



The Effect of Cassava Leaf Meal (*Manihot esculenta*) Substitution in Commercial Rations on The Non-carcass Performance of Quails

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Jambura Journal of Animal Science, Volume: x, Issue: x, Nov, 2024

Keywords:

cassava leaf meal (*Manihot esculenta*); quail; non-carcass weight; non-carcass percentage

Abstract: This study aimed to evaluate the effect of cassava leaf meal (*Manihot esculenta*) substitution in feed on the non-carcass performance of quails. The method used was a completely randomized design (CRD) with five treatments and four replications, involving a total of 140 quails. The feed treatments were as follows: P0 (100% commercial feed), P1 (96% commercial feed + 4% cassava leaf meal), P2 (94% commercial feed + 6% cassava leaf meal), P3 (92% commercial feed + 8% cassava leaf meal), and P4 (90% commercial feed + 10% cassava leaf meal). Variables observed in this study included non-carcass weight, non-carcass percentage, and the weights of non-carcass components such as the head, neck, blood, feet, and feathers. The collected data were analyzed using analysis of variance (ANOVA) at a 5% significance level, followed by a Least Significant Difference (LSD) test if significant differences ($P < 0.05$) were observed. The results showed that cassava leaf meal significantly affected ($P < 0.05$) non-carcass weight, non-carcass percentage, and the weights of the head and neck but had no significant effect ($P > 0.05$) on the weights of blood, feet, and feathers. The LSD test indicated that for non-carcass weight, the control treatment (P0) significantly differed from all other treatments (P1, P2, P3, P4), and P1 significantly differed from P3 and P4, while P2 did not significantly differ from P3 and P4. For non-carcass percentage, P1 significantly differed from P2, P3, and P4 but did not differ from P0, whereas P0 significantly differed from P2, P3, and P4. For head weight, P1 significantly differed from P0, while for neck weight, P0 significantly differed from all other treatments. It can be concluded that cassava leaf meal can be used as a substitute in quail feed to improve non-carcass performance, particularly in the treatment of 96% commercial feed + 4% cassava leaf meal.

Citation APA Style:

Rifai, A., Fathan, S., Gubali, S., Sayuti, M., Zainudin, S. 2025. The effect of cassava leaf meal (*Manihot esculenta*) substitution in commercial rations on the non-carcass performance of quails. *Jambura Journal of Animal Science*, 8(1), 54–64.

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INTRODUCTION

Quails (*Coturnix coturnix japonica*) are a type of poultry with significant potential for providing animal protein, both as egg and meat producers. The increasing market demand for quails is aligned with population growth and greater public awareness of the importance of balanced nutrition. Quails also offer economic advantages due to their ease of care, efficient land use, and feed-saving characteristics.

Feed is a crucial component in the success of quail farming, accounting for approximately 60-70% of total production costs. To enhance production efficiency and reduce feed costs, alternative feed ingredients that are economical and easily accessible are required. One potential feed ingredient is cassava leaves (*Manihot esculenta*), which are high in protein. Baharuddin et al. (2023) reported that cassava leaves are rich in protein and beta-carotene, making them a promising alternative feed ingredient. However, cassava leaves contain antinutritional compounds such as hydrogen cyanide (HCN), necessitating specific treatments before use as feed.

Previous research by Pratama et al. (2020) demonstrated that adding cassava leaf meal at a 9% level in quail feed increased feed intake from 272.44 g/bird/day to 305.38 g/bird/day. This finding indicates that the protein content in cassava leaf meal can enhance feed intake, potentially improving livestock performance. Additionally, research by Latif and Müller (2015) found that the crude protein content of cassava leaves ranges from 17.7% to 38.1%, making it a viable feed source for quails.

The limited studies specifically exploring the effects of feed ingredients on non-carcass weight in quails highlight a knowledge gap that warrants further investigation. This study aims to evaluate the effects of using cassava leaf meal on overall non-carcass weight, including non-carcass components such as the weight of the head, neck, blood, feet, and feathers. Furthermore, this research is expected to provide in-depth insights into the potential of cassava leaves as an economical and nutrient-rich alternative feed ingredient.

MATERIALS AND METHODS

This research was conducted from June to August 2024, at the experimental farm in Helumo Village, Tilongkabila District, Bone Bolango Regency, Gorontalo Province. Data collection took place in the Poultry and Livestock Production Laboratory, Department of Animal Science, Faculty of Agriculture, State University of Gorontalo.

The materials used in this study included quails, commercial feed BR-21E, cassava leaf meal (*Manihot esculenta*), Vitachick, 70% alcohol, water, and disinfectant. A total of 140 quails, 14 days old, were obtained from local farmers in Tamboo Village, Tilongkabila District, Bone Bolango Regency, Gorontalo. The selection of this source was based on the fact that the farmers provided quails with proper husbandry standards for the purpose of the study, and the quails were in good health to ensure sample homogeneity.

The research equipment included a digital scale, trays, blender, feeders and drinkers, battery cages, cardboard, tissue paper, buckets, stationery, camera, surgical knife, surgical clamps, gloves, masks, Petri dishes, and sample plastic bags.

Research Procedure

Cages and Equipment

The cages used in this study were tiered battery cages consisting of 20 compartments. Each compartment measures 40 cm × 40 cm × 30 cm and is made from wire and wood, with each compartment housing 7 quails. The cages were designed with wooden slats and wire mesh, and were equipped with feeders and drinkers. Incandescent bulbs were used for lighting during the night. Beneath the cages, sacks were placed to collect the quail droppings. Once the sacks were full, they were cleaned to maintain the health of the quails and prevent ammonia odor from the droppings.

Feed and Drinking Water

The feed used in this study was BR-21E, produced by PT Sinta Prima Feedmill. The drinking water was sourced from the local water utility (PDAM).

Cassava Leaves

The cassava leaves used in this study were obtained from around residential areas in Gorontalo City. The cassava leaf tips were washed with running water, then sun-dried for approximately 5 hours a day over a period of 3 days until dry. After drying, the leaves were blended into a powder and sifted to obtain fine cassava leaf meal. The cassava leaf meal was then placed in labeled plastic bags according to the treatment groups.

Quail Preparation

The quail rearing began at 14 days of age. Upon arrival, the quails were given Vitachick and sugar water to reduce stress from transportation. The quails were then provided with the experimental feed according to the formulated treatments established in the study.

Randomization of Quails

A total of 200 quails (100 males and 100 females) were initially prepared and weighed to determine their average body weight. Then, 140 quails with body weights closest to the average were selected. These 140 quails were randomly assigned to the experimental units. Each experimental unit contained 7 quails with similar body weights.

Feed Mixing

The feed was mixed daily, with ingredients weighed according to the required amounts. The mixing process started with the ingredient that made up the largest portion, followed by the ingredients in smaller amounts. After mixing, the prepared feed was placed into plastic bags labeled according to the respective treatment groups.

Feed and Water Administration

Feed and water were provided ad libitum. The feed was given three times a day: in the morning, afternoon, and evening. Each morning, the leftover feed from the previous day was weighed to determine the daily feed consumption.

Quail Weighing

The quails were weighed at the beginning of the study and at each replication. Weekly weighing was conducted to monitor the growth and development of the quails during the rearing period.

Sample Collection

At the end of the study, after 4 weeks of treatment (when the quails reached 42 days of age), the quails from each treatment group were weighed. Three quails from each treatment group with weights close to the average were selected for sampling. The total sample size consisted of 60 quails.

Quail Slaughtering

The quails to be slaughtered were fasted for 6 hours, while water was still provided. This procedure aimed to reduce variations in carcass weight due to the content of the digestive tract. After fasting, the body weight of each quail was measured and recorded in grams to obtain live weight. A container was prepared to collect blood during the slaughtering process to determine blood weight, and a sharp knife was used for the slaughtering.

The slaughtering process followed Islamic principles, involving the cutting of the jugular vein, carotid artery, and esophagus at the upper neck near the head. After slaughtering, the feathers were manually plucked and placed in sample bags for weighing to determine feather weight.

Next, the head and legs were removed. The head was separated from the neck by cutting at the atlanto-occipital joint, and the head was weighed to determine head weight. The neck was separated from the quail body at the cervical bone junction (between the occipital bone and atlas), and the weight of the neck was recorded. The legs were removed by cutting at the joint between the tarsal and tibia bones, and the weight of the legs was measured.

Subsequently, the internal organs, including the digestive tract and abdominal fat, were removed. The remaining body parts, excluding the separated ones, were weighed to obtain the carcass weight. The non-carcass weight in this study was obtained by subtracting the carcass weight from the live weight. The percentage of non-carcass was calculated by dividing the non-carcass weight by the live weight and multiplying the result by 100%.

Observation Variables

The observed variables in this study were non-carcass weight (grams), non-carcass percentage (%), as well as the weight of the head, neck, blood, legs, and feathers (grams).

Experimental Design

This study used an experimental method with a completely randomized design (CRD) in a non-factorial arrangement. There were 5 treatments and 4 replications, resulting in a total of 20 experimental units. The study involved substituting cassava leaf meal in the feed at various concentrations. The treatments were as follows:

- P0: 100% commercial feed
- P1: 96% commercial feed + 4% cassava leaf meal
- P2: 94% commercial feed + 6% cassava leaf meal
- P3: 92% commercial feed + 8% cassava leaf meal
- P4: 90% commercial feed + 10% cassava leaf meal

Table 1. Nutritional Requirements of Quail

Nutrient	Starter	Grower	Layer
Moisture content (%)	max. 14	max. 14	max. 14
Crude Protein (%)	min. 19	min. 17	min. 17
Energy (kcal/mg)	min. 2800	min. 2600	min. 2700
Lysine (%)	min. 1.1	min. 0.8	min. 0.9
Methionine (%)	min. 0.4	min. 0.35	min. 0.4
Methionine+Cystine (%)	min. 0.6	min. 0.5	min. 0.6
Calcium (%)	0,9 - 1.2	0,9 - 1,2	0.9 - 1.2
Fat (%)	max. 7	max. 7	max. 7
Fiber (%)	max. 7	max. 7	max. 7
Phosphorus (%)	0.6 - 1.1	0.6 - 1.1	0.6 - 1.1

Source: Standar Nasional Indonesia (2008)

Table 2. Nutritional Content of Commercial Feed BR-21E

Nutrient	Amount (%)
Moisture content	max. 12
Crude protein	20-22
Crude fat	min. 5
Crude fiber	max. 5
Ash	max. 8
Phosphorus	0,5
Calcium	0.8-1.1
Aflatoxin	max. 50 ppb

Source: PT Sinta Prima Feedmill (2024)

Table 3. Nutrient Content of Cassava Leaf Meal

Nutrient	Amount (%)
Moisture content	8.39
Crude Protein	24.81
Fat	14.65
Crude fiber	21.52
Ash	6.78
Calcium	1.2 - 2.5
Phosphorus	0.2 - 0.5

Source: (Widowati, 2022)

Table 4. Feed Formulation Composition

Feed Ingredient	Treatment				
	P0	P1	P2	P3	P4
BR21-E Feed	100	96	94	92	90
Cassava Leaf Meal	0	4	6	8	10
Total (%)	100	100	100	100	100

Table 5. Nutrient Components of Feed

Nutrient Composition	Treatment				
	P0	P1	P2	P3	P4
Dry Matter (%)	88	88.14	88.22	88.29	88.36
Protein (%)	22	22.11	22.17	22.22	22.28
Crude Fiber (%)	4	4.7	5.05	5.4	5.75
Fat (%)	5	5.39	5.58	5.77	5.97
Calcium (%)	0.8	0.8	0.8	0.8	0.8
Phosphorus (%)	0.5	0.5	0.5	0.5	0.5
Metabolizable Energy (kcal/kg)	3084	3084.56	3084.84	3085.12	3085.4

Data Analysis

The data obtained were analyzed using Analysis of Variance (ANOVA). If the analysis shows significant differences ($P < 0.05$), a Least Significant Difference (LSD) test is conducted to determine which treatments are significantly different.

RESULTS AND DISCUSSION

Table 6. Non-Carcass Weight, Non-Carcass Percentage and Non-Carcass Part Weight of Quail

Variable	Treatment				
	P0	P1	P2	P3	P4
Non-Carcass Weight (g)	79,790 ^a	75,240 ^a	65,853 ^b	61,476 ^b	62,468 ^b
Non-Carcass Percentage (%)	44,185 ^{ab}	45,126 ^a	42,064 ^{bc}	39,881 ^{cd}	39,749 ^d
Weight of Non-Carcass Parts:					
Head Weight (g)	6,721 ^a	6,083 ^a	6,086 ^a	6,311 ^a	6,134 ^b
Neck Weight (g)	5,116 ^a	4,064 ^a	4,003 ^a	3,965 ^a	4,057 ^b
Blood Weight (g)	5,397	5,204	4,893	4,461	5,345
Leg Weight (g)	3,183	2,975	2,975	3,118	2,980
Feather Weight (g)	8,191	7,706	8,080	8,340	8,410

Description: ^{abcd}Different superscript letter notations on the same line show a noticeable difference ($P < 0.05$)

Non-Carcass Weight

The results of the study in Table 6 statistically show a significant effect ($P < 0.05$) on the non-carcass weight of quail. Based on the analysis of variance, the differences in the average between treatments were further tested using the LSD (Least Significant Difference) test.

The calculations showed: the difference between treatments P0 and P1 was 4.55, smaller than the LSD value of 6.936, thus this difference was not significant ($P > 0.05$). The difference between P0 and P2 was 13.937, greater than the LSD value of 6.936, indicating that the difference was significant ($P < 0.05$). The difference between P0 and P3 was 18.314, greater than the LSD value of 6.936, so it was considered significant ($P < 0.05$). The difference between P0 and P4 was 17.322, greater than the LSD value of 6.936, meaning this difference was significant ($P < 0.05$).

The differences between other treatments showed: P1 and P2 had a difference of 9.387, greater than the LSD value of 6.936, so the difference was significant ($P < 0.05$). P1 and P3 had a difference of 13.764, greater than the LSD value of 6.936, indicating a significant difference ($P < 0.05$). P1 and P4 had a difference of 12.772, greater than the LSD value of 6.936, thus the difference was significant ($P < 0.05$). P2 and P3 had a difference of 4.377, smaller than the LSD value of 6.936, so this difference was not significant ($P > 0.05$). P2 and P4 had a difference of 3.385, smaller than the LSD value of 6.936, meaning the difference was not significant ($P > 0.05$). P3 and P4 had a difference of 0.992, smaller than the LSD value of 6.936, so the difference was not significant ($P > 0.05$).

In this study, the use of cassava leaf flour as a substitute in the feed resulted in varying non-carcass weights among treatments. The highest to lowest average non-carcass weights were as follows: P0: 79.790 ± 5.659 g/bird; P1: 75.240 ± 4.349 g/bird; P2: 65.853 ± 4.541 g/bird; P4: 62.476 ± 4.089 g/bird; P3: 61.476 ± 4.089 g/bird.

These results indicate that cassava leaf flour can be used as an alternative protein source in feed without significantly reducing the quality of non-carcass weight, although a significant effect was observed in some treatments.

This study's results differ from Setyaningrum et al. (2023), which used yam tuber flour (*Dioscorea esculenta*) as a feed substitute. In their study, the treatments used were P0 (basal feed), P1 (basal feed + 0.3% yam tuber flour), P2 (basal feed + 0.6% yam tuber flour), and P3 (basal feed + 0.9% yam tuber flour). The highest average live weight was found in treatment P2, at 111.53 g with a carcass percentage of 64.28%. Although this study did not directly present non-carcass weight data, calculations based on available data showed that the highest non-carcass weight was found in treatment P3, at 40.81 g. This difference can be explained by the role of yam tuber as an additional energy source due to its high carbohydrate content (31.30 g) (Sabda et al., 2019). However, its effect on non-carcass weight was lower compared to cassava leaf flour, which has a higher protein content (24.81%) compared to yam tuber flour (8.66%) (Herlina et al., 2015). The high protein content in cassava leaf flour supports digestion efficiency and nutrient utilization in quail.

The findings of this study also differ from those of Helda et al. (2022), who used FMplus probiotics as a supplement in drinking water. The treatments in their study included R0 (commercial feed + 0% FMplus probiotics in 240 ml drinking water), R1 (commercial feed + 0.5% FMplus probiotics), R2 (commercial feed + 1% FMplus probiotics), and R3 (commercial feed + 1.5% FMplus probiotics). The highest average live weight was found in treatment R3, at 149.60 g, while the highest carcass weight was found in treatment R2, at 109.53 g. Based on calculations, the highest non-carcass weight was found in treatment R3, at 43.83 g. This result was due to the role of microorganisms in probiotics that improve metabolism, digestion, and nutrient absorption in livestock. Moreover, FMplus probiotics, containing multiple strains of bacteria, were likely more effective in increasing live weight and contributing to better non-carcass weight.

The differences in average non-carcass weight in this study were influenced by the live weight of the quail. Quail fed with feed without cassava leaf flour (*Manihot esculenta*) had higher live weight, while the use of cassava leaf flour reduced non-carcass weight. This decrease was due to reduced feed palatability caused by anti-nutritional substances such as tannins and saponins found in cassava leaves. Saponins impart a bitter taste to the feed, which can reduce feed consumption and cause anorexia (Hasiib & Hartono, 2015). These anti-nutritional factors limit the efficiency of cassava leaf flour as an ingredient in poultry feed, despite its high protein content.

Nurwahyuni et al. (2023) added that the increase in non-carcass weight is influenced by feed consumption. This is due to the amount of feed consumed by livestock, which is one of the important factors directly affecting livestock productivity (Ariani et al., 2023), including non-carcass weight, which is part of the body weight.

Non-Carcass Percentage

Based on the analysis of variance (Table 6), the effect of cassava leaf flour substitution on the non-carcass percentage variable showed a significant difference ($P>0.05$). The highest average was obtained from treatment P1 at 45.126%, with the addition of 4% cassava leaf flour, which was able to increase by 0.9% compared to P0. The increase in cassava leaf flour substitution from 4% to 10% showed a decline in the non-carcass percentage. The lowest average was found in P4 at 39.749%, which was still 0.77% higher than the study by Renaldi et al. (2022), which reported a value of 38.973% using *Physalis* (ciplukan) flour.

The analysis of variance showed differences in the average between treatments, tested using the LSD (Least Significant Difference) test. The calculations indicated that the average difference between P1 and P0 was 0.942, which is smaller than the LSD value of 2.299, meaning the difference between these two treatments was not significant ($P>0.05$). On the other hand, the average difference between P1 and P2 was 3.062, which is greater than the LSD value, and thus the difference was significant ($P<0.05$). The average difference between P1 and P3 was 5.245, and between P1 and P4 was 5.377, both greater than the LSD value, indicating that the differences in these comparisons were significant ($P<0.05$).

Furthermore, the calculations for the comparison of P0 and P2 showed an average difference of 2.121, which is smaller than the LSD value of 2.299. Therefore, the difference between these two treatments was not significant ($P>0.05$). In contrast, the comparison between P0 and P3 resulted in an average difference of 4.303, greater than the LSD value, indicating a significant difference ($P<0.05$). The average difference between P0 and P4 was 4.436, also greater than the LSD value, so this difference was significant ($P<0.05$).

For the comparison between P2 and P3, the average difference of 2.183 was smaller than the LSD value of 2.299, indicating that the difference between these two treatments was not significant ($P>0.05$). However, the average difference between P2 and P4 was 2.315, which was greater than the LSD value, and therefore the difference was significant ($P<0.05$). Meanwhile, the comparison between P3 and P4 produced an average difference of 0.133, smaller than the LSD value, indicating that the difference between these two treatments was not significant ($P>0.05$).

The results of this study show that cassava leaf flour substitution has a significant effect on certain variables, especially in treatments with higher substitution levels. However, some comparisons showed no significant differences, reflecting the limits of the substitution's influence on the measured outcomes. Moreover, feed with cassava leaf flour substitution, balanced with nutrients, proved to be of good quality in supporting non-carcass percentages.

Factors such as age, livestock type, management practices, environment, and feed also played a role in influencing the results of this study. Additionally, the non-carcass percentage can be affected by feed ingredients that contain high levels of crude fiber, as this fiber content can reduce digestion efficiency and nutrient absorption (Purba & Prasetyo, 2014).

Law et al. (2023) stated that feed consumption levels influence the growth rate of livestock live weight. On the other hand, Djunu et al. (2024) added that quail growth will differ based on the protein content in the feed. The feed containing cassava leaf flour serves as an additional source of nutrition.

The results of this study are not in line with the findings of Kulsum et al. (2017), which revealed that higher protein content in the diet resulted in a higher average non-carcass percentage in quail. This difference may be due to the protein in the cassava leaf flour used in this study, which may have an imbalanced or suboptimal amino acid profile for poultry growth. Incomplete protein with essential amino acids may hinder growth and cause changes in body composition, including a decrease in non-carcass percentage.

Head Weight

The results of the study showed a significant effect ($P < 0.05$) on head weight. Treatment P0 had the highest average at 6.72 g/bird compared to the substitution of cassava leaf flour.

Calcium and phosphorus are essential nutrients for head growth (Rasyaf, 2008). Both play a crucial role in bone formation during poultry growth. The calcium content of 0.8% and phosphorus content of 0.5% in the feed treatment did not meet the minimum standards set by SNI (Ca 0.9-1.2%; P 0.6-1.1%), which affected bone development, including the head bones.

Weight of the Neck Section

Table 6 presents the average neck weight, which was significantly ($P < 0.05$) influenced by the feed treatment, with the highest value at P0 (5.116 g/bird) and the lowest at P3 (3.965 g/bird). Protein in animal feed affects growth, with digestibility in poultry reaching 75-90% (Lamiyah et al., 2022).

The similar crude protein content in the treatments, which ranged from 22-22.22%, led to similar protein absorption and metabolism processes into amino acids for growth and development. As a result, the increase in neck weight in quail did not align with the increase in cassava leaf flour substitution, with the weights being nearly the same across treatments.

Blood Weight

Statistically, it can be observed that the substitution of cassava leaf flour did not have a significant effect ($P > 0.05$) on blood weight. The highest to lowest average values were as follows: P0 5.4; P4 5.35; P1 5.2; P2 4.89; and P3 4.46 g/bird. Therefore, the blood percentage is around 3.1%, which is lower than the blood percentage obtained by Zaman et al. (2018), which was 8.74% in ducks. There is a relationship between blood weight and body weight; the larger the body weight, the higher the blood weight (Sunı et al., 2021).

Blood plays an important role in the metabolism of nutrients in livestock. This is because nutrients are distributed throughout the body via the circulatory system. The circulatory system also helps maintain the stability of the livestock's immune system, ensuring they stay healthy (Januardani et al., 2023). Antinutritional compounds inhibit nutrient absorption and affect metabolism.

Leg Weight

The analysis of variance shows that there was no significant effect ($P > 0.05$) on leg weight. The highest treatment was P0 with 3.183 g/bird, and the lowest was P1 with 2.965 g/bird. Ruhimat et al. (2022) mentioned that the feet are part of the poultry's legs, consisting of several components such as skin layers, cartilage, tendons or ligaments, and the bones that form the structure of the feet.

According to Latifah (2021), calcium plays a vital role in the formation and maintenance of bones. The leg bones are the main component that does not accumulate meat, and the legs are part of the body that matures earlier. Therefore, high calcium intake in the feed supports the normal growth of legs from P0 to P4, in proportion to body weight. The earlier growth of the legs causes the leg bone growth to stop earlier than other parts of the body, resulting in the legs having relatively lower weight compared to the total body weight as live weight increases.

Feather Weight

The results of the study showed no significant difference ($P > 0.05$) in feather weight. These findings are consistent with Kuntarto et al. (2019), who stated that the treatments given had no significant effect on feather weight because the range or difference in the levels of cassava leaf meal provided was not large enough. Feather weight is more influenced by the age factor, where the weight increases as the animal ages.

In this study, despite using cassava leaf meal as a feed substitution, the metabolizable energy content in each treatment actually increased, from 3084 kcal/kg in P0 to 3085.4 kcal/kg in P4. This increase in energy supports feather growth. Protein also plays a role in meeting the protein requirements for feather development. As stated by Widodo (2018), protein is essential for poultry as it helps repair damaged tissues, supports the growth of new tissues, provides amino acids, and aids in feather development.

Dustan and Nurdin (2024) mentioned that antinutritional compounds can inhibit nutrient absorption. These compounds can bind to proteins and minerals. However, in this study, the use of cassava leaf meal up to 10% did not significantly interfere with nutrient absorption. The combination of protein-rich and energy-dense feed ingredients, along with the increase in metabolizable energy, ensured that the quail still received sufficient nutrients for feather growth.

CONCLUSION

The use of cassava leaf meal (*Manihot esculenta*) as an alternative feed ingredient has been shown to influence non-carcass parameters in quail. These findings indicate that a 4% substitution in commercial feed can optimally support non-carcass performance. Considering its sustainability and availability as agricultural waste, cassava leaf meal holds significant potential to be integrated into modern animal feed formulations, although its antinutritional content requires careful management.

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