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Pelletized cassava *(Manihot esculenta)* leaf meal based diets on the performance of New Zealand white rabbits

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Abstract

The study was conducted to determine the growth performance of rabbits fed formulated ration with different levels of Cassava Leaf Meal (CLM) in terms of final weight, total weight gain, growth rate, total feed consumption, feed conversion ratio, and average daily gain. It is also conducted to determine the carcass recovery and its profitability. There were four (4) treatments considered in the study: Treatment 1-0% CLM/Control, Treatment 2-10% CLM, Treatment 3-20% CLM, and Treatment 4-30% CLM. The study was laid out in Completely Randomized Design with six (6) replications. The 5-6 week old rabbits were fed for eight (8) weeks under restricted feeding wherein feeds were given at 6:00 AM and 6:00 PM. Results showed significance on the growth performance parameters. Treatment 2 (10%CLM) had the highest weight gain, and growth rate, feed conversion ratio and the highest average daily gain at $P \leq 0.01$. In terms of economic advantage, Treatment 2 (10% CLM) gave the best return above feed cost with P195.87 income per rabbit and the cheapest cost of feed per kilogram weight gain at P61.63. It can be concluded that Treatment 2 (10% CLM) obtained the best result in the following parameters; weight gain, growth rate, feed conversion and average daily gain, return above feed cost and cost of feed per kilogram weight gain.

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Introduction

The rapid increase in the world population in general and in the Philippines in particular has aggravated the animal protein deficiency. The Organization for Economic Cooperation Development (OECD, 2017) reported that the estimated average animal protein consumption in the country is 28.8 kg annually or 78.9 g per capita/day as compared with 32.6 kg annually or 89.3 g per capita/day or even higher of animal protein consumed in first world countries. The increasing demand on animal protein indicates the need to intensify livestock production.

Poultry production which was seen as the quickest way to bridge this animal protein deficiency gap has been observed to be characterized by high cost of production due to high cost of feeds which accounts for more than 70-80% of the total production costs (Ojebiyi *et al.*, 2006). As a result of this high cost of production in the poultry sector, most of the livestock producers are shifting to other farm animals where the cost of production is tolerable; hence Rabbitry is fast becoming popular.

The rabbit has been identified to possess the potential of becoming an important source of animal protein with its ability to utilize efficiently forage, a cheaper feedstuff (Anugwa *et al.*, 1982). Though rabbits have found to perform best when fed on concentrates (Farinu, 1994), the ever increasing costs of grains has created a need to augment both the energy and protein requirement with forage in order to reduce the quantity of the more expensive feed ingredients. For any livestock enterprise to be profitable and sustainable, it has become necessary to find alternative cheap feedstuff that is high in protein which can adequately replace the more expensive and highly competitive ones (Akpodiete *et al.*, 1999). Farinu (1994) evaluated the effects of feeding a compound diet based on non-conventional feedstuffs on growth and organ characteristics of the rabbits and confirmed that it was economical to rear rabbits on mixed diet of concentrate and forage. Cassava (*Manihot esculenta*) is mainly grown for its tubers that are used as staple food or for starch but cassava foliage can be a valuable fodder. It is then cultivated as a semi-perennial forage that can be harvested several times per biological cycle (every two or three months) (Phengvilaysouk *et al.*, 2008). Cassava foliage can be fed fresh, but it is often preferable to dry it (cassava leaf meal) or ensile it as the leaves contain hydrogen cyanide that can be toxic to livestock.

Thus, the effects cassava leaf meal on the performance of rabbits and the combination of grain and forage as protein source may be used for the production of rabbits. This study, therefore, was conducted to determine the growth performance digestibility and cost benefits of feeding rabbits with different levels of cassava leaf meal in a pelletized diet as alternative source of protein with a view to making rabbit production economical, profitable and sustainable.

Materials and methods

Twenty four 7-8 week old New Zealand White Rabbits s were randomly distributed to five treatments with 10 broilers per replicate. The birds were fed with 4 different Cassava Leaf Meal (CLM) levels described as follows Treatment 1- 0% CLM, Treatment 2 10% CLM, Treatment 3 20% CP, and Treatment 4 30% CP. During the pre-feeding period, the rabbits were fed with a diet containing only 2% percent of pelletized Cassava Leaf Meal based diet for one week. They were only fed with their corresponding treatment formulated ration on their 7^{th} - 8^{th} week of age for 8 weeks. Restricted feeding was the type of system used in the study.

The rearing houses were provided with ceramic bowls for the rabbits to feed into. The feeders were filled with estimated amounts which they could consume in one day to prevent wastage due to spoilage. Feed were served twice daily at 06:00 AM and 6:00 PM. Feed offered and the left over were weighed to determine feed intake of the animals. Water was made available at all times through nipple tip automatic drinkers. The experimental cages for the rabbits were based on the recommended space requirement per rabbit.

Four long cages were made with a dimension of 40 x 40 x 240 cm. per cage and divided into 6 individual cages measuring 40 x 40 x 40 per hutch to contain the 24 heads of rabbits that were used for the whole duration of the study.

The cages were provided with a wood partition in between them to minimize interaction of the experimental animals. A nipple drinker is connected to a 500 ml mineral bottle with a hose in its individual cage was also provided to serve as an automatic drinker to the rabbits.

The rabbits were fed with the following ingredients: yellow corn, rice bran, soybean oil meal, coco oil, limestone, Tricaphos, DL-methionine, L-lysine, vitamin premix and salt. The different treatment formulations were computed based on the nutrient composition of each ingredient. All the ingredients were weighed individually based on the amounts calculated in the formulation and mixed manually by the use of shovel on concrete smooth flooring.

Data gathered and statistical analysis

The performance of the broiler chickens in the different treatment groups were evaluated based on average weight gain, feed consumption, feed conversion ratio. The carcass quality was determined by the percentage abdominal fat deposition.

The income over feed cost and broiler chicken cost analysis were estimated to determine the economic profitability. All data gathered were subjected to Analysis of Variance (ANOVA) using MEGASTAT (version 10.4) following a Completely Randomized Design (CRD). Significant differences among treatment means were compared using Least Significant Difference (LSD).

Results and discussion

Initial and bi-weekly body weights

The initial and bi-weekly body weight of growing rabbits is presented in Table 2. The initial body weight of the rabbits ranged from 1214.17 to 1262.50 grams.

Table 1. Composition and Calculated Nutrient Analysis of Formulated Diets Fed to Rabbits with Different Levels of Cassava Leaf Meal.

COMPOSITION	T1(0%CLM)	T2(10%CLM)	T3(20%CLM)	T4(30%CLM)
Corn	50.25	47.24	48.78	50
Rice Bran D1	13.1	12.3	8.0	5
Soybean Oil Meal	15	10	5	-
Fish Meal	2	2	3	4
Molasses	3	3	3	3
Copra meal	13	12	9	5.05
Cassava Leaf Meal	-	10	20	30
DL-Methionine	0.15	.16	.17	.18
L-Lysine	-	0.1	.2	.27
Limestone	1.3	1	.45	-
DicaPhos	1.4	1.4	1.6	1.7
Salt	0.3	0.3	0.3	0.3
Vit/Min Premix	0.5	0.5	0.5	0.5
Total (%)	100.00	100.00	100.00	100.00
Price/kg	16.18	14.53	13.40	12.20
	T1(0%CLM)	T2(10%CLM)	T3(20%CLM)	T4(30%CLM)
Calculated Analysis				
Crude Protein (%)	16.40	16.18	16.09	15.94
Metabolizable Energy (Kcal)	2772.29	2703.32	2676.79	2659.52
Calcium (%)	1.02	1.03	1.02	1.03
Available (%)Phosphorus	0.65	0.65	0.65	0.66
Methionine (%)	0.41	0.40	0.40	0.40
Lysine (%)	0.70	0.69	0.71	0.71

The final body weights of the rabbits showed significant results wherein T_2 (10% CLM) consistently had better weight with 2353.30 grams than T_3 (20% CLM) 2140.00 grams, T_1 (0% CLM/Control) 1927.50 grams and T_4 (30% CLM) with 18925.50 grams respectively. Comparison among means showed that T_2 (10% CLM) differed significantly with T_3 (20% CLM), T_1 (0% CLM/Control) and T_4 (30% CLM) at $P \leq 0.01$. On the other hand, T_3 (20% CLM) differed with T_1 (0% CLM/Control) and T_4 (30% CLM). The result of the study slightly confirms the findings of Ironkwe and Ukanwoko (2012) that final body weight was significantly reduced when cassava leaves were replaced over 50% of dietary maize. But in this study, weight significantly decreased at 30% level of CLM. This finding is completely opposite to the work of (Cheek *et al.*, 1987) when palatable greens are fed free choice, the amount of pelleted feed needed can be reduced by about 50 percent, with no adverse effects on performance.

Table 2. Average Cumulative Performance Values of Rabbits fed Different levels of Cassava Leaf Meal (CLM).

Performance Parameter	Treatment CLM levels				
	1	2	3	4	CV%
Initial Weight(g)	1262.50	1220.83	1250.00	1214.17	
Final Weight(g)	1924.00b	2353.00a	2140.00ab	1892.00b	8.17
Total Gain in Weight	657.5c	1132.50a	890.00b	678.33c	14.85
Growth Rate	7.50b	13.07a	14.32a	10.32a	12.91
Total Feed Consumption	3864.17c	4783.33a	4158.33b	4185.83b	10.20
Average Daily Gain	11.76c	20.22a	15.84b	12.11c	14.85
Feed Conversion Ratio	5.96b	4.24a	4.77a	6,30b	16.11

Means in the same row with different superscripts are significantly different ($P<0.01$).

Cumulative gain in weight

Based from the results obtained, T_2 (10% CLM) with 1132.5 grams significantly differed with T_1 (0% CLM Control) 657.5 grams and T_4 678.3 (30% CLM) grams at $P \leq 0.01$. Comparison of T_2 and the treatment mean of T_3 (20% CLM) 749.2 grams also resulted to significant differences at $P \leq 0.05$. On the other hand, when T_3 was compared with T_1 and T_4 significant results were obtained at $P \leq 0.05$.

The results showed that the inclusion of CLM at 10% and 20 % in the diet had better weight gain than the other treatments. This finding is comparable with the study of Omole and Odwudike (1983) that rabbits fed 15 to 30 % gained more weight. In this study 10 to 20% CLM had better gain in weight compared to other treatments.

Percentage rate of growth

The percentage rate of growth of the rabbits showed significant differences among treatments. Treatment 3 had the highest with 14.32, followed by T_2 with 13.07, T4 with 10.32 and T_1 with 7.54 percent. Comparison among means showed that T_3 and T_1 showed significant difference at $P \leq 0.01$ while T_2 and T_1 differed at $P \leq 0.05$. However, T_2, T_3 and T_4 did not vary significantly.

The findings of the study revealed that the animals with CLM performed better in their growth rate compared to the control diet in almost all of the bi-weekly observation period. The growth rate of T_2 (10% CLM) and T_3 (20% CLM) is comparable with the study of Omole and Onwudke (1983) that rabbits had better growth rate on the 15-30% levels compared to other treatments with higher CLM levels. This study is related to the findings of Akinfala *et al.* (2002) on his observation that replacing maize with either 12.5% or 25% whole cassava plant resulted in reduced growth rate of 13% and 19% respectively in broilers.

Cumulative feed consumption

The total feed consumption of the experimental rabbits revealed that, T_2 obtained the highest cumulative feed intake with 4783.3 grams followed by T_4 with 4185.8, T_3 with 4,158.3 and T_1 with 3864.2 grams. Analysis of variance on the data showed significant differences among treatments.

Table 3. Return above Feed Cost/ Economics of Feeding Rabbits with Different Levels of Cassava Leaf Meal-Based Diets.

	TREATMENTS			
ITEM	$T1_{21\%\ CP}$	$T2_{20\%CP}$	$T3_{19\%CP}$	$T4_{18\%CP}$
Cost				
Cost/kg feed	16.18	14.53	13.40	12.20
Total Cost/Treatment	375.14	417.00	334.32	306.40
Total Cost/Rabbit	62.52	69.50	55.72	51.07
Sales				
Cost/kg Dressed Rabbit	220	220	220	220
Total Sales/Treatment	1303.9	1592	1447.93	1280.40
Total Sales/Rabbit	217.32	265.37	241.32	213.40
Income/Rabbit	154.80	195.87	185.60	162.33
Cost of feed/kg weight gain (P)	97.79	61.63	63.38	76.83

(Cost of feed x FCR)

Comparison among treatment means revealed that T_2 significantly differed with T_1, T_3 and T_4 at $P \leq 0.01$. On the other hand, when T_3, T_4 and T_1 were compared, no variation existed.

This result is in accordance with the findings of Okonkwo *et al.* (2010) that forage free diet is not ideal for optimal performance of rabbits because it induces diarrhea resulting to reduction of feed consumption and weight gain that resulted decreased intake of rabbits in T_1 (0% CLM). The decline in DM intake may be as a result of physical barrier to feed intake due to the coarseness of the feed or as a result of change in satiety level at the satiety control center in the hypothalamus (Okonkwo *et al.*, 1910). The rabbit is a monogastric animal with a distinct preference for high fiber diets (Carregal, 1977). This may be accredited to its functional caecum and the practice of caecotrophy. Being unique from other monogastric animals, it can utilize roughages more efficiently.

Feed conversion ratio and average daily gain

Significant results were obtained on the feed conversion ratio of the rabbits. Treatment 2 had better efficiency in converting feeds into meat than the other treatments. Treatment 2 (10% CLM/Control) had an FCR of 4.24 followed by T_3 (20% CP) with 4.77, T_1 (30% CLM) with 5.96, and T_4 (30% CLM) with 6.30.

Comparison among means revealed that T_2 (10% CLM) significantly differed with T1 (0% CLM) and T_4 (30% CLM) but not with T3 (20%CLM)at $P \leq 0.01$ while T_3 compared to T_1 and T4 differed at $P \leq 0.05$. On the other hand, insignificant differences were recorded when T_1 and T_4 were paired. The FCR range of 4.24 to 5.96 obtained in this work for treatment diets showed good performance of the rabbits.

The values recorded in this study were comparable with 3.9-4.1 range reported by Cheeke (1971) when arginine, lysine and methionine were added to rabbit diet. Olorunsanya *et al.* (2007), Omole *et al.* (2005) and Oluremi and Nwosu (2002) reported poorer FCR for the rabbits. This shows that the 10% and 20% CLM diets in this study were efficiently utilized by the rabbits which made them perform better.

With respect to the average daily gain, T_2 (10% CLM) obtained the highest daily gain with 20.22, followed by T_3 (20% CLM) with 15.89, T_4 (30% CLM) and T_1 (0%CLM/Control) with 11.76 grams. Analysis of variance showed significant differences among treatments.

Comparison among means revealed that T_2 (10% CLM) and T_3 (20% CLM) varied significantly at P ≤0.01. When T_2 was compared with T_1 and T_4, it differed significantly at P≤0.01. Significant results were also obtained when T_3 was compared with T_1 and T_4 at P ≤0.05.

The Average Daily Gain (ADG) decreased with increasing levels of cassava leaf meal except that 10% inclusion was better than the treatment without CLM (0% inclusion). The 20.22g ADG recorded in this study was comparable to the findings of 21.36 g work of J.C. Okonkwo *et al.* (2010) at 15% inclusion level. Also, at 30% level of CLM, the ADG of 12.11 g/day/rabbit was obtained which was comparable to the ranges reported by Olorunsanya *et al.* (2007), Omole *et al.* (2005) and Oluremi and Nwosu (2002) when 30% of other aspects of cassava were fed.

Return above feed cost

The cost per kilogram of feeds for the different treatments showed that Treatment 4 (30% CLM) had the least cost with P12.20, followed by Treatment 3 (2% CLM) with P13.40, Treatment 2 (10% CLM) and the highest cost of feeds was attained by Treatment 1 (0% CLM-Control) with P16.18. It is evident that the higher the CLM content in the ration, the lower will be the cost of feed production, thereby commanding a lower price per kilogram of feed.

The profitability would not rely primarily on the cost of feeds but on the growth performance of the rabbits which could compensate the cost spent on feeds. In this study, results showed that Treatment 2, 10% CLM recorded sales of P265.37 per rabbit followed by T_3 with P241.32, T_1 with 217.32, and T_4 got the lowest sales of rabbit with P213.40. It can be deduced that animals fed with 10 and 20% CLM levels could generate more income because of a better gain in weight which resulted in bigger animals as compared to 0% and 30% CLM levels.

With respect to income per rabbit, again Treatment 2 (10% CLM) got the highest income with P 195.87 which is far from the income achieved by Treatment 1(0%CLM-Control) with P154. It is clear that the treatments with CLM can have a better income than the diet with no CLM. But among the diets with CLM inclusions, Treatment 2 (10% CLM) recorded the best feed cost and return ratio. On the other hand, the cost of feed per kilogram weight gain in Treatment 2 needed only P61.63 which is slightly lower than Treatment 3 with P63.38. Treatment 4 and 1 were more expensive with P76.83 and P97.79, respectively.

Conclusion

Based from the results of the study on the effect of different Cassava Leaf Meal levels in rabbits, Treatment 2 (10% CLM) obtained the best result in the following parameters, weight gain, feed conversion ratio, return above feed cost and cost of feed per kilogram weight gain.

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