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Carcass characteristics and meat quality of growing rabbits fed mango (*Mangifera indica*) leaf meal as a replacement for wheat offal

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Abstract

The increasing demand for animal protein due to population growth has created a pressing need to explore non-conventional feed resources as a sustainable way to protein shortages. Hence, an 8 week trial was conducted to evaluate the potential of mango (Mangifera indica) leaf meal (MLM) as a replacement for wheat offal in the diets of growing rabbits. A total of 18 unsexed, mixed breed rabbits (New Zealand white x Chinchilla), aged between 6-8 weeks with average live weight of 600-800 g were used for this study. These animals were randomly allotted into three dietary treatments; 0, 5, and 10% MLM replaced wheat offal in a completely randomized design. Proximate composition of MLM was determined as well as carcass traits, physico-chemical and sensory indices of the meat of growing rabbits were evaluated. Result revealed that MLM contained 92.17 ± 0.04% dry matter, 9.63 ±0.54% crude protein, 13.26 ± 0.25% crude fibre, 2.05 ± 0.24% ether extract, 49.41 ± 0.91% nitrogen free extract and 2278.06 ± 0.02% metabolisable energy. The inclusion of MLM in the diet did not significantly ($P > 0.05$) affect the carcass characteristics of growing rabbits except the live weight and head. Rabbits fed dietary 0 (1533.33g) and 5 (1526.67g) % MLM had similar ($P>0.05$) values but significantly higher than those on 10% MLM (1286.67g). Meat quality attributes were significantly ($P < 0.05$) influenced by dietary MLM, except for cooking loss and thermal loss. The dry matter (87.43 – 89.35%) and crude protein (22.55-25.98%) content of the meat sample of rabbits fed dietary MLM increased across the dietary treatments as MLM inclusion levels increased. Dietary MLM had no significant ($P>0.05$) influence on the organoleptic indices of meat except the juiciness. Juiciness of meat from growing rabbits fed dietary mango leaf meal significantly increased across the dietary treatments as MLM inclusion level increased. This study concludes that MLM can be incorporated up to 10 % in the diet of growing rabbits as it enhanced certain meat quality parameters like dry matter, crude protein content and juiciness without adversely affecting most carcass traits or other sensory qualities.

***Keywords**: Animal Protein, Meat Quality, Proximate Analysis, Feed Resources, Red Meat, Rabbits*

Introduction

All over the world, the quest for high-quality animal protein is rising rapidly, driven by population growth, urbanization, and increasing awareness of nutrition and health (Wu *et al.*, 2014). In this context, rabbit farming is gaining significant momentum as an efficient, economical, and sustainable means of meat production (Cullere and Dalle, 2018). Rabbits (*Oryctolagus cuniculus*) possess several desirable production traits including a high reproductive rate, short generation interval, rapid growth, and efficient feed conversion all of which make them ideal for both intensive and smallholder systems (Oseni and Lukefahr, 2014). These traits, coupled with the ability to utilize a wide range of fibrous and non-conventional feed resources, enable rabbits to thrive under diverse environmental conditions, particularly in resource-limited settings commonly found in developing countries.

Rabbit meat is widely acclaimed for its excellent nutritional and dietary profile. It is lean, easily digestible, and rich in high-quality proteins (20–21%), essential amino acids, and polyunsaturated fatty acids, while being low in fat, sodium, and cholesterol (Dalle and Szendrő, 2011). These features make it especially suitable for consumers with dietary restrictions and cardiovascular conditions (Hu *et al.*, 2002). Unlike ruminants and poultry, rabbits have a superior ability to convert dietary protein into body tissue with remarkable efficiency, owing to their hindgut fermentation system and minimal maintenance requirements. Consequently, rabbit meat is increasingly recognized as a functional food and a healthy alternative to traditional red meats (Dalle and Szendrő, 2011). In addition to their biological advantages, rabbits serve as a practical tool for poverty alleviation, food security, and gender empowerment (Alabi *et al.*, 2019). According to Oseni and Lukefahr (2014), the low cost of establishment, minimal land requirement, and quick return on investment make rabbit farming particularly attractive to smallholder and peri-urban farmers. As global concern grows over the rising cost of conventional feedstuffs and environmental impact of livestock farming, the need for alternative, low-cost, and eco-friendly protein sources becomes even more urgent (Adegbeye *et al.*,2020).

One of the major challenges facing rabbit producers, especially in low-income regions, is the high cost of compounded feeds, which typically include ingredients like wheat offal, maize bran, and soybean meal. These ingredients are often expensive, limited in availability, or compete with human food supply. Thus, exploring the use of unconventional, underutilized feed resources that are safe, nutritionally adequate, and locally abundant is vital for the sustainability of rabbit production systems.

In this regard, mango (*Mangifera indica*) leaf meal (MLM) presents a promising non-conventional feedstuff. Mango trees are widely cultivated across tropical and subtropical regions, and their leaves often discarded as waste and they are available in large quantities all year-round. Nutritionally, MLM is rich in dry matter, crude fibre, ash, and nitrogen-free extract, and contains considerable levels of bioactive compounds such as mangiferin, flavonoids, phenolics, and tannins. These phytochemicals have been shown to possess antioxidant, antimicrobial, anti-inflammatory, and immunomodulatory properties that can contribute positively to animal health and productivity (Jalo *et al.*, 2024; Mary Momo *et al.*, 2024). While a number of studies have examined the inclusion of MLM in rabbit diets with respect to growth performance, digestibility, and health indices, there remains a notable gap in literature concerning its effect on carcass characteristics and meat quality parameters (Abou-Kassem *et al.*, 2025). These attributes are critical not only for producer profitability but also for consumer acceptance and marketability of rabbit meat. Meat quality traits such as muscle composition, pH, tenderness, juiciness, and sensory acceptability are directly influenced by dietary inputs and can determine the value of the end product (Xu and Falsafi, 2024).

This study, therefore, seeks to evaluate the effects of replacing wheat offal with graded levels of mango leaf meal on carcass characteristics and meat quality of growing rabbits. It is hypothesized that dietary MLM will have no adverse effects and may potentially enhance meat nutritional composition and sensory quality while offering a sustainable, cost-effective alternative for rabbit nutrition. By addressing this knowledge gap, the study contributes to the growing discourse on integrating agro-ecological feed resources into smallholder livestock production systems for improved food security, income generation, and rural resilience.

Materials and Methods

Experimental Site

The experiment was carried out at Rabbitary Unit of Teaching and Research Farm, Ladoke Akintola University of Technology (LAUTECH), Ogbomoso, Oyo State. The area is located at Latitude 8° 10'0'' north and Longitude 4° 16' 5'' east. The altitude is between 380 and 600mm above sea level while the mean annual temperature and rainfall are 27°C and 1247mm respectively (Google Earth Map, 2025).

Collection and Preparation of Mango leaf meal

Mango leaves were harvested within the vicinity of Teaching and Research Farm, LAUTECH, Ogbomoso, Oyo State. Consequently, the leaves were rinsed under running tap water to remove dirt and contaminants. The rinsed mango leaves were shade dried for seven days until it becomes crispy to touch while retaining the greenish colour. The dried mango leaves were milled into meal using a Gasa blender with model number QBL-20140 until they could pass through a 0.5mm screen and stored in airtight bottles till required for analysis and feeding.

Experimental Rabbits, Diets and Management

A total of eighteen (18) mixed sex, mixed breeds (6-8 weeks old), weighing between 600 - 800g were used for the experiment. The rabbits were procured from a stock kept in the University Teaching and Research Farm, Ogbomoso, Nigeria and from a reputable farm in Ibadan. The rabbits were individually housed in a two-tier wire mesh cage and tagged. Each of the cells were equipped with well fitted metallic feeder and bottle nipple drinkers capable of reducing feed and water wastage respectively. The cage was located inside the building with the side wall made of wire mesh to allow adequate ventilation. The rabbits were divided into three dietary treatment groups and six replicates i.e six rabbit growers per treatment. The rabbits were individually weighed, tagged and weight balanced, and randomly assigned to the treatments. Prior to the start of the study, the rabbits were fed the same diet and were allowed adjustment period of one week to enable them get acquainted with the cage. The rabbits were dewormed and appropriate medications administered before the start of the experiment. Rabbits were randomly allotted into three dietary treatments in which MLM were incorporated into their diets at varying inclusion levels of 0, 5 and 10% to replace wheat offal on a weight for weight basis. The diet composition is as shown in Table 1. Feed and water were provided *ad-libitum* throughout the experimental period of eight weeks. At the end of eight weeks, three rabbits per treatment were selected for carcass evaluation. The rabbits were starved overnight to clear the gut but drinking water was provided. The rabbits were slaughtered, drained of blood and eviscerated (Deltoro and Lopez, 1986). The hot dressed carcasses were weighed and compared with the live weight to obtain the carcass yield (dressing percentage). The carcasses were cut into prime parts and weighed. The internal organs and gut contents were also excised, weighed and expressed as a percentage of live weight. The rabbit's meat composition was determined on treatment basis by taking five grams of muscle from the left thigh muscles for the determination of dry matter, crude protein, ash and ether extract. Meat technological qualities according to Lee *et al.* (2015) were carried out to determine the ph, cooking loss and thermal shortening. The meat samples from each treatment were cut into pieces and boiled for 30 minutes at 60^{o}C with no spices added to the meat, wrapped in impervious polythene bags. After boiling, they were allowed to cool and the boiled meat samples were served to 10 members panelist that evaluated the meat for color, flavor, tenderness, texture, juiciness and overall acceptability. The panelists were given biscuit and water to rinse their mouth after each chewing to eliminate any form of taste error. The semi-trained panelists assess the attributes from preference testing using a 9-point Hedonic scale (1=dislike extremely, 9= like extremely). The proximate analysis of the diets, meat samples and mango leaf meal were determined on triplicate basis using AOAC (2023).

Statistical Analysis

Data collected were analyzed using one-way analysis of variance of SAS (2005), the significant differences between means were compared at 5% level of significance using Duncan multiple range tests of the sample.

Results and Discussion

Table 2 shows the proximate composition of dried mango leaf meal. The dry matter, crude protein, ash, crude fibre, ether extract, nitrogen free extract and metabolizable energy were 92.17 ± 0.04%, 9.63 ±0.54%, 13.26 ± 0.25%, 17.83 ± 0.41%, 2.05 ± 0.24%, 49.41 ± 0.91% and 2278.06 ± 0.02% respectively. The results of this study showed that the dry matter, ash, crude fibre, nitrogen-free extract, and metabolisable energy content of the mango leaf meal (MLM) were slightly higher than the values reported by Clement (2025), which were 81.49 ± 1.09%, 12.61 ± 3.26%, 16.29 ± 3.34%, 38.82 ± 4.87%, and 2278.06 ± 0.02%, respectively. However, the crude protein and ether extract contents obtained in this study were lower than Clement (2025) reported values; 19.56 ± 2.48% and 4.67 ± 1.09% respectively. Most of the parameters measured in this investigation were greater than those found by Ali *et al.* (2020). Also, the crude protein obtained in this study were lower when compared with value (14.05%) reported by Ogunsipe and Ibidapo (2021) The variations in proximate composition among studies may be attributed to factors such as differences in geographic location and the maturity stage of the leaves at the time of harvest. Nonetheless, the overall composition of MLM in this study indicates that it is a nutritionally viable feed resource for livestock.

Presented in Table 3 is the carcass, organ and intestinal measurements of growing rabbits fed dietary mango leaf meal. Dietary MLM had no significant (P>0.05) difference on the carcass characteristics of growing rabbits except the live weight and head. Rabbits fed dietary 0 (1533.33g) and 5 (1526.67g) % MLM had similar (P>0.05) values but significantly higher than those on 10% MLM (1286.67g). The relative weight of growing rabbit's head was highest in rabbits fed 0% MLM (9.14%) followed by 10% MLM (8.28% MLM) and 5% MLM (7.43%) respectively. A reduction in live weight at the highest inclusion rate reflects a common dose-dependent response observed with phenolic compounds (Tuntawiroon *et al.*, 1991). However, consistent dressing percentages across treatment groups suggested that carcass productivity were not compromised. This observation was in agreement with findings from previous studies where rabbits fed bamboo and moringa leaf meals maintained stable carcass output (Abubakar *et al.*, 2015; Osman *et al.*, 2023). Furthermore, the relative weights of internal organs and gastrointestinal segments remained unaffected by the inclusion of MLM in the diet. This stability in visceral and intestinal parameters implies that metabolic functions and digestive health were not negatively impacted, which aligned with earlier research involving mango leaf and other tree-derived supplements (Ogunsipe and Ibidapo, 2021; Animashahun *et al.*, 2024). Overall, these outcomes indicate that moderate MLM supplementation (up to 5%) maintains carcass quality and organ development, reinforcing its potential for cost-effective and sustainable rabbit production.

Table 1: Gross Composition of the experimental diets (%)

Ingredients, %	0% MLM	5% MLM	10% MLM
Maize	10.00	10.00	10.00
Corn offal	13.80	13.80	13.80
Soya bean meal	15.00	15.00	15.00
Mango leaf meal	0.00	5.00	10.00
Wheat offal	40.00	35.00	30.00
Rice milling waste	15.00	15.00	15.00
Fish meal (72%)	2.00	2.00	2.00
Dicalcium Phosphates	2.50	2.50	2.50
Limestone	1.00	1.00	1.00
Grower Premix[a]	0.25	0.25	0.25
Salt	0.25	0.25	0.25
Methionine	0.20	0.20	0.20
Total	100.00	100.00	100.00
Determined nutrient composition (%)			
Dry Matter	91.61	90.20	92.92
Crude Protein	18.61	16.65	17.52
Ether extract	1.47	2.99	2.88
Crude fibre	11.68	10.51	11.08
Ash	11.02	10.30	10.29
Nitrogen free extract	48.84	49.75	50.46

[a]Premix supplied/kg diet: Vitamin A (14,000,000 I.U.), Vitamin D3 (3,500,000 I.U), Vitamin E (20,000 I.U.), Vitamin K (2,400mg), Vitamin B1 (1,800mg), Vitamin B2 (5,000mg), Vitamin B6 (1,800mg), VitaminB12 (12mg), Niacin (18,400mg), Pantothenic acid (6,000mg), Folic acid (700mg), Biotin (50mg), Choline (240,000mg), Manganese (96,000mg), Zinc (60,000mg), Iron (40,000mg), Copper (8,000mg), Iodine (1,400mg), Selenium (240mg), Cobalt (250ml

[b] Calculated

Table 2: Proximate composition of mango leaf meal

Parameters (%)	Mango leaf meal
Dry matter	92.17 ± 0.04
Crude protein	9.63 ±0.54
Ash	13.26 ± 0.25
Crude fibre	17.83 ± 0.41
Ether extract	2.05 ± 0.24
Nitrogen free extract	49.41 ± 0.91
[a]Metabolizable energy (Kcal/kg)	2278.06 ± 0.02

** Means of four determinations
[a]Calculated using Pauzenga (1985)

Indicated in Table 4 is the meat composition, pH, cooking loss, and thermal loss of growing rabbits fed dietary mango leaf meal. Dietary MLM had significant ($P<0.05$) influence on the meat quality attributes of growing rabbits observed in this study except the cooking and thermal loss. The dry matter (87.43 – 89.35%) and crude protein (22.55-25.98%) content of the meat sample of rabbits fed dietary MLM increased across the dietary treatments as MLM inclusion levels increased. The inclusion of mango leaf meal (MLM) in rabbit diets significantly improved the nutritional composition of the meat, as reflected by increased dry matter and crude protein content. This enhancement is likely attributed to the presence of bioactive compounds in mango leaves, particularly mangiferin and phenolic antioxidants (Pan *et al.,* 2018), which contribute to the overall nutritive value and functional quality of the meat. This nutrient augmentation aligns with the findings of Peiretti *et al.* (2017), who showed that phenolic compounds can improve meat composition without detriment. The crude fibre content varied significantly across the dietary treatment in which rabbits fed 10% MLM (1.17%) recorded the highest value followed by those on 0% MLM (1.06%) and 5% MLM (0.30%) respectively. The meat sample of rabbits fed dietary MLM had significant higher ether extract when compared with those in control. Ash content varied significantly across the dietary treatments in which rabbits fed 0% MLM (8.73%) recorded the highest value while the lowest value was obtained in those fed 5% MLM (5.57%). The meat sample of the experimental rabbits on 0% MLM (7.03) and 10% MLM (7.04) had similar pH value but significantly higher than those on 5 % MLM (6.86). Meat pH exhibited variation across MLM inclusion levels, resembling trends seen in rabbit studies using *Allium cepa* skin and other plant-based supplements (Assan, 2018). The non-significant in cooking and thermal loss across the dietary treatments, indicated an improvement in the meat's water-holding capacity. This observation aligns with previous findings that leaf meal supplementation can enhance meat juiciness without adversely affecting processing yield (Das *et al.,* 2024).These results reinforced the prior research conducted by Oloruntola *et al.* (2025) who confirmed that dietary mango leaf meal does not impair carcass or meat attributes. The interplay of enhanced nutrient density, stable pH, and retained juiciness underscores MLM’s potential as a functional feed component in rabbit production.

Table 3: Carcass, organ and intestinal measurements of growing rabbits fed dietary mango leaf meal

Parameters (%LW)	0% MLM	5% MLM	10% MLM	SEM	P value
Live Weight (g)	1533.33[a]	1526.67[a]	1286.67[b]	46.08	0.01
Dressed weight	63.08	62.59	60.07	1.10	0.55
Head	9.14[a]	7.43[b]	8.28[ab]	0.30	0.03
Chest	9.14	9.62	10.45	0.37	0.41
Forelimbs	9.14	8.30	8.76	0.28	0.52
Hindlimbs	21.76	21.85	23.15	0.71	0.73
Loin	13.06	14.86	14.86	0.42	0.25
Liver	3.24	3.57	2.92	0.21	0.53
Kidney	0.57	0.59	0.62	0.03	0.83
Lung	0.55	0.48	0.59	0.04	0.60
Heart	0.31	0.24	0.26	0.01	0.17
Small intestine	2.96	3.55	3.06	0.40	0.85
Large intestine	0.52	0.68	0.49	0.05	0.23
Stomach	3.68	6.00	4.69	0.46	0.11
Caecum	7.18	6.80	8.13	0.31	0.22

[abc]Means along the same row with different superscripts are significantly different (P<0.05)

Table 4: Meat composition, pH, cooking loss and thermal loss in growing rabbits fed dietary mango leaf meal

Parameters	0% MLM	5% MLM	10% MLM	SEM	P value
Dry matter, %	87.43[b]	87.79[b]	89.35[a]	0.35	0.03
Crude Protein, %	22.55[c]	25.54[b]	25.98[a]	0.54	0.03
Crude Fibre, %	1.06[b]	0.30[c]	1.17[a]	0.14	0.39
Ether extract, %	5.01[b]	9.20[a]	9.90[a]	0.79	0.49
Ash, %	8.73[a]	5.57[c]	7.64[b]	0.46	0.07
pH	7.03[a]	6.86[b]	7.04[a]	0.03	0.04
Cooking loss (%)	10.31	14.86	15.01	1.53	1.02
Thermal Loss (%)	11.42	11.38	12.18	1.35	0.03

[abc]Means along the same row with different superscripts are significantly different (P<0.05)

Indicated in Table 5 is the organoleptic indices of meat from growing rabbits fed dietary mango leaf meal. Dietary mango leaf meal (MLM) had no significant (P>0.05) influence on the organoleptic indices of meat except the juiciness. Juiciness of meat from growing rabbits fed dietary MLM significantly increased across the dietary treatments as MLM inclusion level increased. Sensory qualities like flavour, juiciness, and texture are key to meat quality and consumer appeal, and they can be positively influenced by diets enriched with bioactive leaf meals (Džinić *et al.*, 2015). The inclusion of mango leaf meal (MLM) in rabbit diets significantly enhanced meat juiciness, which might be attributed to influence of phytochemicals present in the leaves. This observation is consistent with previous findings that phytochemicals influence the water-holding capacity of meat samples, which also improved juiciness and overall acceptability without affecting cooking yield (Biswas *et al.,* 2021). Other sensory attributes such as colour, flavour, tenderness, texture, and overall acceptability remained unaffected, suggesting that MLM selectively enhances certain palatability traits without compromising the overall sensory quality. Similar trends have been observed in studies involving mulberry and cassava leaf meals, where meat quality was preserved even at higher inclusion levels. Collectively, these findings highlight MLM's potential to enhance specific sensory properties particularly juiciness while maintaining overall meat quality, supporting its role as a valuable functional feed additive in rabbit production.

Table 5: Organoleptic indices of meat from growing rabbits fed dietary mango leaf meal

Parameters	0% MLM	5% MLM	10% MLM	SEM	P value
Colour	5.30	4.30	3.90	0.46	0.79
Flavour	4.20	4.90	4.20	0.38	0.35
Tenderness	5.60	6.10	4.60	0.34	1.80
Juiciness	4.10^{b}	5.20^{ab}	5.60^{a}	0.27	0.02
Texture	5.80	6.10	5.80	0.29	0.11
Overall Acceptance	6.10	6.90	5.70	0.26	1.94

^{abc} Mean's along the same row with different superscripts are significantly different (P<0.05)

Conclusion

Based on the results obtained in this study it can be concluded that;

- Mango leaf meal (MLM) exhibited high levels of dry matter, ash, crude fibre, nitrogen-free extract, and metabolizable energy.
- Dietary inclusion of mango leaf meal (MLM) up to 10% significantly enhances the nutritional composition of rabbit meat, particularly in terms of dry matter and crude protein content.
- The inclusion of mango leaf meal (MLM) up to 10% in rabbit's diets significantly improves meat's juiciness

Recommendation

Based on the outcomes of this study;

- It is recommended that mango (*Mangifera indica*) leaf meal be incorporated at levels up to 10% in the diets of growing rabbits as a partial replacement for conventional feed ingredients such as wheat offal.
- Evaluate the long-term effects of dietary MLM on reproductive performance, immune response, and meat shelf life.
- Additionally, standardized processing methods for MLM should be developed to optimize its safety, palatability, and nutrient availability in commercial rabbit production systems.

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