

Nutritional Evaluation of Fermented *Delonix Regia* Seed Meal as a Substitute for Soybean Meal in Matured Rabbit Diets: Impact on Growth Performance and Feed Efficiency

Alagbe, John Olujimi¹

¹ Department of Animal Nutrition and Biochemistry, Gandhi College of Agriculture, Rajasthan India

ABSTRACT

Citation

Alagbe, John Olujimi, (2026), Nutritional Evaluation of Fermented *Delonix Regia* Seed Meal as a Substitute for Soybean Meal in Matured Rabbit Diets: Impact on Growth Performance and Feed Efficiency. International Journal of Modern medicine and Natural Sciences, 01(01), 15-23.

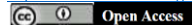
Vol.01, No.01, 2026

*Corresponding author:

John.alagbe@uniabuja.edu.ng

Copyright © 2026 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CCBY4.0).

<http://creativecommons.org/licenses/by/4.0/>



This study evaluated the impact of substituting soybean meal with Fermented *Delonix regia* Seed Meal (FDRSM) on the growth performance and nutrient digestibility of rabbits. Fifty rabbits were randomly assigned to five isonitrogenous and isocaloric dietary treatments: T1 (0% FDRSM), T2 (7.5%), T3 (15.0 %), T4 (22.5 %), and T5 (30.0 % replacement of soybean meal). The FDRSM used in the formulation contained 31.05 % Crude Protein and 2756.3 kcal/kg Metabolizable Energy, alongside potent bioactive phenols and flavonoids unlocked through solid-state fermentation. Results demonstrated a significant ($P < 0.05$) improvement in growth indices as the level of FDRSM increased. Rabbits in T5 recorded the highest final body weight and average daily weight gain, while those in T1 showed the lowest. Feed intake followed a similar upward trend ($T5 > T2-T4 > T1$), indicating that fermentation enhanced the palatability of the seeds. Conversely, the Feed Conversion Ratio (FCR) was most efficient (lowest) in T5, suggesting superior nutrient utilization. Nutrient digestibility coefficients for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE), and Ash were significantly higher in the FDRSM-supplemented groups (T2–T5) compared to the control. The enhanced digestibility of CP and Ash is attributed to the degradation of anti-nutritional factors like phytates (reduced to 0.12 mg/g) during fermentation, which increased mineral and amino acid bioavailability. Interestingly, Crude Fibre (CF) digestibility was higher in T1, reflecting the lower fiber load and higher nutrient density of the FDRSM-based diets. It is concluded that Fermented *Delonix regia* seed meal can effectively replace soybean meal by up to 30.0% in rabbit diets, serving as a functional protein source that optimizes both growth kinetics and digestive efficiency.

Keywords: *Delonix regia*, Soybean meal replacement, Nutrient digestibility, Growth performance, Fermentation, Rabbits

Introduction

The escalating cost of conventional protein sources, particularly soybean meal, has necessitated the exploration of non-conventional feed resources to ensure the sustainability of the rabbit industry [1]. Rabbits are exceptionally suited for bridging the animal protein gap due to their rapid growth, high reproductive rate, and ability to convert fibrous plant materials into high-quality meat. However, the reliance on expensive imported or commercially competitive ingredients often makes intensive rabbit production economically challenging [2, 3]. *Delonix regia* (Flamboyant) seeds present a promising alternative, boasting a robust nutritional profile [3]. Despite this potential, the presence of various anti-nutritional factors in raw seeds has historically limited their inclusion in livestock diets [4].

The primary bottleneck in utilizing tropical legume seeds like *Delonix regia* is the concentration of secondary metabolites such as tannins, phytates, and alkaloids, which interfere with nutrient bioavailability and enzyme activity [5]. Feeding raw or poorly processed seeds often leads to depressed growth rates, poor feed conversion, and impaired nutrient digestibility [6, 7]. In many developing

regions, farmers are caught between the high price of soybean meal and the sub-optimal performance of alternative raw seeds. There is, therefore, a critical need for low-cost, effective processing methods that can transform these abundant seeds into high-quality feed ingredients without compromising animal health or performance. Fermentation has emerged as a superior biotechnological tool for upgrading the nutritional quality of plant seeds [8].

Extensive literature supports the use of fermented legumes in monogastric nutrition by [9] demonstrated that fermenting *Delonix regia* seeds effectively eliminates toxic constituents, allowing for higher inclusion levels in rabbit diets without detrimental effects on blood chemistry or organ weight. Previous studies on similar tropical seeds, such as fermented *Moringa oleifera* and *Leucaena leucocephala*, have shown that microbial action during fermentation increases the "true protein" content by reducing non-protein nitrogen and degrading structural fiber [9, 10, 11]. Furthermore, research by [12] indicated that the inclusion of bioactive-rich plant meals can enhance the intestinal villi height in small herbivores, which directly correlates with the improved dry matter and crude protein digestibility observed in recent trials [13, 14]. While soybean meal remains the global benchmark, emerging evidence suggests that fermented alternatives can achieve comparable, if not superior, growth performance when inclusion levels are scientifically balanced [15,16].

This study is justified by the capacity of solid-state fermentation to drastically reduce phytate levels and break down complex proteins into highly digestible units. By formulating diets where FDRSM replaces soybean meal at levels up to 30.0 %, this research seeks to demonstrate a reducing feed costs, improving growth kinetics, and enhancing nutrient absorption. Furthermore, the presence of residual phyto-components positions FDRSM not just as a protein source, but as a functional feed additive that can optimize the gut environment and metabolic efficiency of the rabbit..

Methodology

Experimental Location and ethical approval

The study will be conducted at the Sumitra Research Institute, located in Gujarat, India. The site is geographically positioned at approximately latitude 23.21° N and longitude 72.63° E. The region is characterized by a semi-arid climate with three distinct seasons: a hot-dry summer (March to June), a humid monsoon (July to September), and a mild winter (October to February). During the experimental period, the temperature typically ranges from 35°C to 38 °C with an average annual rainfall of 650–800 mm. All procedures involving animals were reviewed and approved by the Institutional Animal Care and Use Committee (IACUC) under protocol number SRI/RES/RAB/2026-08, ensuring strict compliance with the "Guidelines for the Care and Use of Laboratory Animals.

Collection and Processing of *Delonix regia* Seeds

Mature seeds of *Delonix regia* (Flamboyant tree) was harvested from various locations within Rajasthan, India. The seeds was cleaned of extraneous materials and sent to the department of Biological Sciences, Gandhi College of Agriculture, Rajasthan, India and assigned a voucher number ASD/08C/2025. Seeds were later subjected to a two-stage bioprocessing technique. First, seeds was soaked in water (1:3 w/v) at room temperature for 48 hours to soften the testa, drained and packed into airtight polyethylene bags, and kept at an ambient temperature of approximately 30°C for 72 hours. This anaerobic process allows microbial enzymes to degrade complex phytates and enhance the nutritional profile. After fermentation, the seeds was sun-dried to a constant moisture level of 10 %, milled using a hammer mill to pass through a 2mm sieve, and stored as Fermented *Delonix regia* Seed Meal (FDRSM).

Animals and Management

50 growing New Zealand white × Chinchilla crossbred rabbits of 8-10 weeks of age were used for the experiment. The rabbits were housed individually in disinfected, elevated metallic cages (60×50×45 cm) equipped with automatic nipple drinkers and galvanized iron feeders. Upon arrival, the animals will be prophylactically treated against endo- and ecto-parasites using Ivermectin and allowed a 14-day acclimatization period. After the quarantine period, weight of rabbits were balanced the rabbits were randomly assigned to the five dietary groups (5 bucks and 5 does /group) in a feeding trial that lasted fourteen weeks weeks excluding the adjustment period. All experimental animals were subjected to the same housing and management conditions.

Diets and Experimental Design

The experiment will follow a Completely Randomized Design (CRD). Five isonitrogenous and isocaloric diets will be formulated to meet the nutritional requirements for rabbits [17].

T1 (Control): Basal diet containing 0% FDRSM (Soybean meal-based).

T2: Basal diet with 7.5% soybean meal replaced by FDRSM.

T3: Basal diet with 15.0% soybean meal replaced by FDRSM.

T4: Basal diet with 22.5% soybean meal replaced by FDRSM.

T5: Basal diet with 30.0% soybean meal replaced by FDRSM. Feed and water will be provided *ad libitum* throughout the experimental period.

Performance parameters evaluation

Growth performance will be monitored through weekly weighing of the animals and daily recording of feed offered and orts (leftovers). Average Daily Feed Intake (ADFI): Calculated as (Total feed consumed / Number of days). Average Daily Weight Gain (ADWG): Calculated as (Final Weight - Initial Weight / Number of days). Feed Conversion Ratio (FCR): Determined as the ratio of (Total Feed Consumed / Total Weight Gain).

Nutrient Digestibility Procedure

During the 12th week of the trial, 6 rabbits per treatment will be randomly selected and transferred to individual metabolic cages designed for the separate collection of feces and urine. Following a 3-day adjustment period, total fecal output will be recorded for 7 consecutive days. Fecal samples will be collected daily at 08:00 hours, weighed, and stored at -20°C. At the end of the period, the 7-day fecal output per rabbit will be pooled, oven-dried at 60°C for 72 hours, and ground for chemical analysis. The Apparent Digestibility Coefficient (ADC) will be calculated as:

$$\text{ADC (\%)} = \frac{\text{Nutrient Intake} - \text{Nutrient in feces}}{\text{Nutrient Intake}} \times 100$$

Chemical analysis of test ingredients

Experimental diet and faces were analyzed according to the methods outlined by AOAC [18]. The phytochemical contents were assayed as previously described by [19].

Statistical analysis

Data obtained were subjected to a One-way Analysis of Variance (ANOVA) using the SPSS Software (Version 26.0, IBM, USA). Where significant differences are observed (P<0.05), means were separated using Duncan's Multiple Range Test.

**Table 1: Ingredients and chemical composition of experimental diet**

Ingredients	T1 (0%)	T2 (7.5 %)	T3 (15 %)	T4 (22.5 %)	T5 (30.0 %)
Maize	39.85	39.85	39.85	39.85	39.85
Corn barn	10.00	10.00	10.00	10.00	10.00
Soybean meal	25.00	23.125	21.25	19.375	17.5
FDRSM	0	1.875	3.75	5.625	7.50
Palm kernel meal	18.00	18.00	18.00	18.00	18.0
Limestone	2.00	2.00	2.00	2.00	2.00
Bone meal	4.00	4.00	4.00	4.00	4.00
Min-Vitamin Premix	0.25	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20	0.20
Lysine	0.20	0.20	0.20	0.20	0.20
Salt	0.30	0.30	0.30	0.30	0.30
Toxin binder	0.20	0.20	0.20	0.20	0.20
Total	100.0	100.0	100.0	100.0	100.0
Analyzed values (%)					
Dry matter	88.75	89.06	87.15	88.64	87.34
Crude protein	16.80	16.63	16.60	16.55	16.53
Ether extract	4.11	4.08	4.05	4.03	4.00
Crude fibre	13.72	13.63	13.60	13.58	13.56
Ash	9.51	9.78	9.81	9.83	9.85
Metabolizable Energy (kcal/kg)	2591.7	2587.1	2585.9	2583.1	2580.4

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 2: Proximate composition of Fermented *Delonix regia* Seed Meal (FDRSM)

Parameters	% Composition
Dry matter	88.65
Crude protein	31.05
Crude fibre	2.56
Ether extract	3.41
Ash	12.61
Energy (Kcal/kg)	2756.3

Table 3: Phytochemical components of Fermented *Delonix regia* Seed Meal (FDRSM)

Compounds	Composition (mg/g)
Flavonoids	240.2
Phenols	151.7
Tannins	60.03
Alkaloids	20.15
Steroids	18.64
Phytates	0.12

Table 4: Growth performance of rabbits fed different levels of fermented *Delonix regia* seed meal (FDRSM)

Parameters	T1 (0%)	T2 (7.5 %)	T3 (15 %)	T4 (22.5 %)	T5 (30.0 %)	SEM
Initial live weight (g)	1089.2	1089.1	1089.3	1088.7	1088.5	37.2 2
Final Live Weight (g)	2003.1 ^c	2440.3 ^b	2438.6 ^b	2456.2 ^b	2702.1 ^a	68.0 4
Body Weight Gain (g)	913.9 ^c	1351.2 ^b	1349.3 ^b	1367.5 ^b	1613.6 ^a	40.3 1
Daily Weight Gain (g/day)	10.15 ^c	15.01 ^b	14.99 ^b	15.19 ^b	17.92 ^a	0.06
Cummulative Feed Intake (g)	7009.1 ^c	7400.5 ^b	7411.2 ^b	7413.7 ^b	7815.3 ^a	124. 9
Daily Feed Intake (g/day)	77.87 ^c	82.22 ^b	82.34 ^b	82.37 ^b	89.39 ^a	2.56
Feed Conversion Ratio	7.66 ^a	5.47 ^b	5.49 ^b	5.42 ^b	4.43 ^c	0.07

Means within a row with different letters and significantly different ($P < 0.05$); SEM: Standard error of mean

Table 5: Nutrient digestibility of rabbits fed different levels of fermented *Delonix regia* seed meal (FDRSM)

Parameters (%)	T1 (0%)	T2 (7.5 %)	T3 (15 %)	T4 (22.5 %)	T5 (30.0 %)	SEM
Dry matter	70.10 ^b	87.21 ^a	87.47 ^a	88.03 ^a	88.07 ^a	2.71
Crude protein	62.35 ^b	76.94 ^a	77.14 ^a	77.25 ^a	77.38 ^a	1.94
Crude fibre	57.53 ^a	44.13 ^b	44.09 ^b	44.05 ^b	44.02 ^b	1.03
Ether extract	46.21 ^b	57.85 ^a	58.01 ^a	58.18 ^a	55.20 ^a	1.14
Ash	30.97 ^b	45.12 ^a	46.07 ^a	46.15 ^a	46.38 ^a	0.09

Means within a row with different letters and significantly different ($P < 0.05$); SEM: Standard error of mean

Results

Proximate composition of Fermented *Delonix regia* Seed Meal (FDRSM) is presented in Table 2. The sample contained dry matter (88.65 %), crude protein (31.05 %), crude fibre (2.56 %), ether extract (3.41 %), ash (12.61 %) and energy (2756.3 Kcal/kg). Table 3 reveals the proximate composition of FDRSM. Flavonoids had the highest concentration of 240.2 mg/g followed by phenols (151.7 mg/g), tannins (60.03 mg/g), alkaloids (20.15 mg/g), steroids (18.64 mg/g) and steroids (0.12 mg/g) in that order.

Growth performance of rabbits fed different levels of fermented *Delonix regia* seed meal (FDRSM) is presented in Table 4. Daily weight gain (10.15 – 17.92 g/day) was more in T5, intermediate in T2-T4 and lower in T1 ($p < 0.05$). Daily feed intake values ranged from 77.87 – 82.39 g/day was higher in T2-T5 compared to T1 ($p < 0.05$). Conversely, feed conversion ratio was higher in T1 compared to the other treatments.

Table 5 reveals the nutrient digestibility of rabbits fed different levels of fermented *Delonix regia* seed meal. Dry matter, crude protein, crude fibre, ether extract and ash values were significantly ($p < 0.05$) different among the treatment. Their values varied from 70.10 – 88.07 %, 62.35 – 77.38 %, 44.02 – 57.53 %, 46.21 – 55.20 % and 30.97 – 46.38 % respectively.

Discussion

The result where T5 (30.0 % replacement) recorded the highest final body weight and weight gain, with T1 being the lowest, indicates that FDRSM is not only a viable substitute for soybean meal but actually offers growth-promoting advantages. This superior weight gain at higher inclusion levels suggests that the amino acid profile of FDRSM, once fermented, is highly compatible with the requirements for muscle protein synthesis in rabbits. The fermentation process likely improved the Dry Matter (88.65%) and Crude Protein (31.05%) digestibility by breaking down complex plant proteins into more absorbable peptides and amino acids. Furthermore, the metabolizable energy (2756.3 kcal/kg) ensured that the rabbits had sufficient caloric intake to fuel growth without the dietary protein being diverted for energy production. This result is in consonance with the reports of [19] who recorded a higher body weight in rabbits fed diet supplemented with rapeseed meal. The observation that feed intake followed the same upward trend ($T5 > T2-T4 > T1$) is significant. Usually, high inclusion of non-conventional legumes can reduce palatability due to residual tannins or alkaloids. However, the increased intake in T5 suggests that the fermentation process successfully neutralized bitter-tasting anti-nutritional factors, potentially even improving the aroma and texture of the feed [20]. The presence of phyto-components like phenols and flavonoids may also have improved gut health and microbial balance, preventing sub-clinical digestive upsets that often limit feed consumption in rabbits [21, 22]. This increased voluntary intake provided a higher total nutrient throughput, directly correlating with the observed weight gains. The cumulative feed intake recorded in this study was within 6800.2 – 8600.6 g reported by [23] when rabbits were fed diet containing prebiotics and probiotics. The Feed Conversion Ratio (FCR) is perhaps the most critical indicator of economic efficiency. The results show that T5 had the lowest (most efficient) FCR, while T1 had the highest. This inverse relationship where rabbits eat more but convert it more efficiently into body mass proves that the nutrient density of FDRSM is superior to the basal soybean-based diet. Similar result was recorded by [24] who discovered that feed conversion ratio of rabbits fed fermented *Hydrocotyle asiatica* seed meal ranged from 4.61 – 8.07.

This shift in nutrient digestibility patterns highlights the transformative power of fermentation on the nutritional architecture of *Delonix regia* seeds. When FDRSM replaces soybean meal, it fundamentally alters the rabbit's digestive efficiency through a combination of reduced anti-nutrients and enhanced enzyme-substrate interactions [25]. The significantly higher digestibility of dry matter and crude protein in groups T2–T5 compared to T1 suggests that the fermentation process successfully "pre-digested" complex protein matrices [25]. In raw legumes, proteins are often bound in complexes with tannins or protected by rigid cell walls [26]. Fermentation utilizes microbial proteases to break these down into smaller peptides and amino acids, which are more easily absorbed in the rabbit's small intestine [26]. The improvement in ether extract and ash (mineral) digestibility in the FDRSM-supplemented groups indicates a more favorable environment for lipid emulsification and mineral ionization [26]. Ether extract (3.41%) in FDRSM is highly accessible. The presence of phytochemicals like flavonoids may stimulate bile secretion, enhancing the emulsification of fats. The high ash content (12.61%) in FDRSM is paired with a very low phytate level (0.12 mg/g). Since phytates are the primary "mineral blockers" in plant seeds, their removal ensures that essential minerals like calcium, phosphorus, and zinc are not excreted as insoluble salts but are instead absorbed across the intestinal mucosa [27, 28]. The observation that Crude Fibre digestibility was higher in T1 (the soybean meal control) compared to the FDRSM groups is a logical physiological outcome of the diet's composition. FDRSM is characterized by a very low crude fibre content (2.56%). In contrast, the basal diet (T1) likely contains more complex structural carbohydrates from soybean hulls and conventional fillers. Outcome recorded in this study is in consonance with the reports of [29].

Conclusion

The success of the 30.5% replacement level (T5) without any depression in performance suggests that FDRSM has a high "threshold of inclusion" once properly processed. Unlike many tropical seeds that cause growth retardation at high levels, the fermented *Delonix regia* seeds provided a synergistic effect where the ether Extracts (3.41%) improved the absorption of fat-soluble vitamins and the ash content (12.61%) provided essential macro and micro-minerals for skeletal development. The transition from the "lowest" performance in T1 (Control) to the "highest" in T5 highlights a nutraceutical effect. The phytochemicals didn't just provide a "buffer" against stress; they actively optimized the metabolic environment of the rabbit. This experiment confirms that FDRSM can effectively displace expensive soybean meal by up to 30.0% in rabbit diets, resulting in heavier animals and better feed utilization, which ultimately translates to higher profitability for the farmer and a more sustainable approach to animal nutrition.

References

- [1] 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.
- [2] Hernandez, M and Alagbe, J.O. (2025). Influence of *Odontonema strictum* oil on the growth performance and Ruminal fermentation of Barbari bucks. *Research in: Agriculture and Veterinary Sciences*, 9(2):1-10.
- [3] Alagbe, J.O. (2025). Dietary supplementation of *Justicia secunda* oil: effect on growth performance, apparent digestibility, ruminal fermentation of Jamunapari Goats. *Discovery Agriculture*, 11(24), e18da3161.
- [4] Alagbe, J.O (2025). Effect of Partial Replacement of Soyameal with *Albizia lebbeck* seed meal on the growth performance, egg quality and haemato-biochemical constituents of Nera black hens. *Discovery Agriculture*, 11(24), e18da3161.
- [5] 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.
- [6] Alagbe, J.O and Anorue, D.N. (2025). Essential oils from *Theobroma cacao* leaf supplementation in the diet of weaned rabbits: effects on growth performance. *Nutrition and Food Processing*, 8(1): 1-8.
- [7] Omokore, E.O and Alagbe, J.O. (2019). Efficacy of dried *Phyllanthus 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(3): 97-104.
- [8] 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.
- [9] Alagbe, J.O. (2015). Performance and blood profile of grass cutters (*Thrynomys swinderianus*) fed wild sunflower (*Tithonia diversifolia*) leaf meal. *International Journal of Science and Research*. 5(6):124-12.
- [10] Liu H, Zhang B, Li F, Liu L, Yang T, Zhang H, Li F. Effects of heat stress on growth performance, carcass traits, serum metabolism, and intestinal microflora of meat rabbits. *Front Microbiol*. 2022;13:998095. <https://doi.org/10.3389/fmicb.2022.998095>

- [11] Amber KH, Yakout HM, Hamed RS. September. Effect of feeding diets containing yucca extract or probiotic on growth, digestibility, nitrogen balance and caecal microbial activity of growing New Zealand white rabbits. In: Proceedings of the 8th World Rabbit Congress, Puebla, Mexico, 7th–10th 2004:737–745.
- [12] Oso AO, Idowu OMO, Haastrup AS, Ajibade AJ, Olowonefa KO, Aluko AO, et al. Growth performance, apparent nutrient digestibility, caecal fermentation, ileal morphology and caecal microflora of growing rabbits fed diets containing probiotics and prebiotics. *Livest Sci.* 2013;157(1):184–90
- [13] Wlazło Ł, Nowakowicz-Dębek B, Czech A, Chmielowiec-Korzeniowska A, Ossowski M, Kułaziński M, et al. Fermented rapeseed meal as a component of the mink diet (Neovison vison) modulating the gastrointestinal tract microbiota. *Animals.* 2021;11(5):1337.
- [14] Amber KH, Yakout HM, Hamed RS. September. Effect of feeding diets containing yucca extract or probiotic on growth, digestibility, nitrogen balance and caecal microbial activity of growing New Zealand white rabbits. In: Proceedings of the 8th World Rabbit Congress, Puebla, Mexico, 7th–10th 2004:737–745.
- [15] Lalhriatpuii M, Patra AK. Feeding rice fermented beer waste improves growth performance, nutrient digestibility and nitrogen utilization in growing rabbits. *J Anim Physiol Anim Nutr (Berl).* 2022;106(1):147–55. <https://doi.org/10.1111/jpn.13545>.
- [16] Alagbe JO. Effect of Different Levels of Dried Delonix regia Seed Meal on the Performance, Hematology, Serum Biochemistry of Growing Grass Cutters. *Agri Res& Tech: Open Access J.* 2018; 18(4): 556064. DOI: 10.19080/ARTOAJ.2018.18.556064.
- [17] NRC, 2007. Nutrient Requirements of rabbits, Nutrient Requirements of Rabbits. National Academies Press, Washington, D.C. <https://doi.org/10.17226/11654>.
- [18] A.O.A.C. (2000). Association of Official Analytical Chemists. Official Methods of Analysis 19th Edition Washington, D.C Pages 69-77.
- [19] Alagbe, J.O (2020). Chemical evaluation of proximate, vitamin and amino acid profile of leaf, stem bark and roots of Indigofera tinctoria. *European Journal of Research Development and Sustainability.* 1(1): 5-10.
- [20] Alagbe, J.O and Anorue, D.N (2026). Effect of Replacing Soybean meal with fermented *Hydrocotyle asiatica* seed meal on the growth performance, semen quality and oxidative stress markers of Rabbit bucks. *Biomedical and Biotechnological Sciences*, 2(1):011.
- [21] Alagbe, J.O and Anorue, D.N (2026). Influence of fermented *Hunteria umbellata* seed oil on the haematology, serum biochemistry, immune response and oxidative status of Growing Rabbits. *Clinical Sciences and Clinical Research*, 8(1): 016.
- [22] Alagbe, J.O (2026). Haemato-biochemical indices of growing rabbits fed diets containing *Hunteria umbellata* seed meal as replacement for Soybean meal. *Hematology and Disorders*, 5(1): 018.
- [23] Singh Sharma., Alagbe Olujimi John., Liu Xing., Sharma Ram and Kumar Amita (2022). 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(6): 18-27.
- [24] Daniel Nnadozie Anorue, Friday Ubong and Alagbe Olujimi John (2023). 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(3): 164 – 174



- [25] Muritala, Daniel Shittu., Alagbe, J.O., Ojebiyi, O.O., Ojediran, T.K and Rafiu, T.A. (2022). 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(2): 57-71.
- [26] Liu X, Zhao XH. Effect of fermentation times and extracting solvents on the in vitro immune potentials of the soluble extracts of mucor-fermented Mao-tofu. *Food Sci Biotechnol.* 2017;26:707–14. <https://doi.org/10.1007/s10068-017-0080-8>.
- [27] Jiwuba PC, Ikwunze K, Dauda E, Ugwu DO. Haematological and serum biochemical indices of growing rabbits fed diets containing varying levels of Moringa oleifera leaf meal. *Br Biotechnol J.* 2016;15(2):1–7. <https://doi.org/10.9734/BBJ/2016/28095>
- [28] Kim YG, Lohakare JD, Yun JH, Heo S, Chae BJ. Effect of feeding levels of microbial fermented soy protein on the growth performance, nutrient digestibility and intestinal morphology in weaned piglets. *Asian-Australas J Anim Sci.* 2007;20(3):399–404. <https://doi.org/10.5713/ajas.2007.399>.
- [29] Strychalski J, Juśkiewicz J, Kowalska D, Gugolek A. Performance indicators and gastrointestinal response of rabbits to dietary soybean meal replacement with silkworm pupae and mealworm larvae meals. *Arch Anim Nutr.* 2021;75(4):294–310. <https://doi.org/10.1080/1745039X.2021.1962171>.