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Growth performance, carcass traits, and economic evaluation of rabbits fed diets with graded levels of sweet potato peel–cassava leaf mix meal as a substitute for maize

Oluwafemi P., Animashahun R.*[1], Alabi O.[1] and Animashahun A[2].

[1] *Department of Animal Science, Landmark University, Km 4 Omu Aran – Ipetu Road, P.M.B. 1001, Omu Aran, Kwara State, Nigeria.*

[2] *Department of Animal Breeding and Genetics, Federal University of Agriculture Abeokuta, Abeokuta, Ogun State, Nigeria.*

***Corresponding author:** animashaun.rasaq@lmu.edu.ng.

Abstract

A study was conducted to evaluate the effects of replacing maize with a sweet potato peel–cassava leaf mix meal (SPPCLM) on the growth performance, carcass characteristics, and economic efficiency of growing rabbits. The SPPCLM was formulated in a 49:1 ratio of sweet potato peels (SPP) to cassava leaves (CL). Thirty-six, 6-week-old Hyla male weaner rabbits (mean body weight of 777.5 g) were randomly assigned to four dietary treatments in a completely randomized design. Each treatment group (T1–T4) had three replicates of three rabbits per replicate. The diets were formulated to replace maize at 0% (T1), 20% (T2), 40% (T3), and 60% (T4) with SPPCLM. The feeding trial lasted eight weeks. Proximate analysis revealed that SPPCLM had 6.18% crude protein, 18.25% crude fibre, and 0.98% ether extract, indicating its suitability as a fibre-rich feed component. Growth performance data showed that rabbits fed the 20% SPPCLM diet (T2) had the highest final weight (2137.0 g), average daily feed intake (94.5 g), and the best feed conversion ratio (3.24), although differences in daily weight gain and total weight gain were not statistically significant. Carcass traits also improved at 20% inclusion, with T2 recording the highest dressing percentage (71.8%) and primal cut yields. However, performance declined at higher inclusion levels, likely due to excessive fibre and anti-nutritional factors. Economically, T2 achieved the lowest cost per kilogram of meat (₦1,154) despite higher total feed intake, while T3 showed the highest feed cost reduction per kilogram of meat (₦183). The results indicate that 20% replacement of maize with SPPCLM optimizes growth, carcass yield, and feed cost efficiency in growing rabbits. This study demonstrates that SPPCLM is a viable, sustainable alternative feed resource that can enhance rabbit production while reducing dependence on conventional grains like maize.

Keywords: Agro-industrial by-products; Alternative feed resources, Novel feed ingredient; Rabbit nutrition; Sustainable livestock agriculture.

Performances de croissance, caractéristiques de la carcasse et évaluation économique de lapins nourris avec des régimes contenant des niveaux gradués de mélange de pelures de patate douce et de feuilles de manioc en remplacement du maïs

Résumé

Une étude a été menée pour évaluer les effets du remplacement du maïs par un mélange de pelures de patate douce et de feuilles de manioc (SPPCLM) sur les performances de croissance, les caractéristiques de la carcasse et l'efficacité économique des lapins en croissance. Le SPPCLM a été formulé dans un rapport 49:1 de pelures de patate douce (SPP) et de feuilles de manioc (CL). Trente-six lapins mâles Hyla sevrés, âgés de 6 semaines (poids corporel moyen de 777,5 g), ont été répartis aléatoirement en quatre traitements alimentaires selon un dispositif complètement randomisé. Chaque groupe de traitement (T1–T4) comprenait trois répétitions de trois lapins par répétition. Les régimes ont été formulés pour remplacer le maïs à des niveaux de 0 % (T1), 20 % (T2), 40 % (T3) et 60 % (T4) par le SPPCLM. L'essai d'alimentation a duré huit semaines. L'analyse proximale a révélé que le SPPCLM contenait 6,18 % de protéines brutes, 18,25 % de fibres brutes et 0,98 % d'extrait éthéré, indiquant son aptitude en tant qu'ingrédient riche en fibres.

Les données de performance de croissance ont montré que les lapins nourris avec le régime à 20 % de SPPCLM (T2) présentaient le poids final le plus élevé (2137,0 g), la prise alimentaire quotidienne moyenne la plus importante (94,5 g) et le meilleur indice de conversion alimentaire (3,24), bien que les différences en gain de poids quotidien et total n'aient pas été statistiquement significatives. Les caractéristiques de la carcasse se sont également améliorées avec une inclusion de 20 %, T2 enregistrant le rendement à l'abattage le plus élevé (71,8 %) et les meilleurs rendements en morceaux nobles. Cependant, les performances ont diminué aux niveaux d'inclusion plus élevés, probablement en raison d'un excès de fibres et de facteurs antinutritionnels.

Sur le plan économique, T2 a présenté le coût le plus bas par kilogramme de viande (₦1 154) malgré une consommation alimentaire totale plus élevée, tandis que T3 a montré la réduction la plus importante du coût alimentaire par kilogramme de viande (₦183). Les résultats indiquent qu'un remplacement de 20 % du maïs par le SPPCLM optimise la croissance, le rendement en carcasse et l'efficacité économique chez les lapins en croissance. Cette étude démontre que le SPPCLM est une ressource alimentaire alternative viable et durable, capable d'améliorer la production cunicole tout en réduisant la dépendance aux céréales conventionnelles comme le maïs.

Mots-clés : Sous-produits agro-industriels ; Ressources alimentaires alternatives ; Ingredient alimentaire innovant ; Nutrition cunicole ; Agriculture animale durable.

Running title: Maize Replacement with SPPCLM in Rabbit Nutrition

Introduction

The global food and agriculture system must undergo significant transformation to eradicate hunger and achieve food security, improved nutrition, and sustainable agriculture by 2030 (Gil *et al*., 2019). Promoting sustainable farming practices among smallholder farmers is vital to attaining the United Nations Sustainable Development Goal 2 (SDG 2).

Rabbits (*Oryctolagus cuniculus*) are notable for their rapid growth, efficient feed conversion, and adaptability (El-Sabrout *et al*., 2023). Their high reproductive rate makes rabbit farming a viable income source for smallholders and marginalized communities (Walia *et al*., 2023). As a source of lean, eco-friendly meat, the rabbit industry holds promise for meeting the growing demand for sustainable animal protein. However, optimizing production efficiency, growth, and meat quality requires exploring alternative feed resources (Makkar, 2018). Rabbit meat is recognized for its high nutritional value, tenderness, and flavor. It is leaner and lower in fat than beef or pork, making it a healthier protein option (Olaleru *et al*., 2019). Rabbits require diets rich in fiber at least 18% crude fiber to support gut health and prevent digestive disorders (Gidenne, 2015). Protein-rich ingredients such as alfalfa hay, legumes, and soybean meal are also essential for optimal growth. Rabbit production can thus serve as a means to improve household nutrition and alleviate poverty through income generation (Moto, 2024).

Feed represents a major portion of production costs in rabbit farming, yet conventional feed ingredients can be expensive or scarce in many regions (Makkar, 2018). This has spurred interest in alternative, cost-effective feed sources such as agro-industrial by-products and food waste. These materials such as peels, brans, husks, and gluten meal offer essential nutrients and energy while reducing reliance on conventional feedstuffs (Murugesan *et al*., 2021). Leaf meals from plants like moringa and cassava also contribute valuable nutrients and help reduce environmental waste (Bakshi *et al*., 2016). Notably, by-products such as sweet potato peels and cassava leaves, often discarded, can serve as nutritious feed alternatives.

Sweet potato peels are rich in minerals (Agubosi *et al*., 2021), while cassava leaves contain antioxidants and essential nutrients (Saragih *et al*., 2020). However, challenges such as bulkiness, anti-nutritional factors, and rapid spoilage must be addressed. Despite their low protein and calcium content, potato peels can support gut health in monogastric animals due to their high fiber content. Up to 15% inclusion of sweet potato peel meal has been shown to have no adverse effects in rabbit diets

(Ibrahim and Olaniyi, 2018). Cassava leaves have also been extensively studied as a feed component in rabbit nutrition. Research has shown cassava leaves can make up to 40% of the diet without negatively affecting growth (Okonkwo *et al*., 2010), and recent findings suggest they can effectively replace soybean meal while enhancing performance (Hang *et al*., 2023). For optimal digestibility, a 10% inclusion rate is recommended (Daquioag, 2023).

Blended use of cassava peels and leaves has also proven effective (Olowoyeye *et al*., 2019). Agunbiade et al. (1999) demonstrated that cassava peels and leaves mixture could replace maize without negative effects, while Amos et al. (2021) reported improved growth and cost-efficiency using up to 40% ensiled cassava root-leaf blends. However, comprehensive research on the combined use of sweet potato peels and cassava leaves especially in a defined mixture ratio in rabbit diets is still limited. This knowledge gap restricts wider adoption in the feed industry. Though studies like that of Oloruntola et al. (2021) have shown positive outcomes using cassava-based mixtures in monogastric animals, data on the nutritional synergy of sweet potato peels and cassava leaves in rabbit diets remain scarce.

In light of global food security concerns and the need for sustainable agricultural practices, the use of these by-products can help reduce waste, lower feed costs, and enhance resource efficiency - contributing to Sustainable Development Goal 12 (Chisoro *et al*., 2023). This study aims to investigate the effects of incorporating a sweet potato peel and cassava leaf mixture into rabbit diets on growth performance, carcass yield and economic evaluation.

Materials and methods

Experimental geographical location

The research was conducted at the Rabbit Section of the Teaching and Research Farm of Landmark University, Omu-Aran, Kwara State located at latitude 8° 9′N and longitude 5° 61′E, 564 meters above sea level with a mean annual rainfall of 1,600 mm and mean temperature of 27°C. It is located approximately 88 kilometers South of Ilorin, the capital of Kwara State, and 16km northeast of Otun Ekiti, in Ekiti State (Kwara State Diary, 2012).

Experimental design

Thirty-six male Hyla breed weaned rabbits at six weeks of age were purchased from a reputable farm in Ilesa, Osun State, Nigeria. The rabbits were randomly assigned to four treatment groups, T1, T2, T3, or T4 of three replicates per treatment and three rabbits in each replicate. The rabbits were housed individually in clean and disinfected wooden hutches and provided with feeders and drinkers. The hutches were raised 1m above the ground level to prevent ant infestation. Anti-stress was administered on arrival of the animals, while antibiotics, anti-coccidiostat, and multivitamins were given prophylactically in the course of the study. Clean and fresh water was provided ad libitum. The feeding trial experiment was for eight weeks. All other routine practices were carried out in accordance to the Declaration of Helsinki on animal welfare and use. The feeding trial experiment was for eight weeks.

Collection and processing of test ingredients

White-fleshed sweet potato (*Ipomoea batatas*) peels were collected from the Landmark University cafeteria, air-dried for 96 hours, ground, and stored in bags. Composite cassava (*Manihot esculenta*) leaves were harvested from the Landmark University Teaching and Research Farm, air-dried for 48 hours, and ground. The ground sweet potato peels were then mixed with the composite cassava leaves in a 49:1 ratio to fortify the peels. The resulting product is referred to as sweet potato peel-cassava leaf mix meal.

Proximate analysis of test ingredients

The proximate composition of cassava leaves, sweet potato peels, and sweet potato peel-cassava leaf mix meal (SPPCLM) were determined using AOAC (2012) to ascertain moisture content, crude protein (CP), crude fibre (CF), ether extract (EE), and ash. The following formula was used to determine the nitrogen-free extract (NFE):

NFE (%) = 100 - (moisture + CP + CF + EE + Ash).

Experimental Diets

Table 1 presents the composition of the experimental diets. Four isonitrogenous (18%) and isocaloric (2700 Kcal/kg) diets were formulated and pelleted according to the nutritional requirements of growing rabbits. The diets, labelled T1, T2, T3, and T4, include sweet potato peel-cassava leaf mix meal at inclusion levels of 0, 20, 40, and 60%, respectively. Additionally, each rabbit was provided with 100g of air-wilted African sunflower (*Tithonia diversifolia*) leaves as a common forage every evening.

Table 1. Composition of the experimental diets

Feed ingredients (%)	Inclusion levels of SPPCLM in the diets			
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)
Maize	60.60	48.50	36.40	24.00
Wheat Offal	20.00	20.20	20.10	19.90
SPPCLM	0.00	12.10	24.20	36.40
Soyabean meal	16.40	16.20	16.20	16.40
Fish Meal	0.00	0.22	0.23	0.23
Bone Meal	2.00	2.00	2.00	2.00
Table 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	0.30	0.30	0.30	0.30

SPPCLM = Sweet potato peel-cassava leaf mix meal.

Growth performance study

Each rabbit was weighed at the beginning of the experiment and subsequently weekly for the period of the feeding trial using a digital weighing scale (PA 512, Ohaus Corp. Pine Brook, USA). The parameters that were carried out for assessing of growth performance were initial weight (g), average feed intake (g), average weight gain (g), and feed conversion ratio (Amin et al., 2019). The feed intake record was documented daily during the feeding trial using a digital balance to 2 decimal places. Each treatment's average daily feed intake was calculated from the total weekly feed consumption. The average weight gain was calculated by deducting the initial weight from the final weight while the feed conversion ratio was calculated from the values obtained from the feed intake and weight gain.

$$\text{Feed conversion ratio} = \frac{Quantity\ of\ feed\ consumed\ (g)}{Weight\ of\ the\ rabbits\ (g)}$$

Carcass evaluation

Following the eight-week feeding study, three rabbits per treatment (one from each replicate) were chosen at random on the last day of the experiment, weighed, and starved for the whole night but offered water. The rabbits were humanely sacrificed by hanging heads down via the rear legs, the animals were then thoroughly bled. To obtain the dressed weight, furs were removed by singeing. The internal organs were then removed from the carcass once it had been dissected (to determine the eviscerated weight). After dividing each carcass into wholesale parts, a digital scale was used to weigh each primal component, which included the neck, thoracic cage, forelimbs, thigh, hind limbs, and loin. Additionally, the weights of the kidney, liver, GIT, heart, and lungs were recorded. The weight of the cut portions and organs was measured and reported as relative to the live weight (Haruna & Muhammad, 2018).

Economy efficiency analysis

Economy efficiency analysis was carried out to compare the feed cost reduction (FRC) between the conventional (control) diet and the other treatment diets including the dietary inclusion of sweet potato cassava leaf mix meal (SPPCLM).

Feed reduction cost = x-y

% Feed reduction cost = $\frac{x-y}{x}$ X 100

Where:

x = Cost of feed per kg of meat/diet in treatment 1

y = Cost of feed per kg in other treatments (treatment 2 or treatment 3 or treatment 4)

Statistical analysis

The data generated were subjected to Analysis of Variance (ANOVA) using the SAS statistical package (2019). The means were separated using Duncan's Multiple Range Test (DMRT) as mentioned by (Duncan, 1955). The cut-off *P* < 0.05 was used to indicate the significance.

Results and discussion

Proximate components of test ingredients

The proximate composition of the individual feed components and their mixture is presented in Table 2. Sweet potato peels (SPP) had a relatively low crude protein (CP) content of 4.08%, while cassava leaves (CL) were significantly richer in protein at 25.39%. The formulated sweet potato peel–cassava leaf mix meal (SPPCLM), prepared in a 49:1 ratio, yielded a CP content of 6.18%. This modest increase reflects the limited contribution of CL to the mix, as the high protein content of cassava leaves was diluted by the predominantly low-protein sweet potato peels.

Crude fibre (CF) in SPPCLM was notably high (18.25%), largely attributable to the substantial fibre content of SPP (18.62%). Elevated fibre levels may influence the digestibility and energy availability of the diets, potentially affecting growth performance. The ether extract (EE**)** content was low across all ingredients, with SPPCLM recording 0.98%, indicating reduced fat levels. Ash content was highest in CL (11.47%), underscoring its mineral richness, and this contributed to the SPPCLM's ash content of 4.74%.

The improved CP level in SPPCLM can be credited to the nutritional enhancement provided by cassava leaves, known for their high-quality protein, vitamins, minerals, and carotenoids (Ekpo *et al*., 2022). The protein and amino acid profiles of cassava leaves are comparable to those of eggs, making them a valuable supplement to nutrient-deficient ingredients like sweet potato peels. Similar synergistic effects have been observed when low-protein feedstuffs are fortified with protein-rich leaf meals such as *Moringa oleifera* (Selim et al., 2021).

The lower EE content in SPPCLM, compared to cassava leaves alone, may offer health benefits by reducing dietary fat levels. Additionally, the high CF content of both SPP and SPPCLM supports gut health and proper digestion in rabbits (Cao *et al*., 2022).

These findings align with those of Iyiola *et al.* (2024), who reported similar proximate values for cassava leaf meal, confirming its potential as a protein and mineral supplement in rabbit nutrition. The values obtained for SPP in this study are comparable to those reported by Idris et al. (2019), although Agubuosi (2022) documented slightly higher CP (7.89%) and ash (6.95%) with lower CF (3.41%). The cassava leaves used in this study had higher CP (25.4%), EE (4.46%), and CF (5.77%) than those reported by Sebiomo and Banjo (2020), likely due to differences in location, cultivar, environmental factors, and processing methods.

Overall, the combination of sweet potato peels and cassava leaves offers a nutrient-rich, fibre-enhanced feed ingredient suitable for rabbits. It provides essential nutrients and bioactive compounds that can support rabbit health, reduce production costs, and contribute to sustainable livestock systems (Ganogpichayagrai & Suksaard, 2020; *Pomar et al*., 2021).

Table 2. Proximate components of the test ingredients

Parameters (%)	Cassava leaf	Sweet potato peels	Sweet potato-cassava leaf mix meal
Moisture	13.00	14.45	14.17
Crude protein	25.39	4.08	6.18
Ether extract	4.46	0.97	0.98
Crude fibre	5.77	18.62	18.25
Ash	11.47	4.73	4.74
Nitrogen free extract	39.91	57.15	56.16

Impact of SPPCLM on growth performance of rabbits

The growth performance of rabbits fed diets containing varying levels of sweet potato peel–cassava leaf mix meal (SPPCLM) is presented in Table 3. Initial body weights were statistically similar across treatments ($P > 0.05$), confirming uniformity at the trial's onset. However, final weights differed significantly ($P < 0.05$), with rabbits on the 20% maize replacement diet (T2) attaining the highest value (2137 g), significantly outperforming those on 40% (T3) and 60% (T4).

Average daily feed intake (ADFI) increased with SPPCLM inclusion, peaking at 94.5 g/day in T2, indicating enhanced palatability at moderate levels. Despite this, feed conversion ratio (FCR) declined with higher inclusion levels, reaching 4.52 and 4.74 in T3 and T4, respectively, compared to 3.28 in the control (T1) and 3.24 in T2. This suggests reduced feed efficiency at higher SPPCLM levels, likely due to increased fiber content and decreased energy density.

These findings align with Adegbola and Okonkwo (2002), who observed reduced performance in rabbits fed diets high in cassava leaf meal. Similarly, Ibrahim and Olaniyi (2018) and reported optimal rabbit growth when maize was replaced with sweet potato peel up to 15%, with performance declining beyond this threshold. Interestingly, while Ibrahim and Olaniyi (2018) noted reduced intake above 10% inclusion, this study found feed intake remained high at 40–60%, possibly due to the influence of cassava leaves, which may enhance palatability (Bakare *et al*., 2022) and support higher intake, especially in fiber-preferring species like rabbits (Christopher *et al*., 2023).

Though total weight gain (TWG) and daily weight gain (DWG) were not statistically significant across treatments, numerical values were highest in T2, highlighting the 20% replacement level as optimal. This could be due to a balanced nutrient profile, combining energy from sweet potato peels and protein from cassava leaves. As Ekpo et al. (2022) observed, increased weight gain can result from protein-rich components promoting muscle development. Jiwuba et al. (2018) and Williams et al. (2023) also reported improved performance in livestock fed cassava-based by-product blends.

The decline in growth metrics beyond 20% replacement level likely reflects excessive fiber hindering nutrient digestibility and absorption. Moreover, higher inclusion levels may reduce palatability or introduce undesirable textures and flavors. Cassava leaves contain anti-nutritional factors like cyanogenic glycosides (Odilia *et al*., 2022), which at elevated levels can impair growth if not adequately detoxified. At 20% inclusion, such compounds are likely below harmful thresholds, whereas higher levels may pose risks.

Overall, the 20% replacement level offers a favorable balance of nutrients and fiber, optimizing growth performance without compromising feed efficiency or health. This study builds upon previous work by Ibrahim and Olaniyi (2018), who reported optimal results at 15% maize replacement with sweet potato peel, demonstrating that combining sweet potato peels with cassava leaves can safely allow for higher substitution levels.

Table 3. Impact of the SPPCLM at varying inclusion levels on growth performance parameters of growing rabbits

Indices in (g)	levels of Sweet Potato peel - Cassava Leaf mix				SEM (±)	P-Value
	T1 (0%)	*T2 (20%)*	*T3 (40%)*	*T4 (60%)*		
Initial body Wt	740.20	780.80	795.80	793.30	0.92	0.99
Final body Wt	1890.00^{ab}	2137.00^{a}	1727.00^{b}	1751.00^{b}	0.91	0.05
ADFI (g)	85.2^{b}	94.5^{a}	91.6^{a}	93.6^{a}	0.61	<0.01
DWG (g)	26.1	30.8	21.2	19.8	0.95	0.22
FCR	3.28	3.24	4.52	4.74	0.91	0.26

SPPCLM = Sweet potato-cassava leaf mix meal; ADFI= average daily feed intake; DWG= daily weight gain; FCR= feed conversion ratio, SEM= Standard error of mean, *P*-value= level of significance

Where $P < 0.05$, it shows that there is a statistical difference in the level of significance while $P > 0.05$ shows no statistical difference in significance.

$^{a,\,b}$ = Values of the same row with different alphabet superscripts are significant.

Impact of SPPCLM on carcass traits of rabbits

Carcass characteristics, as shown in Table 4, were significantly affected by dietary SPPCLM inclusion levels. Rabbits fed the 20% SPPCLM diet (T2) achieved the highest live weight (2013 g), eviscerated weight (1631 g), and dressing percentage (71.8%), indicating superior carcass yield at this inclusion level. Conversely, the 60% maize replacement level diet (T4) recorded the lowest dressing percentage (56.9%), reflecting the detrimental effects of excessive SPPCLM on carcass quality, likely due to impaired nutrient digestibility.

Primal cuts such as the thigh (12.4%) and loin (25.8%) were also maximized in T2, while T4 had the lowest values for these cuts, reinforcing the benefit of moderate SPPCLM levels for muscle development. Notably, forelimb yield increased across treatments, suggesting a consistent positive response to SPPCLM replacement of maize in that region. These observations align with Chodová et al. (2019), who reported that heavier rabbits tend to have better muscle-to-gut content ratios, thereby enhancing carcass yield.

Organ weights were mostly unaffected by diet, with the exception of lung weight, which showed a significant decrease (P < 0.01) across treatments. Lung proportions fell below the expected range of 1–2% (Oloruntola et al., 2018), potentially indicating subclinical respiratory compromise, possibly due to residual hydrogen cyanide (HCN) from cassava leaves not fully removed by air-drying. This is consistent with findings by Jiwuba et al. (2018), who observed reduced lung mass in rabbits fed cassava leaf–based diets. Liver weights were slightly elevated in T3 and T4, potentially exceeding the normal physiological range of 2–3% (Oloruntola et al., 2018). This may indicate metabolic stress from anti-nutritional compounds such as cyanogenic glycosides and oxalates found in both cassava leaves and sweet potato peels, resulting in increased detoxification demand. Although elevated liver weight was also noted in the control group, suggesting possible external factors, the trend in higher replacement diets warrants caution. The gastrointestinal tract (GIT) weight peaked in T2, suggesting better gut fill and adaptation to dietary fiber at moderate inclusion. However, at higher levels, excessive fiber may reduce nutrient absorption efficiency, indirectly affecting carcass development.

These results support earlier findings by Lalabe et al. (2024), who reported improved carcass metrics in rabbits fed up to 20% cassava leaf meal, and Daquioag (2023), who attributed reductions in carcass quality at higher inclusion levels to decreased nutrient digestibility. The superior carcass traits observed at 20% replacement may also be linked to increased feed intake and total weight gain observed in this group. According to Kumar et al. (2023), heavier rabbits often exhibit higher dressing percentages, further supporting these findings. A 20% replacement of maize by SPPCLM in rabbit diets appears optimal for enhancing carcass yield and muscle development, while higher levels may compromise organ health and carcass quality due to anti-nutritional factors and reduced nutrient utilization.

Table 4: Impact of the SPPCLM at varying inclusion levels on carcass traits of rabbits fed the experimental diets

Parameters	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)	SEM (±)	P-Value
Final Live wt (g)	1899.00^{b}	2013.00^{a}	1723.00^{c}	1866.00^{b}	33.20	0.00
Eviscerated. wt (g)	1295.00^{b}	1631.00^{a}	1307.00^{b}	$1205/00^{b}$	55.20	0.05
Dress weight (g)	1130.00^{b}	1441.00^{a}	1141.00^{b}	1063.00^{bc}	67.40	0.07
Dress percentage (%)	59.50	71.80	66.20	56.90	3.43	0.05
Neck (%)	1.77^{b}	2.65^{a}	2.04^{ab}	1.96^{ab}	0.14	0.12
Forelimbs (%)	10.80	12.70	13.60	14.80	0.77	0.34
Thoracic cage (%)	7.07^{b}	8.07^{ab}	9.69^{a}	7.72^{ab}	0.41	0.13
Thigh (%)	10.50^{ab}	12.40^{a}	10.90^{b}	8.61^{b}	0.53	0.05
Hind limbs (%)	12.00^{ab}	10.30^{b}	14.90^{a}	14.90^{a}	0.77	0.53
Loin (%)	22.80^{b}	25.80^{a}	23.60^{b}	18.10^{c}	0.57	0.47
Relative organ weight						
Liver (%)	3.37^{ab}	3.14^{b}	3.46^{a}	3.54^{a}	0.58	0.41
Kidney (%)	0.99^{b}	1.55^{a}	1.35^{ab}	1.39^{ab}	0.86	0.12
Heart (%)	0.30^{a}	0.30^{a}	0.27^{ab}	0.24^{b}	0.01	0.61
GIT (%)	14.10^{c}	17.70^{a}	15.20^{bc}	16.70^{ab}	0.53	0.36
Lungs (%)	0.92^{a}	0.75^{b}	0.69^{b}	0.57^{c}	0.39	0.00

$^{a, b,c}$ = Values of the same row with different alphabet superscripts are significant.
SPPCLM = Sweet potato-cassava leaf mix meal; Ev. Weight= eviscerated weight; GIT= gastrointestinal tract, SEM= Standard error of mean; Where $P < 0.05$, it shows that there is a statistical difference in the level of significance while $P > 0.05$ shows no statistical difference in significance.

Economic Analysis

The economic evaluation (Table 5) revealed a progressive decrease in feed cost per kilogram of feed with increasing SPPCLM levels, dropping from ₦318 in the control diet (T1) to ₦232 in the 60% inclusion diet (T4). However, when examining **cost** per kilogram of weight gain, the 20% inclusion level (T2) was the most cost-effective at ₦1,154, compared to ₦1,319 in T1 and ₦1,256 in T4. This indicates that while higher inclusion levels reduce feed cost per unit, they do not necessarily improve economic returns due to reduced growth performance beyond the optimal threshold. The use of alternative feed resources like SPPCLM presents a sustainable strategy for lowering production costs in rabbit farming. By utilizing agro-industrial by-products, feed expenses can be reduced without compromising animal health or performance, thus contributing to affordable protein production and aligning with UN Sustainable Development Goal 2 (Zero Hunger).

These findings are consistent with Iyiola and Olaniyi (2018), who reported that replacing maize with sweet potato peels up to 15% had no adverse effects on feeding cost or rabbit growth. This underscores the importance of balancing cost savings with performance efficiency when determining optimal inclusion levels for alternative feedstuffs.

Although T2 incurred the highest total feed cost (₦1,553) due to greater cumulative intake (5.3 kg), it still achieved a lower cost per kilogram of meat. This mirrors observations by Adekeye et al. (2021) in broiler chickens fed cassava peel-based diets, where higher feed intake translated into better growth and cost-effectiveness. T3 (40% inclusion) also demonstrated a reduced meat cost (₦1,136) and recorded the highest feed cost reduction (₦183/kg meat) compared to the control. In contrast, the higher **cost** per kilogram of meat observed in T4 was linked to lower weight gain, necessitating more feed to achieve comparable results. This pattern aligns with Adedokun et al. (2021), who found that diets resulting in poor growth performance led to higher per-unit production costs. Overall, the replacement of maize by SPPCLM improved feed cost efficiency, particularly at 20–40% levels. The 20% replacement was optimal, providing the best balance of feed intake, growth performance, and economic return, while higher levels were less cost-effective due to diminished weight gain.

Table 5. Economy efficiency of sweet potato-cassava leaf mix meal in growing rabbits

Parameters	Level of inclusion of potato leaf-cassava peel mix			
	T1 (0%)	T2 (20%)	T3 (40%)	T4 (60%)
Total feed intake (kg)	4.77	5.30	5.10	5.20
Weight gain (kg)	1.15	1.35	1.18	0.96
Total cost of feed (#)	1517.00	1558.00	1341.00	1206.00
Cost of feed/kg (#)	318.00	294.00	263.00	232.00
Cost of feed/1kg meat (#)	1319.00	1154.00	1136.00	1256.00
FRC per kg of the feed (#)	0.00	24.00	55.00	86.00
FRC per kg of meat (#)	0.00	165.00	183.00	63.00

FRC= Feed cost reduction

Conclusion

The results of this study demonstrate that sweet potato peel–cassava leaf mix meal (SPPCLM), formulated in a 49:1 ratio, is a viable alternative feed ingredient for growing rabbits when used to replace maize at moderate levels. The 20% replacement level proved optimal, significantly improving final body weight, carcass traits (notably dressing percentage and muscle cuts), and cost efficiency without compromising health or feed conversion. While higher inclusion levels (40–60%) reduced feed cost per kilogram, they also led to diminished growth performance, lower carcass quality, and signs of metabolic stress, likely due to elevated fiber and anti-nutritional factors. Therefore, replacing maize with SPPCLM at 20% offers a practical and sustainable approach to reduce feed costs, enhance rabbit production, and promote circular use of agro-industrial by-products. This strategy supports the goals of sustainable agriculture and food security, particularly in resource-limited settings.

Recommendations

1. It is recommended that rabbit diets incorporate SPPCLM at a 20% inclusion level to maximize growth performance and feed efficiency, while minimizing potential adverse effects associated with higher levels.
2. Regular assessments of anti-nutritional compounds in SPPCLM should be conducted, especially at higher inclusion rates, to prevent metabolic stress and ensure the health of the rabbits.
3. Additional studies should explore the long-term effects of SPPCLM on rabbit health and performance, as well as the optimal processing methods to reduce anti-nutritional factors, enhancing its nutritional benefits.

Ethical approval

Ethical code LUAC/BCH/2024/002A for this research was obtained from the Ethical Committee of Landmark University

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Competing interests

The authors declare no conflict of interest.

Authors' contributions

Oluwafemi P: Data curation, Formal analysis, Investigation, Resources, Writing – original draft. Animashahun R, A.: Conceptualization, Methodology, Project administration, Resources, Supervision, Validation, Visualization, Writing – review and editing. Alabi O.: Conceptualization, Project administration, Resources, Software, Supervision, Validation, Visualization. Animashahun A. P.: Validation, Visualization, review and editing.

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