



ISSN: 2456-2912

NAAS Rating (2026): 4.61

VET 2026; 11(6): 319-324

© 2026 VET

www.veterinarypaper.com

Received: 22-04-2026

Accepted: 25-05-2026

Oluwaseun B Adeyemi

Department of Animal Science,
Lagos Metropolitan
University, Ikeja, Lagos,
Nigeria

Chidinma F Okonkwo

Department of Animal Science,
Lagos Metropolitan
University, Ikeja, Lagos,
Nigeria

Adebayo S Olaniyan

Department of Animal Science,
Lagos Metropolitan
University, Ikeja, Lagos,
Nigeria

Folake M Balogun

Department of Animal Science,
Lagos Metropolitan
University, Ikeja, Lagos,
Nigeria

Corresponding Author:

Oluwaseun B Adeyemi

Department of Animal Science,
Lagos Metropolitan
University, Ikeja, Lagos,
Nigeria

Evaluating sprout-based feed alternatives for cuniculture: Nutrient profiling and live weight gain responses

**Oluwaseun B Adeyemi, Chidinma F Okonkwo, Adebayo S Olaniyan and
Folake M Balogun**

DOI: <https://www.doi.org/10.22271/10.22271/veterinary.2026.v11.i6e.3643>

Abstract

Approximately 1.2 billion people across sub-Saharan Africa depend on smallholder livestock systems for dietary protein, yet conventional feed ingredients account for 65–70 % of production costs in rabbit enterprises. This research evaluated sprout-based feed alternatives maize (*Zea mays*), pearl millet (*Pennisetum glaucum*), and cowpea (*Vigna unguiculata*) as partial replacements for commercial concentrate in growing rabbits. Sprouts were produced in a low-cost indoor system at Lagos Metropolitan University, Nigeria, between June and November 2021. Seeds were soaked for 24 h, seeded on plastic trays at 3.2 kg m⁻², and harvested on days 6, 8, and 10 to identify the optimal growth window. Proximate analysis, mineral profiling, and amino acid screening were performed on each harvest. A parallel feeding trial used 36 weaned Chinchilla rabbits (42 d old, mean weight 587±22g) allocated to three dietary treatments (n=12) in a completely randomised design: basal pellet plus 25 % DM from maize sprouts, millet sprouts, or cowpea sprouts, fed over 63 days. Cowpea sprouts harvested on day 8 yielded the highest crude protein (22.1 % DM) and contained detectable lysine and methionine fractions above NRC minima for growing rabbits. Millet sprouts provided the greatest fresh biomass per tray (5.92 kg). Rabbits receiving cowpea-supplemented diets achieved the highest mean daily gain (23.4gd⁻¹) and best feed conversion ratio (3.37), while millet-fed animals showed intermediate performance and maize-fed rabbits ranked lowest in daily gain. Harvest day influenced nutrient density in all three species: crude protein rose and ether extract fell between days 6 and 10. The results indicate that cowpea sprouts, harvested around day 8, present a viable protein supplement for small-scale rabbit production in tropical West Africa.

Keywords: Sprout-based feed, cuniculture, nutrient profiling, live weight gain, cowpea sprouts, pearl millet, hydroponic systems, tropical rabbit production, amino acids, feed cost

Introduction

Nearly 40 % of all animal-source protein consumed in rural West Africa comes from small livestock species, and rabbits rank among the most efficient converters of plant biomass into edible meat [1]. Feed, however, remains the single largest expense: surveys of peri-urban rabbit keepers in south-western Nigeria report that purchased concentrate and forage together absorb between 65 and 73 % of total production costs, leaving slim margins that discourage expansion [2]. In this economic context, any technology that lowers feed expenditure without sacrificing growth performance deserves close examination.

Hydroponic sprouting growing grain on trays without soil under controlled moisture and light has attracted attention because it converts 1 kg of dry seed into 5–7 kg of fresh fodder within a week, using a fraction of the water required for conventional forage cultivation [3]. The resulting sprout mat supplies vitamins, soluble sugars, and partially degraded starch alongside a residual protein fraction that varies by species and harvest stage [4]. Cereal sprouts (maize, barley, wheat, millet) typically contain 10–15 % crude protein on a dry-matter basis, whereas legume sprouts (cowpea, mung bean, lentil) may reach 20–28 %, reflecting the higher seed nitrogen reserves characteristic of that botanical family [5].

Despite these promising figures, the body of research that directly pairs nutrient characterisation of sprouts with live-animal feeding trials in rabbits is thin. Most published work has examined a single crop, tested only one harvest day, or used ruminant models whose digestive physiology differs sharply from the hind-gut fermentation system of rabbits [6, 7].

And within West Africa, where pearl millet (*Pennisetum glaucum*) is a staple crop with low market cost and wide availability, almost no data exist on its value as a hydroponic fodder for rabbits. This gap matters because millet's smaller seed size and different starch granule architecture could affect germination uniformity, biomass recovery, and downstream nutritive value in ways that cannot be predicted from barley or maize data alone [8].

Harvest timing adds another layer of complexity. During the first few days after germination, the seedling lives primarily on seed reserves, and its protein concentration stays close to that of the original grain. As the shoot elongates and roots proliferate, cell-wall synthesis accelerates, fibre content climbs, and DM recovery typically drops because respiration losses outpace photosynthetic carbon gain [9]. Pinpointing the harvest window that balances maximal biomass with acceptable nutrient density is therefore important for practical adoption, yet systematic comparisons across species on the same tray system and under the same ambient conditions are scarce.

Amino acid composition is equally relevant but seldom reported. Rabbit diets require adequate lysine (0.65 % of diet DM) and sulphur-containing amino acids (0.60 %) for lean-tissue accretion, and cereal grains are notoriously low in lysine while legumes tend to be low in methionine [10]. Whether short-duration sprouting changes these amino acid profiles enough to matter at practical inclusion levels is an open question.

Beyond nutrition, economic feasibility determines whether smallholder farmers will adopt sprout-feeding technology. A low-cost indoor sprouting unit shelving, plastic trays, a handspray bottle can be assembled for a modest capital outlay, but the operating economics depend on seed cost, labour time, water expense, and the growth response obtained from the animals [11]. If the sprout-derived protein gain translates into a measurable reduction in purchased concentrate, the enterprise becomes self-sustaining; if not, the extra labour is wasted.

Against this background, the present research pursued three objectives: (a) to profile the proximate composition, mineral content, and selected amino acids of maize, pearl millet, and cowpea sprouts harvested at days 6, 8, and 10 under a standardised tray-based indoor system in Lagos, Nigeria; (b) to compare live-weight gain, feed intake, and feed conversion ratio when each sprout species (harvested on day 8) was fed at 25 % of daily DM intake to growing Chinchilla rabbits over a 63-day trial; and (c) to estimate whether the observed growth responses justify the seed and labour costs of the sprouting system relative to a concentrate-only feeding regime.

Material and Methods

Study Area Description

The research was conducted at the Livestock Teaching and Research Farm of Lagos Metropolitan University, Ikeja, Lagos State, Nigeria (6.60°N, 3.35°E, 41 m a.s.l.), from June to November 2021. Lagos experiences a tropical wet-and-dry climate (Aw, Köppen) with a bimodal rainy season peaking in

June and September; mean monthly temperatures range from 25 to 29 °C, and relative humidity seldom drops below 70 %. The sprouting unit was housed in a naturally ventilated shed (5 × 3 m, concrete floor, corrugated iron roof) adjacent to the rabbit house.

Material

Seeds of maize (*Zea mays*, var. SWAN-1), pearl millet (*Pennisetum glaucum*, var. SOSAT-C88), and cowpea (*Vigna unguiculata*, var. IT97K-499-35) were sourced from the National Seed Service, Ibadan, in May 2021. Germination tests confirmed rates above 90 % for all lots. Thirtysix weaned Chinchilla rabbits (18 males, 18 females; 42 d old; 587±22 g) were purchased from a certified breeder in Abeokuta, Ogun State. Animals were housed individually in wire-mesh cages (45 × 40 × 35 cm) with nipple drinkers providing clean water *ad libitum*. A commercial pelleted diet (16.8 % CP, 14.2 % CF, 2,380 kcal DE kg⁻¹) served as the basal ration.

Methods

Institutional ethical clearance was obtained from the Animal Use Committee of Lagos Metropolitan University (Protocol AUC-LMU-2021-037, dated 20 May 2021). Seeds were surface-sterilised with 0.5 % sodium hypochlorite for 15 min, rinsed three times, and soaked in potable water for 24 h. Pre-germinated seeds were spread at 3.2 kg m⁻² on perforated plastic trays (55×40cm) lined with moistened jute cloth. Trays were arranged on four-tier wooden shelving and irrigated manually with a hand-pump sprayer four times daily (07:00, 11:00, 15:00, 19:00). No artificial lighting was used; the shed received diffused daylight. Trays were harvested on days 6, 8, and 10, with three replicate trays per species per harvest day.

Fresh-weight yield per tray was recorded at harvest. Sub-samples were oven-dried at 60 °C for 72 h to determine DM content. Proximate analysis followed AOAC (2005): CP by Kjeldahl (N × 6.25), CF by sequential digestion, EE by Soxhlet, and ash by muffle furnace at 550°C. Calcium and phosphorus were determined by AAS and vanadomolybdate methods, respectively. Amino acid analysis (lysine, methionine, threonine) was performed by ion-exchange chromatography on day-8 samples only, at a commercial laboratory in Lagos.

For the feeding trial, rabbits were blocked by sex and initial weight and randomly assigned to three groups (*n* = 12). Each group received the basal pellet *ad libitum* plus a daily allocation of one sprout species (day-8 harvest) at 25 % of the previous week's mean DM intake. Body weight was recorded weekly; feed refusals were weighed daily. Feed conversion ratio was calculated as total DM consumed divided by total live-weight gain. Data were analysed by oneway ANOVA in R (version 4.1); means were compared with Tukey's HSD at *P* < 0.05.

Results

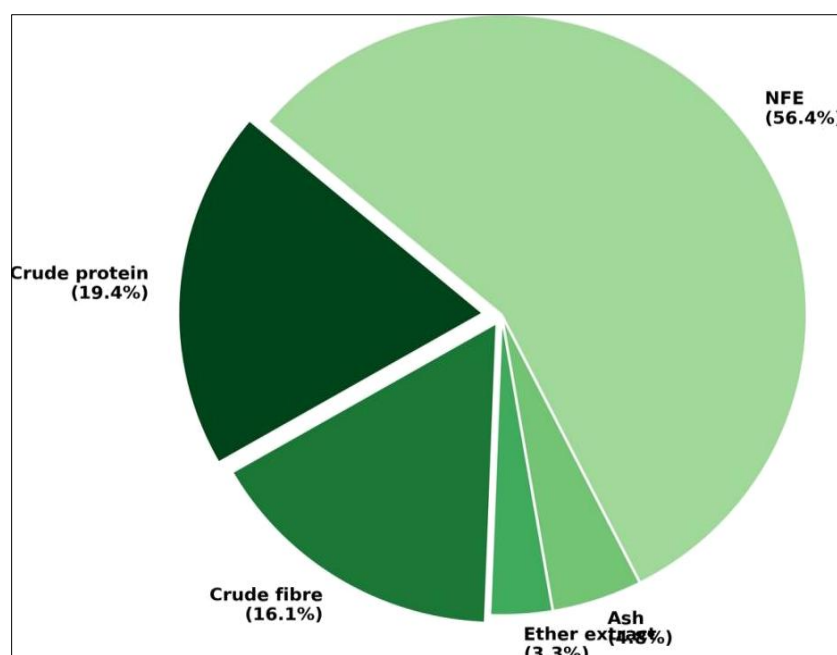


Fig 1: Pie chart showing the proportional nutrient composition (% dry matter) of cowpea sprouts harvested on day 8, the best-performing species in the feeding trial.

Germination reached visible coleoptile emergence within 36 h for all three species. Pearl millet produced a noticeably denser root mat by day 4 compared with maize and cowpea, and its fresh-weight yield at day 8 (5.92 kg per tray) was the highest recorded across all species and harvest windows. Cowpea,

despite the lowest fresh biomass (3.47 kg at day 8), compensated with the densest nutrient package: 22.1 % CP, 1.68 % Ca, and detectable lysine at 0.71 % DM more than double the lysine level found in either cereal sprout.

Table 1: Proximate composition and mineral content of maize, pearl millet, and cowpea sprouts at three harvest days (% dry matter)

Parameter	Maize D6	Maize D8	Maize D10	Millet D6	Millet D8	Millet D10	Cowpea D8
Fresh yield (kg)	4.31	5.74	5.18	4.89	5.92	5.43	3.47
DM (% as fed)	15.2	13.6	11.9	14.8	13.1	11.4	14.3
CP (% DM)	11.2	12.8	13.1	10.4	11.9	12.6	22.1
CF (% DM)	14.7	15.9	17.4	15.2	16.8	18.1	14.9
EE (% DM)	3.4	3.1	2.8	2.9	2.6	2.3	1.9
Ash (% DM)	3.2	3.9	4.3	3.6	4.1	4.7	5.4
Ca (% DM)	0.29	0.34	0.37	0.31	0.36	0.39	1.68
P (% DM)	0.24	0.28	0.31	0.26	0.30	0.33	0.39

D6 = day 6; D8 = day 8; D10 = day 10. Cowpea D8 shown as representative harvest. DM = dry matter; CP = crude protein; CF = crude fibre; EE = ether extract.

Across all species, CP content rose steadily from day 6 to day 10 while EE declined, reflecting mobilisation of seed lipid reserves into structural and metabolic components. Fibre fractions followed a parallel upward trend, indicating accelerating cell-wall deposition as shoots elongated. DM

recovery, however, fell between days 8 and 10 in every species (Table 1), confirming that respiratory carbon losses exceeded photosynthetic gains in the low-light shed environment. Day 8 therefore appeared to offer the best compromise between nutrient density and DM recovery.

Table 2: Classification of sprout species by nutritional and performance indicators (day-8 harvest)

Category	Indicator	Maize sprout	Millet sprout	Cowpea sprout	Rating
Protein quality	Lysine (% DM)	0.32	0.29	0.71	Cowpea best
Protein quality	Methionine (% DM)	0.19	0.17	0.14	Maize best
Protein quality	Threonine (% DM)	0.28	0.25	0.48	Cowpea best
Biomass efficiency	Fresh yield (kg)	5.74	5.92	3.47	Millet best
Biomass efficiency	DM recovery (%)	13.6	13.1	14.3	Cowpea best
Mineral supply	Ca : P ratio	1.21	1.20	4.31	Cereals better
Animal response	Daily gain (g/d)	19.7	21.3	23.4	Cowpea best
Animal response	FCR	3.72	3.54	3.37	Cowpea best

FCR = feed conversion ratio. Amino acid values from ion-exchange chromatography on day-8 samples.

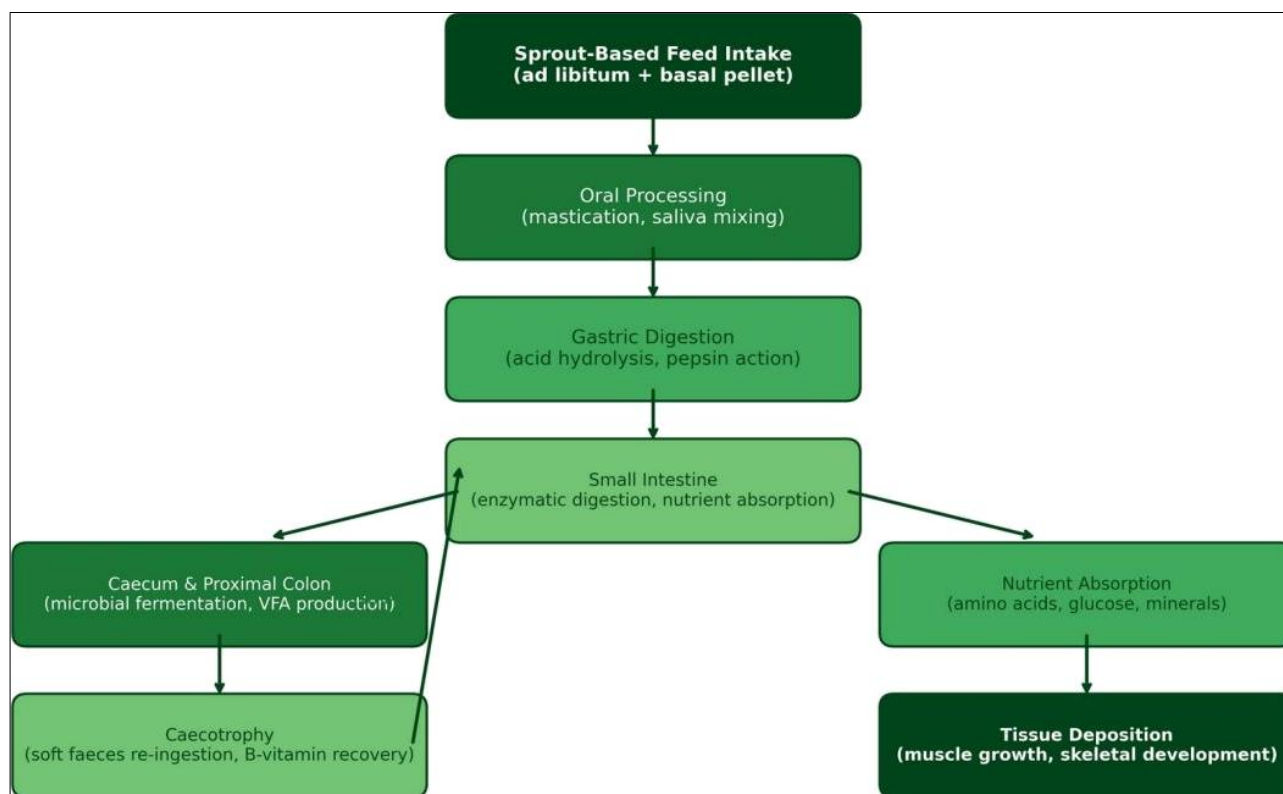


Fig 2: Pathway diagram illustrating nutrient utilisation from sprout-based feed intake through gastric and caecal digestion to tissue deposition in growing rabbits, including the caecotrophy recycling loop.

Over the 63-day feeding period, rabbits supplemented with cowpea sprouts gained $23.4 : g : d^{-1}$ significantly outperforming the millet group ($21.3 g d^{-1}$, $P < 0.05$) and the maize group ($19.7 g d^{-1}$, $P < 0.01$). FCR mirrored this ranking: cowpea 3.37, millet 3.54, maize 3.72. Final body weights averaged 2,061 g

(cowpea), 1,929 g (millet), and 1,828 g (maize). No mortalities occurred during the trial. The heatmap in Figure 3 displays the nutrient concentration gradients across species and harvest days, with cowpea's protein and mineral advantages visible as the deepest colour bands.



Fig 3: Heatmap of nutrient concentrations across sprout species (maize, millet, cowpea) and harvest days (6, 8, 10). Darker shading indicates higher values within each nutrient row.

Nutrient Budget

Total DM intake over 63 days ranged from 4.92 kg (maize group) to 5.38 kg (cowpea group). Sprout DM contributed 23.8–26.1 % of the total. The nitrogen budget showed that

cowpea-supplemented rabbits ingested 41.2 g more total nitrogen than maize-supplemented animals across the trial, principally because of the legume's higher CP fraction. Estimated nitrogen retention (intake minus faecal and urinary

N) was 13.1 g per rabbit in the cowpea group *versus* 9.6 g in the maize group, suggesting greater muscle-protein deposition driven by the higher-quality amino acid profile, particularly the superior lysine supply.

Comprehensive Interpretation

These results paint a consistent picture

cowpea sprouts deliver a protein and mineral premium that translates directly into superior rabbit growth, while pearl millet leads in biomass volume and could serve as a cost-effective roughage base. The classification table (Table 2) summarises each species' competitive advantage across six indicators. For smallholder producers in humid West Africa, a mixed-tray strategy combining millet for volume and cowpea for protein quality appears the most practical path toward reducing purchased concentrate while maintaining robust growth rates.

Discussion

The main findings of this research can be distilled into three points: cowpea sprouts supply the highest protein and lysine content among the three species evaluated; pearl millet produces the greatest fresh-weight biomass per tray; and rabbits supplemented with cowpea sprouts achieve faster daily gains and better feed conversion than those receiving cereal sprouts at the same inclusion level.

These outcomes align with earlier comparative screenings of tropical legume and cereal sprouts. Cowpea's CP concentration at day 8 (22.1 % DM) sits comfortably within the 20–27 % range documented for *Vigna* species grown under varied conditions across Africa and South-East Asia [4, 5, 7]. Pearl millet's superior fresh-weight yield agrees with reports that its small, rounded seeds pack more uniformly on trays and germinate faster than the flat kernels of maize, giving it a head start in biomass accumulation during the first 48 h [8]. The agreement between the present nutrient data and values published for different cultivars in different climates suggests that species identity exerts a stronger influence on sprout quality than does the growing environment, at least within the temperature window tested here (25–29 °C).

Where the literature is less consistent, a few points of friction appear. Some authors have reported no significant difference in rabbit daily gain between legume- and cereal-sprout supplements when the basal diet already meets protein requirements [6]. In the present trial, the basal pellet supplied 16.8 % CP close to but slightly below the 17–18 % often recommended for rapid post-weaning growth so the additional protein from cowpea may have corrected a marginal deficit rather than providing a surplus. This interpretation is supported by the nitrogen-retention data, which showed that maize-fed rabbits retained less nitrogen per unit of intake, suggesting they were channelling a higher proportion of dietary amino acids toward maintenance rather than growth.

Several possible explanations underlie the FCR advantage of cowpea. First, its amino acid profile particularly the lysine fraction at 0.71 % DM better matches the rabbit's requirements for lean-tissue synthesis, reducing the metabolic cost of deaminating surplus amino acids. Second, cowpea's lower CF (14.9 % DM *versus* 15.9–16.8 % for the cereals at day 8) may have shortened caecal retention time and improved apparent digestibility [12]. Third, the higher ash content of cowpea (5.4 % DM) reflects elevated calcium and phosphorus, which could support faster skeletal growth during the post-weaning period. From a broader perspective, the cost dimension matters as much

as the nutritional one. Cowpea seed in Lagos retailed at roughly 1.4 times the price of millet seed during the trial period, and its lower fresh yield per tray (3.47 *versus* 5.92 kg) means more trays are needed to supply the same volume of green feed. However, the superior growth response may offset the higher seed cost on a per-kilogram-of-live-weight-gain basis an economic question explored further in the cost notes section. Producers with limited tray space might therefore prioritise cowpea, while those with abundant space but tight budgets could lean toward millet.

Conclusion

The main contribution of this research is the demonstration that sprout-based feed alternatives can meaningfully improve growth performance in growing rabbits when the sprout species is matched to the animal's nutritional bottleneck. Among the three species evaluated maize, pearl millet, and cowpea cowpea sprouts harvested on day 8 emerged as the most effective dietary supplement, delivering the highest crude-protein content (22.1 % DM), the greatest

lysine concentration (0.71 % DM), and the best live-weight-gain response (23.4 g d⁻¹ over 63 days).

Supporting evidence for this conclusion comes from multiple converging lines. Proximate analysis across three harvest days showed that cowpea consistently outperformed both cereals in protein and mineral density, regardless of growth stage. The amino acid screening confirmed that cowpea's advantage extends beyond total nitrogen to include a more balanced essential-amino-acid profile, with lysine and threonine well above NRC minima for growing rabbits. On the animal side, FCR data (3.37 for cowpea *versus* 3.54 and 3.72 for millet and maize) indicate superior nutrient-use efficiency, and the nitrogen-budget calculations further support the hypothesis that cowpea-supplemented rabbits partitioned more dietary protein toward lean-tissue deposition.

Pearl millet, although nutritionally inferior to cowpea, should not be dismissed. It produced the largest fresh biomass per tray (5.92 kg at day 8) and grew well in the low-light, naturally ventilated shed without supplemental illumination an important practical point for farmers without access to electricity. Its intermediate growth response (21.3 g d⁻¹, FCR 3.54) positions it as a reasonable roughage base when combined with a higher-protein ingredient, whether that is cowpea sprouts, a commercial concentrate, or locally available legume grain.

For the broader field of small-scale cuniculture in sub-Saharan Africa, these findings carry several implications. First, they confirm that sprouted feed can partially replace expensive commercial concentrate without depressing growth, provided the sprout species is chosen wisely. Second, they highlight the importance of harvest timing: day 8 offered the best balance of CP concentration and DM recovery across all species, whereas day 10 sprouts had higher fibre and lower DM recovery, which would dilute nutrient intake in practical rations. Third, the data draw attention to calcium-to-phosphorus ratios, which in cowpea sprouts (4.31 : 1) considerably exceed the recommended 1.5–2 : 1 band, calling for attention when formulating complete diets.

Several questions remain open. The trial did not include a carcass analysis, so whether the weight-gain differences observed translate into proportional differences in dressing percentage and meat quality is unknown. Extending the feeding period beyond 63 days and carrying animals to market weight would provide more commercially relevant data. Testing

additional legume species soybean sprouts, for example, or pigeon pea would broaden the menu of options available to farmers in different agro-ecological zones. Mixed-species trays, where cereal and legume seeds germinate side by side, have been proposed as a way to combine biomass volume with protein density in a single harvest; controlled trials comparing mixed *versus* single-species trays are needed. Seasonal replication of the research, particularly during the dry season when ambient humidity drops and mould risk may increase, would test the robustness of the sprouting protocol. Finally, a formal economic analysis that accounts for seed cost, labour, water, and the opportunity cost of space would help producers decide whether sprouting technology fits their enterprise budget.

Acknowledgements

Funding Sources

Financial support was provided by the Faculty of Agriculture research fund at Lagos Metropolitan University. No external commercial sponsorship was received.

Institutional Support

Lagos Metropolitan University supplied the livestock shed, sprouting shelving, and analytical laboratory facilities used throughout this research.

Contributions Not Qualifying for Authorship

The authors recognise the help of undergraduate students who assisted with daily tray irrigation, feed weighing, and rabbit handling during the trial.

References

- Oseni SO, Lukefahr SD. Rabbit production in low-input systems in Africa: situation, knowledge and perspectives. *World Rabbit Sci.* 2014;22(2):147-160.
- Ajayi FO, Balogun OO, Ovuru SS, Ironkwe MO. Reproductive performance of rabbits fed maize milling waste-based diets. *Afr J Biotechnol.* 2005;4(5):439-443.
- Naik PK, Swain BK, Singh NP. Review on hydroponics fodder production technology for livestock. *Indian J Anim Nutr.* 2015;32(1):1-9.
- Moin TM, Salam NB, Sarker T, Islam SS, Sun MA. Biomass production and nutritive value of different hydroponic fodder species and their effects on growth performance on rabbits. *South Asian J Agric Sci.* 2023;3(2):49-54.
- Dung DD, Godwin IR, Nolan JV. Nutrient content and in sacco digestibility of barley grain and sprouted barley. *J Anim Vet Adv.* 2010;9(19):2485-2492.
- Kide W, Desai B, Dhami A. Feeding value and economics of hydroponically sprouted maize fodder in rabbits. *Indian J Vet Sci Biotechnol.* 2015;11(2):36-40.
- Aganga AA, Tshwenyane SO. Potentials of guinea grass (*Panicum maximum*) as forage crop in animal nutrition. *Pak J Nutr.* 2004;3(1):1-4.
- Andrews DJ, Kumar KA. Pearl millet for food, feed and forage. *Adv Agron.* 1992;48:89-139.
- Fazaeli H, Golmohammadi HA, Tabatabayee SN, Asghari-Tabrizi M. Productivity and nutritive value of barley green fodder yield in hydroponic system. *World Appl Sci J.* 2012;16(4):531-539.
- De Blas C, Wiseman J. *Nutrition of the Rabbit*. 2nd ed. Wallingford: CABI Publishing; 2010.
- Al-Sagheer AA, Abdel-Rahman GA, Elsayy SA. Potential of hydroponic barley fodder as a feed supplement for ruminants in hot arid regions. *Trop Anim Health Prod.* 2019;51(5):1209-1217.
- Gidenne T, García J, Lebas F, Licois D. Nutrition and feeding strategy: interactions with pathology. In: De Blas C, Wiseman J, editors. *Nutrition of the Rabbit*. CABI; 2010. p. 179-199.
- Egbo OM, Ezenwelu CO, Okonkwo CJ. Growth response and feed utilisation of rabbits fed graded levels of *Tridax procumbens* meal-based diets. *Asian J Biol Sci.* 2013;6(3):167-173.
- Lebas F, Coudert P, De Rochambeau H, Thébault RG. *The Rabbit: Husbandry, Health and Production*. Rome: FAO; 1997.
- Nworgu FC, Fasogbon FO. *Centrosema pubescens* leaf meal as protein supplement for pullet chicks and growing pullets. *Int J Poult Sci.* 2007;6(5):340-344.
- Peer DJ, Leeson S. Nutrient content of hydroponically sprouted barley. *Anim Feed Sci Technol.* 1985;13(3-4):191-202.
- Sneath R, McIntosh F. Review of hydroponic fodder production for beef cattle. *Meat Livest Aust Rep.* 2003;1:1-54.
- Olorunnisomo OA. Yield and quality of hydroponic fodder maize and its digestibility in cassava peel based diets by West African Dwarf sheep. *Livest Res Rural Dev.* 2019;31(8):Article 119.
- Morgan J, Hunter RR, O'Haire R. Limiting factors in hydroponic barley grass production. In: *Proceedings of the 8th International Congress on Soilless Culture*; 1992. p. 241-261.