Nigerian J. Anim. Sci. 2023, 25 (2): 148-156

Digestibility and metabolic coefficients of weaner rabbits fed leafy multi-nutrient mini-blocks

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Target Audience: Farmers, Scientists, Feed Producers

Abstract

Poor feed resource digestibility, metabolic rift, and nutrient imbalances are associated with various conditions that affect feed efficiency and ultimately animal production efficiency. Therefore, A 7-day digestibility/metabolic study was conducted to assess the suitability of a leafy multi-nutrient mini-block (MNB) for rabbits. The study involved using twenty-four 10-week-old rabbits, selected from 96 rabbits, and four treatment groups. The MNB was produced from cement and a mixture of pawpaw and tridax leaves, with four mixing ratios (0:0, 1:1, 3:2, 7:3). The dietary treatments significantly impacted the apparent digestibility coefficients of dry matter, crude protein retention, crude fibre, and ether extract digestibilities, ash availability, and gross energy. The control group had the highest coefficients, except for ash availability. The amount of pawpaw leaf and tridax in the diets affected ash availability. Dry matter digestibility ranged from 77.21% to 94.30%, while crude protein retention ranged from 64.73% to 79.22%. The dietary treatments significantly affected energy measurements, with the control group having higher values. Nitrogen intake was not significantly affected, while faecal nitrogen and total nitrogen excretion had similar trends. The inclusion of pawpaw and tridax leaves at a ratio of 7:3 in Multi-nutrient Miniblock diets, therefore, was found to encourage better nutrient utilization and adjudged most suitable for rabbits.

***Keywords**: coefficient, digestibility, metabolic, multi-nutrient, mini-block,*

Description of problem

Background knowledge and understanding of the concept of nutrient utilization are necessary tools in evaluating feedstuffs and defining the nutrient requirements of animals. Nutrient utilization refers to the extent to which a particular nutrient is used for a particular body function or purpose. Nutrient utilization from a given feedstuff is affected by factors such as age, physiological state, type of gastrointestinal tract, level of consumption (plane of nutrition), physical form in which the feed is provided (pelleted, mash, blocks, and forages) presence of anti-nutritional factors, presence of diseases and parasites, and course the balance of nutrients with the feed (1). Methods used in the evaluation of nutrient utilization in rabbit includes growth trials, feeding trials, digestion trials, metabolic studies nutrient balance trials, purified diet experiment, and some advanced techniques like surgical technique, biotechnological modeling (microbiological methods), and blood evaluation techniques (1). Papaya or pawpaw trees are found in tropical and sub-tropical America and Africa. The sap or latex of papaya is rich in papain, an enzyme that breaks down protein. (2) Tridax is a common leaf that could be found as a weed in cultivated crops, lawns, waste places, and roadsides. Tridax was found to contain 97.04% Dry matter, 15.83% Crude protein, 21.94% crude fibre, 2.92 ether extract, 15.35% Ash, and 41.00 Nitrogen free extract (3) while pawpaw leaves contain 86.87% dry matter, 26.50% crude protein,13.56 % crude fibre, 2.11% ether extract, 5.70% ash, and 39.00% nitrogen-free extract (3). The manufacture of nutrient mini blocks was suggested by (3). One big advantage over rabbit pellets or mash diets is that they can be simply spread on the ground without the need for a specialized feeder and the same prevents wastage of feed often associated with rabbit feeding. This study aimed to investigate the suitability of leafy-based multi-nutrient mini-block diets for rabbits.

Materials and methods

The study was conducted at the Directorate of University Farms (DUFARMS), rabbit unit, Federal University of Agriculture Abeokuta, Ogun state, Nigeria.

Dietary treatments and preparation

All of the ingredients in the multi-nutrient block rations (MNB1-3) were fixed, with the exception of the pawpaw and tridax leaves, which were combined at ratios of 1:1, 3:2, and 7:3. As a binder, 10% of cement was utilized (3). A mash diet was utilized as a control and had the same ratio of protein to calories. Table 1 displays the feed composition of the treatments. Local suppliers provided the cement and other feed components, while the molasses came from the Dangote Sugar Industry in Apapa, Lagos State. The leaves of pawpaw and tridax were harvested, air-dried for three weeks, and then ground separately before being combined at the aforementioned ratios. All the ingredients were weighed out and placed in a mixing dish, and vitamin premix and salt lumps were avoided.

Table 1: Composition of the experimental diets

	Composition (g/kg)			
Ingredient	Control diet	MNB 1	MNB2	MNB3
Maize	492.00	100.00	100.00	100.00
Soybean	245.00	137.00	137.00	137.00
Pawpaw leaves	-	250.00	300.00	350.00
Tridax leaves	-	250.00	200.00	150.00
Molases	50.00	50.00	50.00	50.00
Fish meal	10.40	10.40	10.40	10.40
Blood meal	10.40	10.40	10.40	10.40
Wheat offal	150.00	150.00	150.00	150.00
Oyster shell	10.60	10.60	10.60	10.60
Bone meal	10.00	10.00	10.00	10.00
Methionine	4.00	4.00	4.00	4.00
Vit/min premix	2.50	2.50	2.50	2.50
Salt	2.50	2.50	2.50	2.50
Total	1000.00	1000.00	1000.00	1000.00

Mixing of feed ingredients, Molding and drying of mini blocks

Small amounts of feed components were mixed. To create a homogeneous mixture, approximately 25kg of feed was blended in each batch. (3) recommended combining the elements for tiny blocks in that sequence. The binder (cement) was dissolved in a bucket, properly mixed, and then put into the drum that already had the molasses dissolved in it. To create an even mixture, the two solutions were appropriately combined and stirred. Tridax leaves, pawpaw leaves, maize, wheat offal, soya bean meal, bone meal, oyster shell, fish meal, blood meal, methionine, vitamin premix, and salt were also included. Each component was only introduced after the other ingredients had been well blended (3). To create mini-blocks that weigh 15 g, the finished block was pressed into mini-block molds. During the dry season, the small blocks were allowed to dry for at least four days in a semi-shaded area.

Experimental design, housing, and management

Twenty-four 10-week-old rabbits *(1 rabbit per replicate group)* were purposefully selected from Ninety-six rabbits on the basis of 4 treatments and 6 replicate groups earlier used for a feeding trial (3). The treatment groups consisting of a control, MNB1, MNB 2 and MNB 3 groups arising from four (0:0, 1:1, 3:2, 7:3) mixing ratios of Pawpaw and Tridax leaves respectively.

Pawpaw and tridax leaves were included in multi-nutrient mini blocks to provide an appropriate feed strategy for rabbit production as a dependable protein source. A 3-day acclimatization period was observed which was subsequently followed by a 4-day digestibility and metabolic studies. All data collected were arranged in a Completely Randomized Design (CRD).

Digestibility and metabolic trials

At the tenth week of the experiment, three rabbits were randomly selected from each of the replicates per treatment and were housed individually in metabolic cages which had been thoroughly cleaned and disinfected. The metabolic cage compartments were equipped with separate feeders and water troughs such that the feed and water could not spill into the droppings. Wire nettings were placed on the tray to collect droppings and urine. Three days adjustment period was observed prior to the four days collection period during which faeces and urine were collected separately. Faeces and urine were collected each morning before feeding. The faecal samples were dried at 80^{o}C in an oven, thus determining the moisture content and the dry matter for each treatment group. Dried faecal samples were finely ground, pooled, labeled, and used for subsequent laboratory analyses. The urine was equally collected by placing a flat plastic tray underneath the cage, the urine was collected in vessels containing 2ml of 0.01M hydrochloric acid as a preservative. An Aliquot of this urine was taken for gross energy and nitrogen determination. The crude protein (CP), Crude fibre (CF), ether extract (EE), and Ash were analyzed using the standard procedure (4). Ballistic bomb calorimeter was used to determine the gross energy of the experimental diets, faecal and urine samples.

Table 2: Determined analysis of experimental diets

Experimental diets (g/kg DM Composition)				
Component	Control	MNB1	MNB2	MNB3
Dry Matter	900.00	920.00	900.00	890.00
Crude Protein	204.90	224.40	229.70	237.30
Crude Fibre	38.90	114.00	109.60	105.50
Ether Extract	34.20	29.50	28.20	26.80
NFE	563.20	439.90	420.50	414.90
ASH	53.80	115.10	110.30	105.50
Gross energy(kcal/kg)	4263.44	3848.85	3912.90	3977.42

MNB 1= multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 1:1*,
MNB 2 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 3:2*,
MNB3 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 7:3*

Nutrient intake, digestibility percentage, and other parameters were determined such as: feed gross energy (FGE), Digestible energy (DE), Metabolizable energy (ME), Nitrogen intake (NIT), Crude protein intake (CPI), Apparent Gross Energy Digestibility (AGED), Apparent Nitrogen Digestibility (AND), formulae used for calculation

- Digestible energy (DE) = Feed gross energy -Faecal gross energy.
- Metabolizable energy (ME) =Digestible energy DE -Urine gross energy
- Nitrogen intake (NIT) =Feed intake X %Nitrogen
- Crude protein intake (CPI) = Feed intake X %Crude protein
- Apparent gross energy digestibility (AGED) =

$$\frac{\text{Energy intake - Energy output}}{\text{Energy intake}} \times 100$$

Daily energy intake DEI = Daily feed intake X kcal/energy/kg

Daily energy loss = Daily FE + Daily UE

Daily energy retained = Daily energy intake – (Faecal energy +Urinary energy)

Other Formulae used:

a. Dry Matter Digestibility (DMD)

$$= \frac{\text{DM intake – Faecal output DM}}{\text{DM intake}} \times 100$$

b. Protein digestibility (Nitrogen Retention)

$$NR = \frac{N_2 \text{ intake} - N_2 \text{ in dropping}}{N_2 \text{ intake}} \times \frac{100}{1}$$

c. Crude fibre Digestibility

$$CFD = \frac{\text{CF in feed – CF in faecal}}{\text{CF in feed}} \times \frac{100}{1}$$

d. Crude Fat Digestibility

$$CFD = \frac{\text{EE in feed – EE in faecal}}{\text{EE in feed}} \times \frac{100}{1}$$

e. Ash Availability (AA)

$$AD = \frac{\text{Ash in feed – Ash in faecal}}{\text{Ash in feed}} \times \frac{100}{1}$$

Statistical Analysis

The data obtained from this study were statistically analyzed and subjected to One Way Analysis of Variance (ANOVA) in a Completely Randomized Design. Significant ($P<0.05$) differences among means were separated using Duncan's Multiple Range Test. This analysis was performed using the Statistical Analysis System (5) package.

The model for the response is

$Y_{ij} = \mu + T_i$ + random error

Where Y_{ij} = observation for which X_1= i (i and j denote the level of factor and replication within the level of the factor, respectively)

μ = location parameter (overall population mean)

T_i = effect of having treatment level i

Results and Discussion

Apparent digestibility coefficient of rabbits fed multi-nutrient blocks

The parameters evaluated are the digestibility coefficients of Dry matter (DMD), Crude protein (CPD) (retention), Crude fibre (CFD), Ether extract (EED), Ash (availability), NFE, and Energy in rabbits fed different dietary treatments. Table 3 showed that all coefficients were significantly influenced by the dietary treatment. Rabbits exhibit increasing (MNB1 – MNB3) DMD, CFD, and EED with increasing pawpaw leaf and lower tridax inclusion in the diets (Tables 1 and 3) which suggests an inverse relationship between digestibility and ingesta viscosity of rabbits fed mini-block diets, supporting superior macronutrient digestion at high viscosity rather than low viscosity as noticed by (6). The DM digestibility values of MNB2 and MNB3 rabbits were within the range reported by (7) who fed *moringa oleifera* leaf-based diets to growing rabbits. The significantly low (64.73%) retention of crude protein and 51.84% fibre digestibility noticed in rabbits fed MNB1 signified that those rabbits utilized the dietary protein poorly due to more fibre in the gastrointestinal tract compared with CP retention values of 78.65% and 79.22% noticed in the control and MNB3 groups having correspondingly higher fibre digestibility coefficients. Proteins are known to bind with fibre at the absorption site and limit their absorption into the blood system, thereby increasing faecal excretion of CP (8). Also, it was inferred that the presence of higher concentrations of papain in the diet due to pawpaw leaf improves protein retention, particularly in the MNB3 diet, which has been reported (2) to have the ability to enhance proteolytic digestion. The little linear ($P<0.05$) improvement in the CP digestion might have culminated in an increase in the CP retention values (64.73 - 79.22%) noticed in MNB1-MNB 3 which could also be linked to the effect of caecotrophy and the presence of caecal microorganisms in rabbits which could translate to rapid growth performance in rabbits as asserted by (9) who linked caecotrophy mechanism in rabbit to proficient digestion of protein. Dietary fibre digestibility was better in the control compared to other block treatments and values obtained for protein digestion, suggesting that the fibre in the diets MNB1 and MNB2 was not well digested (Table 3). Caecotrophy in rabbits was in favor of the digestion of protein and other fractions of forage-based diets and less favorable to fibre digestion (9 and 3). When digestibility was related to the proximate composition of the diets and faeces, it was observed that a decrease in the dietary fibre from MNB1-MNB3 resulted in a decreased level of fibre in the faeces (Table 2). (10) found that the digestion of NDF is apparently limited by lignin, which lowers intake (11), and found that one unit of lignocellulose added led to a 1.2-1.5-point decrease in organic matter digestibility.

However, in this study, the linear decrease (563.20 – 414.90g/kg diet) in dietary fat (Table 2) does not result in a well-defined linear decrease in fat digestibility coefficient values (Table 3). This could be due to a decrease in the total body lipid with higher dietary fibre intake, as reported by (12). (13) suggest that the source and type of fatty acid, the composition of the diet, with the age of the animal, can all affect fatty acid digestion.

Table 3: Apparent digestibility coefficient of rabbits fed multi-nutrient blocks

	TREATMENTS				
PARAMETERS(%)	CONTROL	MNB1	MNB2	MNB3	SEM
Dry matter	94.30[a]	77.21[c]	85.57[b]	89.09[b]	7.31
Crude protein (retention)	78.65[a]	64.73[b]	68.65[b]	79.22[a]	4.98
Crude fibre	66.03[a]	51.84[c]	60.68[b]	63.00[ab]	3.99
Ether extract	88.82[a]	61.98[c]	71.85[b]	78.49[ab]	4.11
Ash (availability)	66.71[a]	75.86[a]	70.85[ab]	68.86[b]	3.24
NFE	73.14[a]	71.11[ab]	70.59[b]	71.41[ab]	0.50
Energy	74.49[a]	65.66[b]	68.90[b]	70.11[a]	2.66

[abc] Values in a row without a superscript or with the same superscripts are not significantly different (P > 0.05).
MNB 1= multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 1:1*,
MNB 2 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 3:2*,
MNB3 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 7:3*,
SEM = Standard error of the mean

Energy metabolism of rabbits fed multi-nutrient blocks

The results of energy metabolism and partitioning measurements presented in Table 4 include gross, digestible, metabolizable, faecal, and urinary energy respectively. The control group without leaf had significantly higher energy partition values (P< 0.05) than the other groups, suggesting that feeding forage altered energy metabolism and partition. Energy metabolism parameters measured significantly decreased with an increased level of dietary fibre (Tables 2 and 4), as energy values increased with an increase in the levels of pawpaw with a concomitant decrease in the level of tridax in the mini-blocks (Table 1). (14) stated that the quantity of various nutritional and antinutritional components that affect energy-rich nutrient absorption, digestibility, and availability in the forage determines the quality of the forage. Mini-blocks fed in this study resulted in a significant linear increase in energy partition indices (Table 4) which were directly proportional to the gross energy contents of the respective mini-blocks (Table 1). Energy losses in the faeces ranged from 33.61% to 35.89% of the dietary gross energy indicating fairly good energy utilization efficiency which corroborates the conclusion of (15) who reported that Rabbits have a high level of energy efficiency.

Table 4: Energy metabolism of rabbits fed multi-nutrient blocks

	TREATMENTS (Kcal/kg)				
PARAMETERS (Kcal/kg)	CONTROL	MNB1	MNB2	MNB3	SEM
Feed gross energy (GE)	4263.44[a]	3848.85[b]	3912.90[b]	3977.42[b]	103.11
Digestible energy (DE)	2782.45[a]	2467.22[b]	2553.68[b]	2640.45[b]	86.33
Metabolizable energy (ME)	2643.33[a]	2341.63[b]	2426.00[b]	2510.66[b]	71.01
Faecal gross energy (FE)	1480.99[a]	1381.63[b]	1359.22[b]	1336.97[b]	48.95
Urinary gross energy (UE)	139.12[a]	129.79[b]	127.68[b]	125.59[b]	9.00
Daily Total energy loss	320.44	349.40	310.65	308.89	7.13
Daily energy retained	287.64	264.36	265.10	271.32	8.22

[abc] Values in a row without a superscript or with the same superscripts are not significantly different (P > 0.05).
MNB 1= multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 1:1*,
MNB 2 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 3:2*,
MNB3 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 7:3*,
SEM = Standard error of the mean

Nitrogen metabolism on the rabbits fed multi-nutrient blocks

Nitrogen intake, Faecal N g/day, Urinary N g/day, Total N excreted g/day, and N retained g/day were not significantly affected by the dietary treatment, except for the percentage of nitrogen retained (Table 5). Faecal nitrogen and total nitrogen excretion followed a similar trend, with the highest values in the control group and the lowest in the MNB1 group. Urine nitrogen excretion was significantly lowest in the MNB2 group. The control and MNB3 group's diet had a higher percentage of nitrogen retained when compared with rabbits fed the mini-block MNB1 and MNB2, which may be associated with the presence of higher soybean (24.50%) in the control diets and higher (35%) proportion of pawpaw leaves in MNB3 diets and its inherent papain enzyme (16).

Table 5: Nitrogen metabolism of the rabbits fed multi-nutrient blocks

	EXPERIMENTAL DIETS				
PARAMETERS	CONTROL	MNB1	MNB2	MNB3	SEM
N intake g/day	3.35	2.76	3.02	3.24	0.42
Faecal N g/day	1.44	1.20	1.43	1.29	0.13
Urinary N g/day	0.40	0.36	0.34	0.39	0.03
Total N excreted g/day	1.84	1.56	1.77	1.68	0.09
N retained g/day	1.51	1.12	1.25	1.56	0.23
% N retained of N intake	45.30[a]	40.60[b]	41.3[b]	48.10[a]	2.11

[abc] Values in a row without a superscript or with the same superscripts are not significantly different (P > 0.05).
MNB 1= multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 1:1,*
MNB 2 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 3:2,*
MNB3 = multi-nutrient block having a *mixture of Pawpaw and Tridax leaves at a ratio of 7:3,*
SEM = Standard error of the mean

The dietary treatments (Table 5) showed that there was a linear relationship between nitrogen intake, urinary nitrogen loss, and the percentage of nitrogen retained in the nitrogen intake. A strong inverse relationship has also been reported between lignin (fibre) consumption and calorie intake, while nitrogen intake was inversely correlated with insoluble non-starch polysaccharides of the diet (8). Reduction in the tridax content of MNB1 and the subsequent replacement with pawpaw leaf in MNB2-MNB3 (Table 1), resulted in a non-significant increment in N-retention (Table5), which prompted a proportionate increase in the crude protein profile of pawpaw rich diets (MNB 3).

Conclusion and Applications

1. There was a linear relationship between nitrogen intake, urinary nitrogen loss, and the percentage of nitrogen retained by the rabbits fed leaf-based Multi-Nutrient Mini-blocks.
2. Energy metabolism coefficients of rabbits fed leafy-based Multi-nutrient Mini-blocks decreased with increased levels of dietary fibre while the dietary energy values increased with an increase in the levels of pawpaw with a concomitant decrease in the level of tridax in the mini-blocks.
3. Inclusion of pawpaw and tridax leaves therefore at a ratio of 7:3 in Multi-Nutrient Miniblocks encouraged better nutrient digestibility, energy utili-

zation, and nutrient metabolism by rabbits and was therefore adjudged a suitable ratio.

4. It was evident in the study that leafy multi-nutrient Miniblock production is a readily available and suitable source of energy, protein, and mineral for weaner rabbit feeding.
5. Supplementing rabbit ration with it would provide an adequate quantity of these nutrients that will lead to improved digestibility and ultimately efficient animal protein production.

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