OPEN ACCESS Journal of Animal Health and Production

Research Article

Graded Replacement of Maize with Sweet Potato Peel–Cassava Leaf Mix: Effect on Malondialdehyde and other Hematological and Biochemical Parameters in Rabbits

Razaq Adekunle Animashahun[1A], Olayinka Olubunmi Alabi[1A], Precious Toluwalodaraju Oluwafemi[1], Abiodun Adebayo Idowu[4], Deborah Yemi Ologbosere[2A,*], Adedeji Peculiar Animashahun[3], Oluwagbenga Paul Olorunfemi[1], Emmanuel Oluwatobiloba Olowolagba[1], Feranmi Gbenga Omoniyi[1], and Collins Collins Francis[1]

[1]Animal Science Programme, College of Agriculture, Landmark University, P.M.B. 1001, Omu Aran, Kwara State, Nigeria; [2]Teaching and Research Farm, Landmark University, P.M.B. 1001, Omu Aran, Kwara State, Nigeria; [3]Depatment of Food and Nutritional Science, University of Reading, Whiteknight Campus, UK; [4]Department of Animal Breeding and Genetics, Federal University of Agriculture Abeokuta, P.M.B. 2240, Abeokuta, Ogun State. Nigeria.

Abstract | This study evaluated the effects of replacing maize with sweet potato peel–cassava leaf mix meal (SPPCL) on hematological indices, serum biochemical parameters, and lipid peroxidation in growing rabbits. Sweet potato peels and cassava leaves were processed to reduce antinutritional factors, blended in a 49:1 ratio, and incorporated into diets at 0% (control), 20%, 40%, and 60% maize replacement levels. Forty-eight healthy Hyla weaner rabbits (650–700 g, 6–8 weeks old) were allotted to the four dietary treatments in a completely randomized design with three replicates of four rabbits each. The feeding trial lasted eight weeks. Hematological indices including hemoglobin, packed cell volume, red and white blood cell counts, and mean corpuscular indices showed no significant differences ($P > 0.05$) among treatments, Similarly, serum proteins, liver enzymes, glucose, lipid fractions, creatinine, and uric acid remained within physiological ranges without significant variation ($P > 0.05$), confirming the systemic safety and nutritional adequacy of the diets. Malondialdehyde (MDA), an oxidative stress marker, decreased significantly ($P < 0.05$) in all SPPCL diets compared with the control, with the lowest level observed at 40% inclusion. These findings demonstrate that SPPCL can replace maize by up to 60% in rabbit diets without compromising health or metabolism while enhancing oxidative stability. This offers a cost-effective, sustainable feeding strategy that valorizes agro-residues and may improve rabbit meat shelf life.

Keywords | Agro-industrial by-products, Blood profile, Meat quality, Nutrition, Oxidative-stability, Sustainability

Received | September 01, 2025; **Accepted** | November 29, 2025; **Published** | March 29, 2026
***Correspondence** | Razaq Adekunle Animashahun, Animal Science Programme, College of Agriculture, Landmark University, P.M.B. 1001, Omu Aran, Kwara State, Nigeria; **Email:** animashaun.rasaq@lmu.edu.ng
Citation | Animashahun RA, Alabi OO, Oluwafemi PT, Idowu AA, Ologbosere DY, Animashahun AP, Olorunfemi OP, Olowolagba EO, Omoniyi CFG, Francis C (2026). Graded replacement of maize with sweet potato peel–cassava leaf mix: Effect on malondialdehyde and other hematological and biochemical parameters in rabbits. J. Anim. Health Prod. 14(2): 504-511.
DOI | https://dx.doi.org/10.17582/journal.jahp/2026/14.2.504.511
ISSN (Online) | 2308-2801

INTRODUCTION

Global population growth, projected to reach 9.7 billion by 2050, is intensifying food demand and exacerbating food insecurity, particularly in developing nations (FAO, 2023). Sustainable, cost-effective livestock production is essential to meet rising protein needs while aligning with Sustainable Development Goals (SDGs 1 and 2) aimed at ending poverty and achieving zero hunger (Vlaicu *et al*., 2024). Rabbits offer strategic advantages in this context due to their high reproductive rate, short gestation period, rapid growth, efficient feed conversion, and low space requirements (Zamaratskaia *et al*., 2023).

Feed, however, constitutes over 60–70 % of total production costs in rabbit farming (Akinmutimi *et al*., 2020), and reliance on maize, the dominant energy source creates direct competition with human food demand. In Nigeria, recurrent maize price spikes since 2023 have prompted policy interventions (e.g., temporary import-tax waivers) and renewed interest in locally available alternatives (Reuters, 2024; World-Grain, 2024). These pressures make the substitution of conventional cereals with agro-industrial by-products both an economic necessity and a food-systems priority.

Sweet potato peels (SPP) and cassava leaves (CL) are abundant co-products in cassava- and sweet-potato-producing regions such as sub-Saharan Africa (Amadi *et al*., 2022). Sweet potato peels (SPP) supply fermentable energy along with polyphenols, carotenoids, and anthocyanins with antioxidant potential (Ćetković *et al*., 2025; Islam, 2024), whereas CL contribute protein and minerals but require processing to reduce cyanogenic glycosides (Mohidin *et al*., 2023). Together, they form a nutrient-complementary pair that can partially replace maize in rabbit diets when inclusion levels are carefully managed (Esonu *et al*., 2018; Ogbuewu *et al*., 2017).

Evidence from monogastric livestock supports the safety and utility of these resources. In broilers, sweet-potato peel meal can replace maize by up to ~25 % without adverse effects on growth, carcass traits, or blood chemistry (2024–2025 reports), while cassava co-products have been shown to maintain performance and normal hematological indices (Ojediran *et al*., 2022; Sugiharto, 2023). In pigs, peel co-products have demonstrated neutral serum chemistry when appropriately processed and dosed (World-Grain, 2024). In rabbits, phytochemical-rich botanicals such as butterfly-pea extract, dried bergamot pulp, and coffee silverskin have improved oxidative stability and reduced lipid peroxidation without compromising performance (Kovitvadhi *et al*., 2024; Scerra *et al*., 2025; Foti *et al*., 2025). Similarly, cassava leaf meal (CLM) has been fed successfully at sensible inclusion levels (~20–30 %) with no detrimental effects on hematology or meat quality (Ekenyem and Madubuike, 2020), and sweet-potato by-products have maintained growth and feed efficiency when replacing maize in weaned rabbits (Amaefule and Obioha, 2019). Recent work using fermented cassava root–leaf blends in rabbits indicates improved caeca microflora with no adverse outcomes (Mafimidiwo *et al*., 2023).

Despite this progress, key knowledge gaps remain. First, rabbit studies reporting the combined effects of SPP and CL on hematology, serum biochemistry, and lipid-peroxidation markers are scarce. Second, while CL is protein-rich, cyanogenic glycosides necessitate rigorous processing oversight (Mohidin *et al*., 2023). Third, the graded-replacement response of an SPPCL mix against a maize control has not been comprehensively profiled for systemic safety alongside oxidative stress indices. Addressing these gaps will clarify whether SPPCL can provide cost relief and antioxidant benefits without compromising animal health.

While the individual use of SPP or CL in rabbit nutrition has been previously explored, studies that investigate their combined use remain largely absent. This study introduces a novel dietary strategy by mixing SPP and CL in a fixed ratio to partially replace maize in a graded fashion. The approach leverages the complementary nutritional qualities of both by-products, SPP as a fermentable energy source with antioxidant compounds (Ćetković *et al*., 2025), and CL as a protein and mineral rich (Makieu *et al*., 2025) input to potentially enhance physiological resilience without compromising health. This composite inclusion reflects a more practical and ecologically sound feeding option, especially in resource-constrained settings. To our knowledge, this is the first study to examine the systemic and oxidative responses to a maize replacement strategy using a sweet potato peel–cassava leaf (SPPCL) mix in growing rabbits.

Therefore, the objective of this study was to evaluate the effects of graded replacement of maize with an SPPCL on hematological indices, serum biochemical parameters, and lipid peroxidation in growing rabbits.

MATERIALS AND METHODS

Study location and ethical approval

The feeding trial was conducted at the Rabbitry Unit of the Teaching and Research Farm, Landmark University, Omu Aran, Kwara State, Nigeria under hygienic and standardized management practices. The experimental protocol was reviewed and approved in compliance with the institution's Animal Care and Use Committee guidelines. All procedures conformed to the principles of animal welfare of Landmark University Research Ethics Subcommittee on Animals Studies.

Feedstuff preparation and diet formulation

Sweet potato peels and cassava leaves were collected fresh from local farms. The sweet potato peels were thoroughly washed and sun-dried for 3–5 days at an ambient temperature of 30–33 °C until a constant weight (average moisture content of about 10–12%) was achieved, after which they were milled to pass through a 2 mm sieve. Cassava leaves were wilted for 6–8 hours, then sun-dried under the same temperature range to reduce cyanogenic glycosides, and ground to a similar 2 mm particle size. The reduction in cyanogenic glycosides after drying was confirmed by the characteristic absence of the bitter-almond odour and by referring to established literature values indicating that sun-drying under tropical conditions for 2–3 days typically reduces cyanide content to below safe dietary levels (<50 mg HCN/kg DM) (Tambalo *et al*., 2023). A 49:1 blending ratio of sweet potato peels to cassava leaves was adopted to form the sweet potato peel–cassava leaf mix meal (SPPCL), following previous studies and nutrient composition assessments, with cassava leaves included primarily as an additive to enhance protein and micronutrient content of the mixture.

The SPPCL was incorporated into rabbit diets at 0% (Control), 20%, 40%, and 60% replacement levels of maize. It was ensured that all diets meet the nutrient requirements of growing rabbits as outlined by NRC (1977). The diets' composition, is as shown in Table 1.

Table 1: Composition of the experimental diets.

Feed ingredients (%)	Inclusion levels of sweet potato peels and cassava leave mix			
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)
Maize	60.59	48.91	36.47	22.20
Wheat offal	20.20	20.17	20.06	18.31
SPPCL meal	0.00	12.10	24.32	33.29
Soybean meal	16.36	15.75	16.07	33.29
Fish meal	0.00	0.22	0.23	0.33
Bone meal	2.00	2.00	2.00	2.00
Salt	0.25	0.25	0.25	0.25
Methionine	0.20	0.20	0.20	0.20
Lysine	0.10	0.10	0.10	0.10
Premix[1]	0.30	0.30	0.30	0.30
Total	100.00	100.00	100.00	100.00
Crude protein (%)	18.90	18.40	18.22	17.95
Moisture	8.83	8.00	8.17	9.17
Ash	5.17	6.50	6.83	8.33
Ether extract (%)	11.67	11.50	11.20	12.50
Crude fiber (%)	5.04	4.98	7.83	8.49

[1]Premix Composition (2.5 kg per tonne of feed): Each 2.5 kg of premix supplied the following nutrients per kilogram of feed: 10,000 IU of vitamin A, 2,000 IU of vitamin D_3, 10 mg of vitamin E, 2 mg of vitamin K_3, 1.5 mg of vitamin B_1 (thiamine mononitrate), 4 mg of vitamin B_2 (riboflavin), 2 mg of vitamin B_6 (pyridoxine hydrochloride), 0.01 mg of vitamin B_{12} (cyanocobalamin), 20 mg of niacin (vitamin B_3), 10 mg of calcium pantothenate, 0.5 mg of folic acid, 0.05 mg of biotin, and 20 mg of vitamin C (ascorbic acid), 80 mg of manganese, 60 mg of iron, 50 mg of zinc, 8 mg of copper, 1 mg of iodine, 0.2 mg of cobalt, and 0.15 mg of selenium per kilogram of feed.

Experimental animals and management

A total of 48 healthy Hyla breed weaner rabbits, aged 6–8 weeks and averaging 650–700 g body weight, were obtained from a reputable commercial breeder. Upon arrival, the rabbits were housed individually in well-ventilated wooden hutches with wire-mesh floors to facilitate droppings removal and maintain hygiene. Each hutch (0.6 m × 0.45 m × 0.45 m per rabbit) provided adequate space, ventilation, and protection from direct sunlight and rain. Regular cleaning and disinfection were carried out to ensure good health and minimize disease risk. The animals were allowed a one-week acclimatization period during which they received a basal diet and clean drinking water *ad libitum*. After acclimatization, rabbits were randomly allotted to four dietary treatments corresponding to 0%, 20%, 40%, and 60% maize replacement with SPPCL, in a completely randomized design (CRD) with three replicates of four rabbits each. Feed and water were provided *ad libitum*, and standard vaccination and medication protocols were maintained throughout the trial. The inclusion levels of SPPCL (0%, 20%, 40%, and 60%) were selected based on results from previous studies and nutrient formulation targets to achieve balanced diets with adequate energy–protein ratios for growing rabbits. The experimental feeding trial lasted for eight (8) weeks.

Blood collection and laboratory analysis

At the end of the feeding trial, a total of 10 mL of blood was collected from rabbits in each replicate via the marginal ear vein using sterile syringes. Of this, 5 mL was placed into EDTA-coated tubes for hematological analysis, whereas the remaining 5 mL was collected into plain tubes for serum biochemical and oxidative stress assays and allowed to clot at room temperature. The clotted samples were centrifuged at 3,000 rpm for 10 minutes, and the resulting sera were carefully harvested for subsequent analyses.

Hematological parameters such as hemoglobin (Hb), packed cell volume (PCV), red blood cells count (RBC) and white blood cells count (WBC) were analyzed with an auto-hematology analyzer (Sysmex K-1000; Sysmex Corporation, Kobe, Hyōgo Prefecture, Japan). Serum biochemical parameters (such as total protein, albumin, globulin, alanine aminotransferase (ALT), aspartate aminotransferase (AST), total cholesterol, and triglycerides) were determined using an automated chemistry analyzer (RX daytona+; Randox Laboratories Ltd., Diamond Road 55 Crumlin County Antrim BT29 4QY United Kingdom) with commercially available diagnostic kits according to the manufacturer's instructions.

Lipid peroxidation

Lipid peroxidation was quantified by measuring malondialdehyde (MDA) levels in serum using the thiobarbituric acid reactive substances (TBARS) method. The assay was performed with the OxiSelect™ TBARS Assay Kit (Cell Biolabs, Inc., San Diego, CA, USA; catalog no. STA-330), following the manufacturer's protocol. This colorimetric/fluorometric method detects MDA, a major end-product of lipid peroxidation, through its reaction with thiobarbituric acid (TBA) to form an MDA-TBA adduct, which was subsequently measured at 532 nm using a microplate reader. MDA concentrations were calculated from a standard curve generated with known MDA equivalents and expressed as nmol/mL of serum

Statistical analysis

All data represent the mean of three replicates per treatment. The data were analyzed using one-way analysis of variance (ANOVA) in SAS statistical software (SAS version 9.4M9; SAS Institute Inc., Cary, NC, USA). Prior to ANOVA, assumptions of normality and homogeneity of variances were assessed using the Shapiro-Wilk and Levene's tests, respectively. When the ANOVA indicated significant differences ($p < 0.05$), mean separation was conducted using Duncan's Multiple Range Test (DMRT). Results are presented as means ± standard error of the mean (SEM), with statistical significance declared at $P < 0.05$.

Ethical consideration

Ethical code LUAC/BCH/2024/002A for this research was obtained from the Ethical Committee of Landmark University. The approval signifies that the study was reviewed and deemed ethically sound in accordance with established ethical guidelines and standards for raising rabbits.

RESULTS AND DISCUSSION

Hematological responses

The hematological profiles of rabbits fed diets containing graded levels of SPPCL as a maize substitute are presented in Table 2. None of the measured parameters differed significantly among treatments ($P > 0.05$), although slight numerical variations were observed.

Hemoglobin (Hb) concentration declined marginally from 11.10 g/dL in the control (T1) to 10.04 g/dL at 60% SPPCL inclusion (T4), while red blood cell (RBC) counts showed a modest increase (4.99 → 5.96 × 10^{12}/L). Packed cell volume (PCV) remained relatively stable (33.18–34.39%), and white blood cell (WBC) counts were comparable across groups (19.05–19.73 × 10^9/L). The mean corpuscular indices (MCV, MCH, MCHC) exhibited minor, non-consistent reductions.

Although these changes were not statistically significant, the mild increase in RBC suggests a compensatory erythropoietic response possibly linked to the moderate dietary fiber in SPPCL, which may enhance nutrient partitioning and stimulate erythropoiesis. The observed hematological stability agrees with Ahemen *et al.* (2015), who reported normal erythrocyte and leucocyte counts in rabbits fed cassava leaf meal (CLM). All erythrocytic indices remained within physiological limits (Melillo, 2007), indicating no hematopoietic suppression or pathological alteration in hemoglobin synthesis.

Table 2: Hematology parameters of rabbits fed the experimental diets.

Parameters	Replacement levels of maize by SPPCL				SEM (±)	P value
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)		
Haemoglobin (g/dl)	11.10	10.66	10.42	10.04	0.98	0.99
RBC (x10^{12}/L)	4.99	5.20	5.52	5.96	0.27	0.72
PCV (%)	33.18	34.39	32.06	33.24	4.05	0.99
MCV (fL)	68.50	67.80	61.10	58.30	1.00	0.98
MCH (pg)	22.70	20.90	19.90	17.40	0.26	0.93
MCHC (g/dL)	0.36	0.32	0.33	0.30	0.04	0.70
WBC (x10^9/L)	19.05	19.09	19.68	19.73	1.46	0.99
Neutrophils (%)	42.26	46.90	43.91	44.23	4.76	0.99
Eosinophils (%)	1.86	2.09	2.10	2.04	0.23	0.99
Lymphocytes (%)	54.16	48.69	51.17	51.02	12.67	0.99
Monocytes (%)	3.20	2.31	2.82	2.72	0.68	0.98

SPPCL= Sweet Potato Peel–Cassava Leaf mix meal; RBC= red blood cells; PCV= Packed cell volume; MCV= mean corpuscular volume, MCH= mean corpuscular haemoglobin; MCHC= mean corpuscular haemoglobin concentration; WBC= white blood cells; SEM denotes Standard Error of the Mean; and P-value indicates the level of statistical significance. A P-value less than 0.05 ($P < 0.05$) signifies a statistically significant difference, whereas a P-value greater than 0.05 ($P > 0.05$) indicates no statistically significant difference.

Table 3: Serum biochemical profile analysis.

Serum/parameters	Replacement levels of maize by SPPCL				SEM (±)	P value
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)		
AST (IU/l)	105.35	104.48	105.58	107.35	6.31	0.99
ALT (IU/l)	22.22	22.63	21.46	22.45	2.20	0.99
ALP (IU/l)	15.33	13.19	12.17	11.98	0.72	0.40
Total Protein (g/l)	4.15	3.81	2.88	2.95	0.42	0.75
Albumin (g/l)	1.49	1.47	1.53	1.52	0.08	0.99
Globulin (g/l)	1.43	1.27	1.15	1.40	1.94	0.97
Glucose (mg/dl)	143.97	139.51	138.97	141.75	6.53	0.99
Cholesterol (mg/dl)	121.71	109.08	115.07	109.53	3.80	0.72
Creatinine (μmol/l)	0.88	1.28	1.45	1.38	0.19	0.82
Bilirubin (mg/dl)	1.95	1.72	1.49	1.64	0.27	0.96
Uric Acid (mg/dl)	2.81	2.82	3.06	2.48	0.41	0.98
HDL (mg/dl)	22.87	23.75	23.10	23.68	2.22	0.99
LDL (mg/dl)	84.16	80.20	82.66	82.10	3.10	0.98
Triglycerides (mg/dl)	142.23	134.13	137.04	137.74	4.27	0.95

SPPCL= Sweet Potato Peel–Cassava Leaf mix meal; AST= Aspartate aminotransferase; ALT= Alanine aminotransferase; ALP= Alkaline phosphatase; HDL= high-density lipoprotein, LDL= low-density lipoprotein; SEM denotes Standard Error of the Mean; and P-value indicates the level of statistical significance. A P-value less than 0.05 ($P < 0.05$) signifies a statistically significant difference, whereas a P-value greater than 0.05 ($P > 0.05$) indicates no statistically significant difference.

Mechanistically, the fiber–polyphenol matrix of SPPCL may protect erythrocytes and support erythropoiesis by improving antioxidant capacity, enhancing iron bioavailability, and mitigating oxidative degradation of red blood cells. Polyphenols such as flavonoids and tannin derivatives can stabilize erythrocyte membranes, scavenge free radicals, and modulate erythropoietic gene expression (e.g., via erythropoietin signaling). This effect is consistent with reports showing that polyphenol-rich feed ingredients maintain erythrocyte integrity under nutritional stress (Olajide *et al*., 2024; El-Sabrout *et al*., 2023).

Leukocyte indices, including differential counts (neutrophils, lymphocytes, monocytes, and eosinophils), also remained within normal physiological ranges, suggesting that immune function and systemic health were unaffected. Similar findings were reported by Omole *et al*. (2007) in rabbits fed diets containing agro-industrial by-products.

Overall, the hematological stability observed across dietary treatments indicates that SPPCL can replace maize up to 60% without impairing erythropoiesis or immune competence. From a production standpoint, the maintenance of normal hematological indices implies adequate oxygen transport, nutrient utilization, and immune resilience, which are key factors supporting optimal growth and feed efficiency in rabbit production systems.

Serum biochemical profile

Serum biochemical responses to graded inclusion of SPPCL are summarized in Table 3. As with hematological parameters, no significant ($P > 0.05$) differences were observed, but some consistent numerical trends provide valuable physiological insights.

Serum protein fractions (total protein, albumin, globulin) remained within normal physiological limits for rabbits (Melillo, 2007). A slight, non-significant decline in total protein and globulin with increasing SPPCL inclusion may reflect reduced digestibility associated with dietary fiber. However, the stability of albumin levels suggests maintained hepatic synthetic function and protein turnover. Liver enzymes (AST, ALT, ALP) also showed no significant variations, with ALP declining slightly from 15.33 IU/L (T1) to 11.98 IU/L (T4), implying normal hepatocellular integrity and metabolic stability, consistent with Akinmutimi (2004) in cassava-based diets.

Glucose concentrations exhibited a mild reduction at higher inclusion levels, likely reflecting delayed carbohydrate digestion and absorption due to the high fiber content. Lipid fractions (total cholesterol, HDL-C, LDL-C, triglycerides) showed numerically lower values in SPPCL diets compared with the control. Such hypocholesterolemic tendencies have been attributed to the ability of soluble fiber and polyphenols to bind bile acids, enhance cholesterol excretion, and upregulate hepatic LDL receptor activity (Fasuyi and Aletor, 2005; Okereke *et al*., 2015). Comparable reductions in plasma lipid indices were also reported in rabbits fed fiber- and phytochemical-rich by-products (Ferlisi *et al*., 2023; Ogbuewu et al., 2017; Foti *et al*., 2025).

The observed biochemical stability suggests that SPPCL supports normal hepatic, renal, and metabolic function. The slight improvement in lipid metabolism reflects an additional health benefit of the fiber–polyphenol complex, which may improve cardiovascular resilience by reducing lipid peroxidation and supporting antioxidative defense mechanisms. These physiological effects translate to practical benefits such as improved carcass quality and meat lipid stability.

Lipid peroxidation (Malondialdehyde, MDA)

Malondialdehyde (MDA) concentrations, an indicator of lipid peroxidation and oxidative stress, differed significantly among treatments ($P < 0.05$; Figure 1). Rabbits on the control diet (0% SPPCL) recorded the highest MDA value (0.42 nmol/mL), while all SPPCL diets significantly reduced MDA: 0.23 nmol/mL (20%), 0.12 nmol/mL (40%), and 0.21 nmol/mL (60%). The lowest MDA concentration at 40% inclusion indicates an optimal antioxidant response at this level.

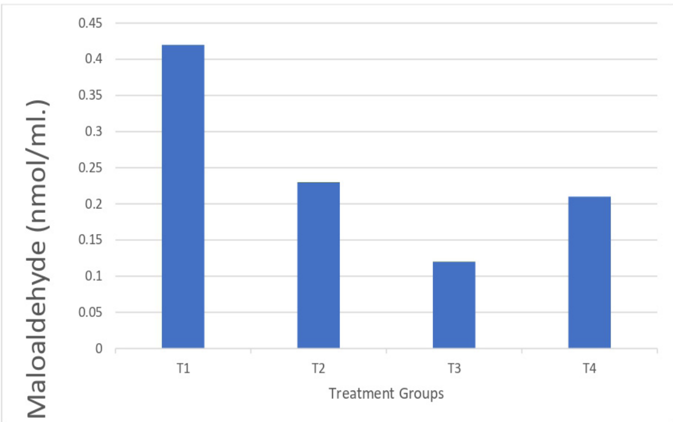

Figure 1: Malondialdehyde levels (nmol/dL) in grower rabbits fed diets containing graded Sweet Potato Peel-Cassava Leaf Mix Meal as substitute for maize.
T1= Control group (0% maize replacement), T2= 20% maize replacement, T3= 40% maize replacement, T4= 60% maize replacement.

The reduction in MDA reflects the synergistic antioxidant activity of polyphenols, carotenoids, and vitamins inherent in sweet potato peels and cassava leaves. These compounds enhance endogenous antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), and glutathione peroxidase (GPx), thereby lowering lipid peroxidation. Similar antioxidant enhancements have been reported in rabbits and poultry fed polyphenol-rich ingredients (Ibrahim and Olaniyi, 2018; Ojediran *et al*., 2022; Kovitvadhi *et al*., 2024).

A mild rebound in MDA at 60% inclusion may indicate reduced antioxidant bioavailability due to higher dietary fiber interfering with polyphenol absorption an observation consistent with Singh and Kim (2021). Nevertheless, all SPPCL-fed groups exhibited lower MDA than the control, confirming improved oxidative stability.

This antioxidant improvement is not only beneficial to animal health but also carries production implications, including enhanced meat shelf life, reduced rancidity, and better carcass quality. Sweet potato peels are rich in phenolic compounds and β-carotene (Ooi *et al*., 2021), while cassava leaves supply vitamins C and E (Li *et al*., 2023), all contributing to reduced oxidative stress and improved product quality.

Collectively, the hematological, biochemical, and oxidative stress indicators confirm that replacing maize with SPPCL up to 60% did not compromise physiological homeostasis in growing rabbits. The maintenance of normal erythrocyte and leukocyte counts, liver and renal markers, and reduced lipid peroxidation demonstrate adequate nutrient utilization and metabolic balance.

From an applied perspective, these physiological responses translate into stable growth performance, improved feed cost efficiency, and enhanced carcass oxidative stability (attributes essential for sustainable and economically viable rabbit production). The combination of energy-rich sweet potato peels and protein-rich cassava leaves thus represents an effective agro-residue valorization strategy for smallholder and commercial rabbit enterprises.

CONCLUSION AND RECOMMENDATIONS

The inclusion of sweet potato peel–cassava leaf meal (SPPCL) as a partial replacement for maize in rabbit diets up to 60% maintained normal hematological and serum biochemical profiles, indicating efficient nutrient utilization, stable metabolic function, and overall physiological safety. The marked reduction in serum malondialdehyde (MDA), particularly at 40% inclusion, signifies enhanced antioxidant defense and oxidative stability, which are associated with improved health, better feed efficiency, and extended meat shelf life.

These physiological advantages translate into practical production benefits, including sustainable feed cost reduction, improved nutrient use, and enhanced carcass quality. Therefore, SPPCL inclusion between 20% and 40% is recommended as the optimal range for achieving both economic and functional gains in rabbit production. Future studies should focus on evaluating carcass quality, meat lipid oxidation, and sensory properties to confirm consumer-level benefits of the improved antioxidant response. Additionally, exploring nutrient digestibility and fiber processing methods such as fermentation or enzyme supplementation, could further enhance protein utilization at higher inclusion levels. Long-term feeding trials in breeding and lactating rabbits are also warranted to assess reproductive and offspring performance under continuous dietary SPPCL inclusion.

ACKNOWLEDGMENTS

We are very grateful to the Management of Landmark University for making her facilities (Rabbit Unit of teaching and research farm, as well as the Animal Science Laboratory) available for this study.

NOVELTY STATEMENT

This study uniquely demonstrates that a processed sweet potato peel–cassava leaf mix (SPPCL) can replace maize in rabbit diets by up to 60% while improving oxidative stability and maintaining normal haematological and biochemical status. By integrating malondialdehyde (MDA) assessment with comprehensive physiological indices, the study provides new evidence that SPPCL functions not only as an energy substitute but also as a functional antioxidant-rich feed resource. The observed reduction in lipid peroxidation, particularly at 40% replacement, highlights the health-promoting potential of this agro-residue blend. These findings advance SDG 2 (Zero Hunger) through improved feed efficiency, SDG 3 (Good Health and Well-being) via enhanced metabolic health, and SDG 12 (Responsible Consumption and Production) by valorizing agro-industrial wastes into sustainable livestock nutrition.

AUTHOR'S CONTRIBUTION

All authors made equal and significant contributions to the research design, data collection, analysis, and manuscript preparation. All authors have read and approved the final version.

Generative AI and AI-assisted technology statement

Artificial intelligence–based tools were used only for minor language refinement, including grammar and stylistic adjustments, to improve manuscript readability. These tools were not used for study design, data analysis, data interpretation, result generation, or drawing scientific conclusions. All aspects of the research and the final content of the manuscript remain the sole responsibility of the authors.

Conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Ahemen T, Bitto L, Oluremi O, Anugwa F (2015). Effect of feeding graded levels of cassava leaf meal on haematology of rabbit does in a southern Guinea savanna environment of Nigeria. Nig. J. Anim. Prod., 42(2): 265–268. https://doi.org/10.51791/njap.vi.7576

Akinmutimi AH (2004). Evaluation of sword bean (*Canavalia gladiata*) as an alternative feed resource for broiler chickens. Ph.D. Thesis, Michael Okpara Univ. Agric., Umudike.

Akinmutimi AH, Agwunobi LN, Chikwendu CI (2020). Feeding value of some agro-industrial by-products in rabbit nutrition. Nig. J. Anim. Prod. 47(2): 45–54.

Amadi G, Anyaegbunam HN, Amadi CO (2022). Adoption of improved varieties of root and tuber crops for agricultural development and food security in Nigeria. J. Community Commun. Res., 7(1): 66–84.

Amaefule KU, Obioha FC (2019). Performance of growing rabbits fed diets containing graded levels of sweet potato peels. Anim. Prod. Res. Adv., 15(3): 211–218.

Ćetković G, Vučetić A, Cvanić T, Šovljanski O, Ranitović A, Lončar B, Filipović V, Travičić V (2025). Phytochemical value and bioactive properties of sweet potato peel across varieties and drying techniques. Processes, 13(7): 2004. https://doi.org/10.3390/pr13072004

Ekenyem BU, Madubuike FN (2020). Performance and haematological responses of weaner rabbits fed cassava leaf meal. Int. J. Agric. Rural Dev., 23(1): 123–129.

El-Sabrout K, Khalifah A, Ciani F (2023). Current applications and trends in rabbit nutraceuticals. Agriculture., 13(7): 1424. https://doi.org/10.3390/agriculture13071424.

Esonu BO, Okoli IC, Udedibie ABI (2018). Evaluation of cassava leaf meal as replacement for soybean meal in broiler diets. Livest. Res. Rural Dev., 30(4): Article 56. http://www.lrrd.org/lrrd30/4/eson30056.html

FAO (2023). The state of food security and nutrition in the world 2023. Food and Agric. Organ. United Nations. https://www.fao.org/publications/sofi/2023

Fasuyi AO, Aletor VA (2005). Varietal composition and functional properties of cassava leaf meal and leaf protein concentrates as alternative protein sources in animal nutrition. Pak. J. Nutr., 4(1): 43–49. https://doi.org/10.3923/pjn.2005.43.49

Ferlisi F, Tang J, Cappelli K, Trabalza-Marinucci M (2023). Dietary supplementation with olive oil co-products rich in polyphenols: A novel nutraceutical approach in monogastric animal nutrition. Front. Vet. Sci., 10: 1272274. https://doi.org/10.3389/fvets.2023.1272274

Foti F, Scerra M, Caparra P, Bognanno M, Cilione C, Fortugno P, De Caria P, Chinè V, Mangione G, Gagliano S, Chies L (2025). Effect of coffee silverskin on meat quality of growing rabbits. Foods, 14(5): 812. https://doi.org/10.3390/foods14050812

Ibrahim H, Olaniyi OJ (2018). Effect of sweet potato (Ipomoea batatas Lam.) peel meal as replacement of maize on growth performance and cost of feeding weaner rabbits. Nig. J. Anim. Prod., 45(2): 409–411.

Islam S (2024). Sweet potatoes (*Ipomoea batatas* (L.) Lam): The super food of the next century? An intensive review on their potential as a sustainable and versatile food source for future generations. CyTA J. Food, 22(1): 2397553. https://doi.org/10.1080/19476337.2024.2397553

Kovitvadhi A, Gasco L, Zoccarato I, Rukkwamsuk T (2024). Effects of butterfly pea extracts on phagocytic activity of blood polymorphonuclear leukocytes and muscular lipid peroxidation in rabbits. Animals, 14(6): 958. https://doi.org/10.3390/ani14060958

Li M, Zi X, Lv R, Zhang L, Ou W, Chen S, Hou G, Zhou H (2023). Cassava foliage effects on antioxidant capacity, growth, immunity, and ruminal microbial metabolism in Hainan black goats. Microorganisms, 11(9): 2320. https://doi.org/10.3390/microorganisms11092320

Mafimidiwo AN, Olayemi WA, Adebayo BJ, Awoh CD (2023). Effect of fermented cassava root–leaf blend on caecal microflora of weaned rabbits. Nig. J. Anim. Prod., 45(2): 22–25.

Makieu P, Kanu MS, Sillah A, Sheriff A (2025). Nutritional values of cassava leaves in three districts, Kenema, Kailahun, and Bo, Sierra Leone. Food Hum., 4: 100592. https://doi.org/10.1016/j.foohum.2025.100592

Melillo A (2007). Rabbit clinical pathology. J. Exot. Pet Med., 16(3): 135–145. https://doi.org/10.1053/j.jepm.2007.06.002

Mohidin SRNSP, Moshawih S, Hermansyah A, Asmuni MI, Shafqat N, Ming LC (2023). Cassava (*Manihot esculenta* Crantz): A systematic review for the pharmacological activities, traditional uses, nutritional values, and phytochemistry. J. Evid. Based Integr. Med., 28:

NRC (1977). Nutrient requirements of rabbits. 2nd rev. ed. Natl. Res. Counc., Natl. Acad. Press, Washington, DC. https://doi.org/10.1177/2515690X231206227

Ogbuewu IP, Okoli IC, Iloeje MU (2017). The growing importance of cassava as an alternative energy source in animal diets. Res. J. Anim. Sci., 11(2): 45–52.

Ojediran T, Aroyehun B, Emiola I (2022). Evaluation of cassava distillers' waste meal in the diet of broiler chickens. Anim. Sci. Genet., 18(2): 41–55. https://doi.org/10.5604/01.3001.0015.8961

Okereke CO, Eze DC, Ukanwoko AI (2015). Effect of dietary levels of sweet potato peels on the performance of weaned rabbits. Asian J. Anim. Vet. Adv., 10(7): 366–370.

Olajide OO, Olaleye JO, Abdulkadir MT, Ewegbemi OT, Akinkuolie EA (2024). Haematology and serum biochemistry profile of growing rabbits fed diets supplemented with alligator pepper (*Aframomum melegueta*) seed meal. Nig. J. Anim. Prod., 45(2): 2019–2023. https://doi.org/10.51791/njap.vi.7420

Omole AJ, Sowande OS, Ogunjimi O (2007). Performance characteristics of weaner rabbits fed graded levels of dried cassava leaves and peels in the humid tropics. J. Anim. Vet. Adv., 6(4): 491–495.

Ooi SF, Sukri SAM, Zakaria NNA, Harith ZT (2021). Carotenoids, phenolics and antioxidant properties of different sweet potatoes (*Ipomoea batatas*) varieties. In: IOP Conf. Ser. Earth Environ. Sci., 756(1): 012077. IOP Publishing. https://doi.org/10.1088/1755-1315/756/1/012077

Reuters (2024). Nigeria to suspend taxes on certain food imports to curb rising prices. Retrieved from: https://www.reuters.com/world/africa/nigeria-suspend-taxes-certain-food-imports-curb-rising-prices-2024-07-08/

Scerra M, Foti F, Caparra P, Bognanno M, Fortugno P, Viglianti D, Autolitano D, Mangione G, Musati M, Chies L (2025). Grape seed supplementation in growing rabbits: Effect on meat quality. Meat Sci., 226: 109843. https://doi.org/10.1016/j.meatsci.2025.109843

Singh AK, Kim WK (2021). Effects of dietary fiber on nutrients utilization and gut health of poultry: A review of challenges and opportunities. Animals, 11(1): 181. https://doi.org/10.3390/ani11010181

Sugiharto S (2023). The effect of using fruit peel on broiler growth and health. Vet. World, 16(5): 987–1000. https://doi.org/10.14202/vetworld.2023.987-1000

Tambalo FMZ, Capuno RBA, Estrellana CD, Garcia JF, Arcillas LSN (2023). Effect of processing on the antinutrient and protein contents of cassava leaves from selected varieties. Philipp. J. Sci., 152(2): 561–570. https://doi.org/10.56899/152.02.03

Vlaicu PA, Untea AE, Oancea AG (2024). Sustainable poultry feeding strategies for achieving zero hunger and enhancing food quality. Agriculture, 14(10): 1811. https://doi.org/10.3390/agriculture14101811

World-Grain (2024). Nigeria plans suspension of food import taxes. https://www.world-grain.com

Zamaratskaia G, Havrysh O, Korzeniowska M, Getya A (2023). Potential and limitations of rabbit meat in maintaining food security in Ukraine. Meat Sci., 204: 109293. https://doi.org/10.1016/j.meatsci.2023.109293