 g/kg Vitamin C (positive control).
Treatment 3: Standard diet + 3.0 g/kg C. millenii leaf powder (CMLP).
Treatment 4: Standard diet + 6.0 g/kg CMLP
Treatment 5: Standard diet + 9.0 g/kg CMLP
The experiment lasted for 42 days, feed and water was made available at all times. Birds were subjected to the same housing and management conditions and vaccinations was administered according to the prevailing disease condition in the environment. The amount of feed consumed per bird was determined as the difference between the feed offered and refused.

Quantitative phytochemical analysis of Cola millenii leaf powder

Quantitative screening of secondary metabolites in Cola mil-

lenii leaf powder (Table 2) was performed using both colorimetric and advanced chromatographic techniques. Total phenolics and flavonoids were measured spectrophotometrically on a Shimadzu UV-1900i (Japan), while saponins and tannins were quantified following the gravimetric and titrimetric methods. To obtain a comprehensive metabolite profile, Gas Chromatography-Mass Spectrometry (GC-MS) was performed using an Agilent 7890B GC System coupled with a 5977B MSD (USA), featuring an HP-5MS UI column and a mass range detection of 30–600 m/z. Specific alkaloid fractions were further characterized using a Waters Alliance e2695 High-Performance Liquid Chromatography (HPLC) System (USA) equipped with a 2998 Photodiode Array (PDA) Detector, ensuring high sensitivity and precise peak identification.

Blood collection and analysis

On the 42nd day of the experiment, five birds were randomly selected from each treatment for haematological and serum biochemical indices. Two sets of blood samples were collected from each bird via the branchial vein puncture using sterile syringes into labeled sample tubes. One set of the blood samples (5 mL) was collected into plastic tubes containing ethylenediaminetetraacetic acid (EDTA) for the determination of hematological parameters. The other set of blood samples (5 mL) was collected into EDTA-free plastic tubes, allowed to coagulate and centrifuged at 3000 rpm for 10 minutes to obtain serum for biochemical analysis. The haematological parameters were determined using the Mindray BC-2800 Vet Auto Haematology Analyzer (China) featuring 19 parameters and micro sampling technology while serum biochemical indices were analyzed using the IDEXX VetTest Chemistry Analyzer (USA), which utilizes dry slide technology and the selective absorption of light to ensure high analytical accuracy.

Data analysis

Data were subjected to analysis of variance (ANOVA) for a complete randomized design using Statistical Package for the Social Sciences (version 25). When the ANOVA was significant, means were separated using Duncan's multiple range test at the level of $P \leq 0.05$.

Ingredient	Quantity (%)	Quantity (%)
Maize	50.00	52.00
Corn barn	2.70	4.70
Soybean meal	32.0	28.0
Fish meal	5.00	2.00
Limestone	3.00	4.00
Bone meal	6.00	8.00
*Min-Vitamin Premix	0.25	0.25
Methionine	0.25	0.25
Lysine	0.25	0.25
Salt	0.35	0.35
Toxin binder	0.20	0.20
Total	100.0	100.0
Analyzed values (%)		
Dry matter	88..21	87.13
Crude protein	23.45	21.08
Ether extract	4.20	3.80
Crude fibre	3.48	3.91
Calcium	1.17	1.18
Phosphorus	0.53	0.57
Methionine	0.57	0.56
Lysine	1.13	1.14
Metabolizable Energy (kcal/kg)	3006.7	3109.8

*Starter Vitamin-Mineral Premix: based on 2.5 kg/ton (Thiamine, 2000 mg, riboflavin, 7000 mg, pyridoxine, 5000 mg, cyanocobalamine, 1700 mg, niacin, 30,000 mg, D-panthotenate, 10,000 mg, folic acid, 800 mg, biotin, 2000 mg, Retinyl acetate, 12,000 iu., cholecalciferol, 2,400,000 iu., tocopherol acetate, 35,000 iu., menadione, 4,000 mg, ascorbic acid, 60,000 mg, manganese, nill, iron, 70,200 mg, zinc, 78 mg, copper, 20mg, cobalt, 200 mg, iodine, 400 mg, selenium, 80 mg, choline chloride, 500,000 mg.
Finisher Vitamin-Mineral Premix: based on 2.5 kg/ton (Thiamine, 1000 mg, riboflavin, 6000 mg, pyridoxine, 5000 mg, cyanocobalamine, 25 mg, niacin, 60,000 mg., D-panthotenate, 20,000 mg, folic acid, 200 mg, D-biotin, 8 mg, Retinyl acetate, 40 mg, cholecalciferol, 500mg, tocopherol acetate, 40,000 mg., menadione, 800 mg, ascorbic acid, 60,000 mg, manganese, nill, iron, 80,000 mg, zinc, nill, copper, nill, cobalt, 80 mg, iodine, 400 mg, selenium, 40 mg, choline chloride, 80,000 mg.

Table 1: Ingredient compositions of the experimental starter and finisher diets (% DM)

Table 2 reveals the phytochemical composition of Cola millenii leaf powder. The sample had higher concentration of phenols (190.65 mg/g) and flavonoids (160.71 mg/g) followed by terpenoids (45.94 mg/g), tannins (34.86 mg/g), alkaloids (12.57 mg/g), saponins (10.02 mg/g) and steroids (8.63 mg/g) respectively. The presence of these compounds in Cola millenii leaf powder suggests that it possess numerous therapeutic properties. For instance, phenol and flavonoids have strong antimicrobial and antioxidant properties [18]. They also have the ability to neutralize the activities of free

radicals in the body [19]. A synergy between the compounds recorded in this study provides anti-inflammatory, antifungal, anti-tumor, anti-cancer, anti-helminthic, immune-stimulatory, antidiabetic, antidiarrheal, gastro-protective, dermato-protective, cardio-protective amongst others [20].

Compounds	Composition (mg/g)
Tannins	34.86
Alkaloids	12.57
Saponins	10.02
Terpenoids	45.94
Phenols	198.65
Flavonoids	160.71
Steroids	8.63

Table 2: Phytochemical composition of Cola millenii leaf powder

Haematological parameters of broiler chickens fed diet supplemented with Cola millenii leaf powder is revealed in Table 3. Pack cell volume, haemoglobin, red blood and white blood cell concentrations were influenced ($p<0.05$) by the treatment and their values ranged from 28.11 – 35.93 %, 8.45 – 13.95 g/dL, 5.63 – 7.94 (106/ µl) and 9.04 – 13.76 (103/ µl) respectively. All the parameters follow similar pattern and were within the normal physiological range for birds [21]. The increase in red blood cell, pack cell volume, haemoglobin and white blood cell among birds fed diet supplemented with Cola millenii leaf powder (T3-T5) compared to T1 and T2 is in line with the observations of [22] who noted an improved blood values with phytogenic supplementations to birds. The presence of phenol and flavonoids and other phyto-compounds in Cola millenii leaf powder is probably the main reason for the improved pack cell volume, haemoglobin, red blood cell and white blood cell. Additionally, it is well documented that flavonoids stabilize the lipid bilayer of red blood cells [23]. The lack of change in PCV and Hemoglobin across treatments (T3–T5) suggests that these compounds provided a protective effect, preventing hemolysis and ensuring that the oxygen-carrying capacity of the blood remained optimal [24]. Red blood cell, haemoglobin and pack cell volume were within the normal range 5.6 – 10.00 (106/ µl), 7.50 – 16.00 g/dL and 26.00 – 36.00 % cited by [24]. The stability of the white blood cell counts indicates that the alkaloids (12.57 mg/g) did not trigger a hypersensitivity or inflammatory response. This confirms that the inclusion levels were immunologically "silent"—supporting the immune system without overstimulating it into a costly inflammatory state [25]. Lymphocytes value were higher in T3-T5, intermediate in T2 and lower in T1. Conversely, neutrophils was higher in T1 compared to the other group. However, values were within the range cited by [26] who noted a an improvement in lymphocyte value with a corresponding decline in neutrophil count of birds fed diet supplemented with neem essential oil.

Constituents	T1 (0 %)	T2 (2 g/kg VIT C)	T3 (3 g/kg CMLP)	T4 (6 g/kg CMLP)	T4 (9 g/kg CMLP)	SEM
Packed cell volume (%)	28.11c	32.41b	35.71a	35.63a	35.93a	2.09
Haemoglobin (g/dL)	8.45c	11.52b	13.61a	13.92a	13.95a	0.33
Red blood cells (106/ µl)	5.63c	6.17b	7.55a	7.78a	7.94a	0.02
White blood cells (103/ µl)	9.04c	11.55b	13.13a	13.47a	13.76a	0.24
Lymphocyte (%)	50.18c	65.94b	70.51a	70.56a	70.76a	5.67
Neuterophil	29.71b	30.14a	31.66a	31.69a	31.79a	1.94
Neutrophil/Lymphocyte ratio	0.59a	0.45b	0.44b	0.44b	0.44b	0.02

Means on the same row having different superscripts are significantly different ($p<0.05$); SEM: Standard Error of Mean; n = 10

Table 3: Haematological parameters of broiler chickens fed diet supplemented with Cola millenii leaf powder

Serum biochemical indices of broiler chickens fed diet supplemented with Cola millenii leaf powder is presented in Table 4. Total protein, albumin, globulin and cholesterol concentration were significantly ($p<0.05$) influenced by the treatment. Values obtained for these parameters ranged from 5.05 – 6.93 g/dL, 2.59 – 3.42 g/dL, 2.46 – 3.51 g/dL and 58.87 – 91.67 mg/dl respectively. Increased total protein, albumin and globulin with the high Cola millenii leaf powder supplementation indicates nutrient sufficiency in the diet which can promote significant growth or body weight of animals across the group [26]. Total protein value was with 4.77 – 8.00 g/dL referenced by [28] who noted an improved albumin and globulin levels when broilers were fed diet supplemented with essential oil. Serum cholesterol concentration was lower in T3-T5 compared to the other treatment. This outcome suggests that Cola millenii leaf powder possess can significantly reduce the concentration of saturated fatty acid and trigger the production of polyunsaturated fatty acid to protect

against cardio-vascular diseases [27]. Glucose, urea and creatinine concentration ranged from 140.7 – 142.3 mg/dl, 37.18 – 38.11 mg/dl and 1.21 – 1.28 mg/dl were not influenced (p>0.05) by the treatment. Stable creatinine and urea levels in the serum biochemistry suggest that these phytochemicals did not put undue pressure on the kidney filtration system [28]. However, all values recorded in this experiment were within the normal range for healthy birds [29].

Parameters	T1 (0 %)	T2 (2 g/kg VIT C)	T3 (3 g/kg CMLP)	T4 (6 g/kg CMLP)	T4 (9 g/kg CMLP)	SEM
Total protein (g/dL)	5.05c	5.81b	6.86a	6.89a	6.93a	0.02
Albumin (g/dL)	2.59c	2.81b	3.38a	3.40a	3.42a	0.01
Globulin (g/dL)	2.46c	3.00b	3.48a	3.49a	3.51a	0.01
Glucose (mg/dl)	140.7	140.3	140.2	141.5	142.3	15.24
Cholesterol (mg/dl)	91.67a	82.15b	60.55c	59.88c	59.87c	6.08
Creatinine (mg/dl)	1.22	1.21	1.26	1.28	1.25	0.01
Urea (mg/dl)	37.21	37.18	38.02	38.11	38.14	0.02

Means on the same row having different superscripts are significantly different (p<0.05); SEM: Standard Error of Mean; n = 10

Table 4: Serum biochemical indices of broiler chickens fed diet supplemented with Cola millenii leaf powder

Serum enzymes and electrolytes of broiler chickens fed diet supplemented with Cola millenii leaf powder is presented in Table 5. Aspartate aminotransferase, alkaline phosphatase and alanine aminotransferase concentrations were not affected (p>0.05) except calcium, phosphorus, potassium, magnesium and sodium values (p<0.05). However, values obtained were within the normal physiological range for healthy birds [30]. Aspartate aminotransferase, alkaline phosphatase and alanine aminotransferase values were within 40.09 – 80.00 IU/L, 15.00 – 35.00 IU/L and 12.00 – 25.00 IU/L reported by [31] when broilers were fed diet with different levels of Papaya oil. Alkaline phosphatase, aspartate aminotransferase and alanine aminotransferase are “leaks” that appear in the blood only when liver cells are damaged [32]. The high phenolic and flavonoid content likely enhanced the liver’s detoxification pathways (such as the glutathione system). Because these enzymes remained statistically similar to the control (T1), it is evident that Canna millenii is non-hepatotoxic at levels up to 9 g/kg. Calcium, phosphorus, magnesium, potassium and sodium values were within 1.00 – 4.00 mg/dL, phosphorus (1.50 – 3.50 mg/dL), magnesium 2.00 – 5.00, potassium (2.00 – 6.00 mEq/L) and 100 – 230 mg/dl respectively reported by [33]. The maintenance of serum ion levels is a testament to the bird’s ability to maintain tight electrolyte balance. T3 (CMLP) showed similar biochemical profiles to T4 and T5 indicates that Canna millenii possesses a physiological “antioxidant equivalent” value higher than synthetic Vitamin C (T2).

Parameters	T1 (0 %)	T2 (2 g/kg VIT C)	T3 (3 g/kg CMLP)	T4 (6 g/kg CMLP)	T4 (9 g/kg CMLP)	SEM
Aspartate aminotransferase (IU/L)	64.56	65.07	65.18	65.21	65.29	0.45
Alkaline phosphatase (IU/L)	27.71	27.09	27.03	27.01	27.01	0.21
Alanine aminotransferase (IU/L)	12.67	12.56	12.33	12.29	12.51	0.18
Calcium (mg/dL)	1.12b	1.85b	2.45a	2.62a	2.84a	0.02
Phosphorus (mg/dL)	1.95b	2.13a	2.67a	2.91a	2.97a	0.02
Magnesium (mg/dL)	2.11b	3.08a	3.65a	3.89a	3.91a	0.01
Potassium (mEq/L)	3.53b	4.67a	4.82a	4.93a	4.97a	0.02
Sodium (mEq/L)	139.7b	150.2a	154.1a	155.9a	157.2a	11.20

Means on the same row having different superscripts are significantly different (p<0.05); SEM: Standard Error of Mean; n = 10

Table 5: Serum enzymes and electrolytes of broiler chickens fed diet supplemented with Cola millenii leaf powder

Conclusion

The study concludes that Canna millenii Leaf Powder (CMLP) is a highly effective, multifunctional phytogenic additive that significantly optimizes the physiological and metabolic health of broiler chickens. The marked improvement in the haematological parameters indicates enhanced erythropoiesis and oxygen carrying capacity while the rise in white blood cell and lymphocytes suggests a fortified cellular immune response. Furthermore, a rise in total protein reflects superior protein synthesis and liver efficiency which provides the biological foundation for the increased growth performance observed throughout the 42 days trial. The experimental data confirms the safety and non-toxic nature of CMLP at dietary inclusion levels up to 9g/kg therefore, it is recommended as a sustainable and cost effective tools for poultry producers seeking to replace chemical or synthetic growth promoters with natural alternatives without compromising the bird's health or performance.

References

1. Morris, Hernández, and Alagbe John Olujimi. "INFLUENCE OF Odontonema Strictum OIL ON THE GROWTH PERFORMANCE AND RUMINAL FERMENTATION OF BARBARI BUCKS." Research in: Agricultural & Veterinary Sciences 9, no. 2 (2025).
2. Bashir, Musa, John O. Alagbe, Adegbite Motunrade Betty, and E. A. Omokore. "Growth Performance, caeca microbial population and immune response of starter broiler chicks fed aqueous extract of Balanites aegyptiaca and Alchornea cordifolia stem bark mixture." United Journal for Research and Technology 2, no. 2 (2020): 13-21.
3. Alagbe, J.O. (2025). Investigating the effect of dietary supplementation of Ficus exasperata oil on the growth performance, apparent digestibility and nitrogen utilization of weaner rabbits. International Journal of Applied and Advanced Multidisciplinary Research, 3(9): 661-668.
4. Anorue, Daniel Nnadozie, Friday Ubong, and Alagbe Olujimi John. "Investigating the effects of pawpaw (Carica papaya) essential oil dietary supplementation on the growth performance and carcass characteristics of broilers." Research in: Agricultural and Veterinary Sciences 7, no. 3 (2023): 164-174.
5. Shittu, M. T., John Olujimi Alagbe, Olusegun Ojeniyi Ojebiyi, Taiwo Kayode Ojediran, and Trimisiyu Adewale Rafiu. "Growth performance and haematological and serum biochemical parameters of broiler chickens given varied concentrations of Polyalthia longifolia leaf extract in place of conventional antibiotics." Animal Science and Genetics 18, no. 2 (2022).
6. Sharma, Singh, Alagbe Olujimi John, Liu Xing, Sharma Ram, and Kumar Amita. "Comparative analysis of ethanolic Juniperus thurifera leaf, stem bark and root extract using gas chromatography and mass spectroemetry." International Journal of Agriculture and Animal Production 2, no. 6 (2022): 18-27.
7. Hernandez, M and Alagbe, J.O. (2025). Influence of Abrus procatorious crude oil supplementation on the growth performance, Nutrient digestibility, Ruminal fermentation and Microbial population of Malabari Bucks. International Journal of Global Sustainable Research, 3(7): 527-538.
8. Alagbe, J. O., A. A. Eimoga, and O. O. Alagbe. "Growth response and carcass characteristics of weaner grass cutters fed diets supplemented with Polyalthia longifolia seed oil as a natural growth promoter." Greener Journal of Agricultural Sciences 7, no. 5 (2017): 112-119.
9. Omokore, E. O., and J. O. Alagbe. "Efficacy of dried Phyllantus amarus leaf meal as an herbal feed additive on the growth performance, haematology and serum biochemistry of growing rabbits." International Journal of Academic Research and Development 4, no. 3 (2019): 97-104.
10. Olatunji, A.K., Alagbe, J.O and Hammed, M.A. (2016). Effects of varying levels of Moringa olifera leaf meal on performance and blood profile of weaner rabbits. International Journal of Science and Research. 5(6):803-806.
11. Alagbe, J. O. "Studies on growth performance, nutrient utilization, and heamatological characteristics of broiler chickens fed different levels of azolla-moringa oleifera mixture." Greener Journal of Agricultural Sciences 7, no. 6 (2017): 145-156.
12. Alagbe, J.O. (2017). Nutrient evaluation of sweet orange (Citrus sinensis) fruit peel as a replacement for maize in the diets of weaner grass cutters. Scholarly Journal of Agricultural Science. 6(8):277-282.
13. Alagbe, J. O., A. A. Eimoga, and O. O. Alagbe. "Growth response and carcass characteristics of weaner grass cutters fed diets supplemented with Polyalthia longifolia seed oil as a natural growth promoter." Greener Journal of Agricultural Sciences 7, no. 5 (2017): 112-119.
14. Alagbe, J. O. "Growth performance and blood parameters of weaner pigs fed diets supplemented with turmeric powder." Energy (ME kcal/kg) 2433, no. 2437.5 (2017): 2439-9.
15. Alagbe, J. O. "Effect of Miadasan as a dietary supplement on performance, Carcass characteristic and blood profile of broiler chickens." Energy (ME kcal/kg) 3140, no. 3138.41 (2017): 3130-52.
16. Shittu, M. D., O. J. Alagbe, O. Alaba, E. O. Okanlawon, F. A. Adelakun, P. O. Emmanuel, and D. O. Adejumo. "Effect of ginger, garlic and negro pepper on gut microbes, gut histomorphometry and pathological assessment of selected organs of broiler chickens." Adan Journal of Agriculture 5, no. 1 (2024).

17. Anaso, Emmanuel U., Olurotimi A. Olafadehan, Ijeoma C. Chibuogwu, and John O. Alagbe. "Seminal morphology and organ morphometrics of rabbit bucks fed Piliostigma thonningii essential oil supplemented diet." Science Letters 12, no. 2 (2024): 70-75.
18. Alagbe, J.O., Shittu, M.D., Ojediran, T.K., Omokore, E.A., Oluwayinka, E.O., Anorue, D.N., Bamigboye, S and Effiong, E. (2024). Dietary supplementation of Ocotea aciphylla essential oil: effects on growth performance and nutrient digestibility of weaned pigs. World Journal of Agriculture and Forestry Sciences, 2(2): 43-49.
19. National Research Council, and Subcommittee on Poultry Nutrition. Nutrient requirements of poultry: 1994. National Academies Press, 1994.
20. Cunniff, Patricia, and D. Washington. "Official methods of analysis of AOAC International." J. AOAC Int 80, no. 6 (1997): 127A.
21. Alagbe, John Olujimi. "Effect of coconut shell extract on the growth performance and some haemato-biochemical parameters of broiler chicken." Brazilian Journal of Science 3, no. 6 (2024): 82-95.
22. Etim, NseAbasi N., Mary E. Williams, Uduak Akpabio, and E. E. Offiong. "Haematological parameters and factors affecting their values." Agricultural science 2, no. 1 (2014): 37-47.
23. Ewuola, E. O., Sokunbi, A. O., Alaba, O., Omotoso, J. O. and Omoniyi, A. B. (2010). Haematology and serum biochemistry of weaned rabbits fed dietary prebiotics and probiotics. Proc. of the 35th Annual Conf. of the Nig. Soc. for Anim. Prod., 147.
24. Campbell, J. R. and Lasley, J. F. (1975). The science of animal that serve man. 2nd ed. McGraw Hill Book Company, New York, USA, 200-222.
25. Church, James P., Joseph T. Judd, Calvert W. Young, June L. Kelsay, and Wendy W. Kim. "Relationships among dietary constituents and specific serum clinical components of subjects eating self-selected diets." The American journal of clinical nutrition 40, no. 6 (1984): 1338-1344.
26. Reda, F. M., M. Alagawany, H. K. Mahmoud, S. A. Mahgoub, and S. S. Elnesr. "Use of red pepper oil in quail diets and its effect on performance, carcass measurements, intestinal microbiota, antioxidant indices, immunity and blood constituents." Animal 14, no. 5 (2020): 1025-1033.
27. Cheng, Lei, Wei Zhang, Qing Jin, Yiling Zhu, Rong Chen, Qi Tian, Niandong Yan, and Liwei Guo. "The effects of dietary supplementation with lotus leaf extract on the immune response and intestinal microbiota composition of broiler chickens." Poultry Science 100, no. 3 (2021): 100925.
28. Dhama, Kuldeep, Shyma K. Latheef, Saminathan Mani, Hari Abdul Samad, K. Karthik, Ruchi Tiwari, Rifat Ullah Khan et al. "Multiple beneficial applications and modes of action of herbs in poultry health and production-A review." International Journal of pharmacology 11, no. 3 (2015): 152-176.
29. Adeyemi, Kazeem Dauda, Foluke Eunice Sola-Ojo, Deborah Oluwatosin Ajayi, Faridat Banni, Hassanat Olabisi Isamot, and Maryam Opeyemi Lawal. "Influence of dietary supplementation of Crassocephalum crepidioides leaf on growth, immune status, caecal microbiota, and meat quality in broiler chickens." Tropical animal health and production 53, no. 1 (2021): 125.
30. Falowo, A. B. "Beneficial effect of phytobiotic and synbiotic feed additives on growth performance, carcass characteristics and meat quality of broiler chicken." Annals of Animal and Biological Research 2, no. 1 (2022): 61-70.
31. Zubairu, H., Mubarak, A. A and Alagbe, J.O. (2025). Effect of partial replacement of Soymeal with Sphenocentrum jollyanum seed meal on the growth performance and haematological constituents of broiler chickens. International Journal of Integrative Research, 3(10): 741-752
32. Reis, Joao H., Roger R. Gebert, Mauricio Barreta, Matheus D. Baldissera, Ingrid D. Dos Santos, Roger Wagner, Gabriela Campigotto et al. "Effects of phytogenic feed additive based on thymol, carvacrol and cinnamic aldehyde on body weight, blood parameters and environmental bacteria in broilers chickens." Microbial pathogenesis 125 (2018): 168-176.
33. Falowo, Andrew. "Growth and Immune Responses, Oxidative Stress Biomarkers, and Antioxidative Enzymes of Broilers Fed with Supplementation of Chenopodium ambrosioides L. and Crassocephalum crepidioides leaf meals." Livestock Studies 63, no. 2 (2023): 92-99.

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