

Growth response and apparent nutrient digestibility of weaner rabbits fed with diets containing bamboo leaf meal

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Abstract

A ten-week feeding trial was conducted to determine the growth response and apparent nutrient digestibility of weaner rabbits fed with diets containing bamboo leaf meal (BLM). Eighty weaner rabbits were allotted into four dietary treatment groups of twenty rabbits each. The dietary treatment groups consisted of four rations containing 0 (control), 10, 20 and 30% BLM respectively. Rabbits fed diet containing 10% BLM had the highest ($P<0.05$) final live weight, weight gain and apparent ether extract digestibility. Lowest ($P<0.05$) final live weight, weight gain, apparent crude protein and ash digestibility were noticed with rabbits fed with diets containing 20% or 30% BLM. Rabbits fed with diet containing 30% BLM recorded the highest ($P<0.05$) feed intake and lowest ($P<0.05$) NDF digestibility. It was concluded that inclusion of 10% BLM in diets for weaner rabbits supported improved growth and nutrient digestibility.

Key words: Bamboo leaf meal, digestibility, performance, rabbit

Introduction

Rabbit is a promising animal which can be used as alternative meat protein sources due to its rapid growth, higher meat to bone ratio and feed conversion efficiency (Davidson and Spreadbury, 1975). Unlike the chickens which compete with man for cereal grains, rabbits can be sustained on diets low in grains but high in forages, grasses and shrubs due to its ability to digest leaf protein effectively. Bamboo plant (a perennial forage species) is a member of the grass family with over 1200 species available worldwide (Chapman and Peat, 1992). *Bambusa arundinaria*, a warm temperate genus occurred naturally in Nigeria and holds a lot of potential in livestock feeding. The seeds produced (called 'bamboo rice') are rich in protein

(Invista, 2011) while the leaf holds a lot of potential as feed ingredients in ruminant nutrition. (Devendra, 1992) reported that bamboo leaf hay contained 12.0, 27.0, 0.8 and 18% crude protein, crude fibre, ether extract and ash, respectively. Bamboo leaf meal (BLM) contained 9.30% digestible protein, 2150 Kcal/kg digestible energy and a metabolisable energy content of 1760 Kcal/kg (Devendra, 1992). Studies investigating the use of bamboo leaf meal as dietary fibre source in rabbit nutrition are rare. This study therefore, seeks to investigate the growth response and apparent nutrient digestibility of weaner rabbits fed with diets containing bamboo leaf meal.

Materials and methods

Preparation and chemical composition of Bamboo leaf meal (BLM)

Bamboo (*Bambusa arundinaria*) stems were plucked using a sharp knife from the Farm site of College of Plant Science, University of Agriculture Abeokuta, Nigeria. Fresh foliage leaves from the top of the stems were cut, manually separated from the midrib, chopped into smaller pieces (using a sharp knife) and dried (at 60°C for 48 hrs) in a drying chamber. The dried leaves were milled (2.5 mm sieve), bagged and mixed with other feed ingredients to formulate the experimental diets. Representative samples of the bamboo leaf meal (BLM) were analyzed for its proximate composition (AOAC, 1990) (reference identification numbers 924.05, 920.39, 984.13). For the determination of the fibre fraction, content of NDF was determined without sodium sulfite and with a heat-stable amylase (Van Soest *et al.*, 1991). Acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined by sequential analysis of the residual NDF and not expressed exclusive of residual ash (Van Soest *et al.*, 1991). The hemicellulose was calculated as the difference between NDF and ADF while cellulose was calculated as the difference between ADF and ADL. The gross energy of the samples of BLM was determined using a Gallenkamp Ballistic bomb calorimeter (Cam Metric Ltd, Cambridge, UK). For mineral analysis, dried samples were ashed at 450°C, and digested in 10 mL 1 mol/L HCl. Phosphorus content was determined colorimetrically using Molybdo-vanadate method (Kitson and Mellon, 1944). Sodium and potassium content were determined in the ash solution by emission spectroscopy at 589.0 and 766.5 nm respectively, by using an air-acetylene flame. Calcium and magnesium content were measured in the

ash solution by atomic absorption spectroscopy (Techtron model AA-10) at 422.7 and 285.2 nm respectively. For magnesium determination, a strontium chloride solution was added with the aim of avoiding chemical interferences (OJEC, 1973.). Iron and manganese were determined by atomic absorption spectroscopy using single element hollow cathode lamps and air-acetylene flame at 248.3 and 279.5 nm, respectively (AOAC, 1990). Total tannin content was determined colorimetrically as described by AOAC(1990).

Experimental animals, design and management

Eighty, male, six weeks old mixed-bred rabbits (weaned at five weeks) with a mean body weight of 446 ± 1.65 g were used for the study. The rabbits were randomly allotted into four dietary treatment groups of 20 rabbits each. Rabbits were housed individually in hutches (240 cm × 75 cm × 75 cm (LWH)). Each hutch has four cage units and each unit (with a dimension of 60 cm × 75 cm × 75 cm (LWH)) housed a rabbit. Five of such hutches were used per treatment. The cages were thoroughly cleaned and disinfected two weeks before the arrival of the rabbits. The front side of the hutch was made of wire mesh to allow for aeration while the base made of strong wire netting to allow easy passage of the droppings. Four experimental diets were formulated such that BLM was included at 0 (control), 10%, 20% and 30% inclusion levels, respectively. Diets were formulated to meet the nutrient requirements of rabbits as stated by (De Blas and Mateos, 1998). Strict hygiene was maintained during the experimental period. Rabbits assigned to each treatment were fed with their respective diets. The feeds were fed ground. Rabbits were fed without restriction with experimental diets while clean water was

offered on daily basis throughout the expiration of the study. The composition of experimental diets is as shown in Table 1. The feeding trials lasted for 70 days. Uneaten feed was weighed on a daily basis and discarded. Feeders and drinkers were cleaned every morning after which fresh feed and clean water were offered.

Growth response and nutrient digestibility

Weight gained and feed intake was determined weekly. Feed conversion ratio was calculated as a ratio of feed consumed to weight gained. At the expiration of the feeding trial (70 days), 8 rabbits per dietary treatment were randomly selected and housed in individual wire metabolism cages (each measuring 400 × 500 × 400 mm). Prior to the commencement of the trial, rabbits were acclimatized for three days in the metabolic cages followed by four days collection period. The rabbits were fed daily with known weights of feed (which match their daily intake). The faeces (free of feed and visible hair contaminants) were collected daily from each cage and dried overnight at 60°C. The dried faecal droppings were stored at -20°C before analysis. Prior to analysis, faeces collected were freeze dried and ground (2 mm wire mesh). Refusals and samples of the feeds offered to the animals (during metabolic trial) were collected at the end of the faecal collection period. Pooled samples of refusals, feed and dried faecal samples were used for proximate analysis according to the procedures of Official Methods of Association of Analytical Chemists (AOAC, 1990). The faecal and feed samples were analyzed for ash (method no. 924.05), ether extract (method no. 920.39) and crude protein (total nitrogen × 6.25; method no. 984.13) according to the procedures of Official Methods of Association of Analytical Chemists

(AOAC, 1990). Gross energy values of the samples were determined using the bomb calorimeter. Fibre fractions of the samples were determined without sodium sulfite and with a heat-stable amylase as previously described (Van Soest *et al.*, 1991).

Statistical Analysis

Data generated during the study were arranged in a completely randomized design and analyzed using one way analysis of variance. Analysis was done using the SAS Computer Package (SAS Institute, 1992). Differences between significant mean values were separated using the Duncan's Multiple Range Test (Duncan, 1955)

Table 1. Determined Chemical composition of Bamboo leaf meal (BLM)

Parameters	Composition values
Proximate composition (%)	
Dry matter	76.00
Crude Protein	12.00
Nitrogen free extract	29.40
Crude Fibre	29.00
Ash	20.00
Gross energy (MJ/kg)	9.42
^a Digestible energy (MJ/kg)	4.21
Fibre Fraction (%)	
Neutral detergent fibre	52.91
Acid detergent fibre	35.10
Acid detergent lignin	10.10
Hemicellulose	17.81
Cellulose	25.00
Mineral profile (%)	
Ca	0.88
P	0.32
Mg	0.68
Na	0.03
K	1.00
Mn (mg/kg)	103.00
Fe (mg/kg)	210.00
Cu (mg/kg)	5.00
Tannin (g/kg)	9.00

Results and Discussion

Composition of Bamboo leaf meal

The determined proximate composition of Bamboo leaf meal (BLM) as presented in Table 1 revealed a high dry matter content, moderately low crude protein and low gross energy content. The low gross and estimated digestible energy content were indicative of the limitations involved in the use of BLM as dietary energy sources in rabbit nutrition. The high dry matter obtained could be due to the period of leaf collection (within the peak of dry season). The high crude fibre and low protein content assayed for BLM suggested it as a potential fibrous low protein source in rabbit nutrition. Rabbits have the potentials

to utilize efficiently fibrous feedstuffs and forages (Garcia *et al.*,1996). The crude protein value of BLM was closer to values reported for some leaves obtained from trees of fodder and browse plants commonly consumed by rabbits and other ruminant animal (Khanal *et al.*, 1999).

The mineral profile of BLM showed a high Ca, Mg, K and moderate P content. The high Ca and P content of BLM implied that it contained essential minerals needed for bone development in rabbits. The P content of BLM was close to 0.37% while the Ca content was higher than 0.22% being P and Ca values, respectively recommended by (Chapin, and Smith, 1967) for growing rabbits. The Mg and K content were higher than the values of 30-40 mg/100g and 0.6%

Table 2. Gross composition (%) of the experimental concentrate diets

Ingredients	Level of inclusion of BLM (%)			
	0	10	20	30
Maize	44.00	35.20	27.10	21.30
Soybean meal	18.00	16.80	14.90	12.70
Bamboo leaf meal	-	10.00	20.00	30.00
Fish meal (72% Crude Protein)	1.00	1.00	1.00	1.00
Brewers dried grain	30.00	30.00	30.00	30.00
Rice husk	3.50	3.50	3.50	3.50
Oyster shell	1.00	1.00	1.00	1.00
Bone meal	2.00	2.00	2.00	2.00
^a Vitamin/Mineral premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Determined Analysis				
Dry matter (%)	89.56	90.00	90.13	90.60
Gross energy (MJ/kg)	17.38	16.60	15.97	15.21
Crude protein (%)	18.84	17.97	16.91	15.62
Crude fibre (%)	15.12	17.52	19.01	21.12
Ether extract (%)	1.13	1.44	1.56	1.73
NDF (%)	30.40	31.70	32.02	34.42
ADF (%)	17.90	18.02	18.79	18.97
ADL (%)	3.40	3.63	3.80	3.98

^a Vitamin/Mineral premix (providing the following per kg of premix: 233g Ca; 1,200,000IU Vit A; 300,000 Vit D3; 4200mg Vit E; 4200mg Vit E; 200mg Vit K3; 200mg Vit B1; 664mg Vit B3; 500mg VitB6; 2000µg B12; 100mg Folic acid; 15 mg Bitoine; 1500; 1500mg Ca Panthothenate, 70g Choline chloride; 12mg antioxidant (BHT); 500mg Cu; 5135mg Zn; 6g Fe;7100mg Mn; 62mg I; 20mg Se

values being Mg and K levels recommended, respectively for growing rabbits. The Cu content of BLM was higher than the dietary level of 3 mg/kg suggested by (Smith and Ellis, 1947) for growing rabbits. The Mn content was far higher than dietary level of 2.5 - 8.5 mg/kg reported by (Smith and Ellis, 1947) to show deficiency symptoms in growing rabbits. The fibre fraction analysis of BLM showed that it contained a high NDF, ADF, ADL and cellulose content. The NDF and ADF fraction was higher than 33 - 40% NDF (9) and 17% ADF (García *et al.*, 1999) being values recommended for growing rabbits. The high lignin content of BLM could be implicative of low mineral intake by animals (McDowell and Conrad, 1990). Value of tannin reported for BLM in this study was low and may not be considered to have negative effect on the feed utilization and performance of rabbits. Although, lignin and tannin have been reported as the most anti-nutrients present in leaves of trees commonly consumed by animals (Khanal *et al.*, 1999).

Growth performance and apparent nutrient digestibility

Growth performance and apparent nutrient digestibility of rabbits fed with diets

containing BLM is as shown in Table 3. Low (P<0.05) final liveweight, weight gain, apparent crude protein and ash digestibility were recorded with rabbits fed with diets containing 20 and 30% BLM. The low apparent crude protein and ash digestibility recorded for rabbits fed with 20 and 30% BLM could be linked with increased dietary fibre (as BLM inclusion increased) which reduced nutrient absorption and utilization (Champe and Maurice , 1983 and Cheeke *et al.*, 1986). Such increased dietary fibre have been reported to modified the concentration of caecal VFA , reduce nutrient digestibility (Longe and Adetola, 1983) and affect energy and nutrient balance (Noblet and Le Goff, 2001). Although, feed intake appreciated with increasing dietary inclusion of BLM, rabbits fed diets containing 30% BLM had the worst (P<0.05) feed to gain ratio, apparent ether extract and NDF digestibility. Highest (P<0.05) apparent crude protein and ash digestibility were recorded with control fed rabbits while those fed with diet containing 10% BLM had the highest (P<0.05) final liveweight, weight gain and apparent ether extract digestibility. Beyond 10% BLM inclusion level, weight gain and final liveweight

Table 3: Growth response and apparent nutrient digestibility of rabbits fed diet containing bamboo leaf meal

Measurements	Level of inclusion of Bamboo leaf meal (%)			
	0	10	20	30
Litter number	20	20	20	20
Initial weight (g/rabbit)	447.23 ± 16.89	446.00 ± 15.57	443.90 ± 16.92	447.77 ± 16.92
Final liveweight (g/rabbit)	1381 ± 71.28 ^b	1409.87 ± 86.83 ^a	1317.50 ± 175.15 ^c	1325 ± 36.32 ^c
Weight gain (g/rabbit)	934.53 ± 96.23 ^b	963.87 ± 142.76 ^a	873.60 ± 157.70 ^c	877.57 ± 116.80 ^c
Total feed intake (g/rabbit)	4499.47 ± 205.11 ^c	4466.67 ± 196.35 ^b	4494.97 ± 327.61 ^b	5732.90 ± 462.66 ^a
Feed conversion ratio	4.39 ± 0.88 ^b	4.63 ± 0.74 ^b	5.15 ± 0.83 ^{ab}	6.53 ± 1.01 ^a
Apparent nutrient digestibility				
Dry matter (%)	75.57 ± 1.90	71.90 ± 4.06	70.26 ± 5.94	69.03 ± 3.70
Crude protein (%)	85.83 ± 1.19 ^a	81.86 ± 2.62 ^b	65.35 ± 2.49 ^c	64.39 ± 4.51 ^c
Ether extract (%)	74.26 ± 2.00 ^b	83.68 ± 2.36 ^a	73.70 ± 4.45 ^b	66.94 ± 3.34 ^c
Ash (%)	81.51 ± 0.66 ^a	77.97 ± 1.97 ^b	71.31 ± 1.89 ^c	72.26 ± 3.12 ^c
NDF (%)	49.11 ± 1.11 ^a	48.50 ± 1.02 ^a	49.00 ± 2.01 ^a	45.20 ± 1.04 ^b
ADF (%)	42.10 ± 1.09	42.22 ± 1.04	41.97 ± 1.62	42.00 ± 2.01
ADL (%)	44.10 ± 1.99	43.97 ± 1.42	44.13 ± 1.20	44.21 ± 2.08

Means on the same row with different superscripts are significantly different (P <0.05)

reduced ($P < 0.05$) significantly. This could be attributed to the increasing lignin content of the diet as BLM inclusion level increased resulting in reduced nutrient utilization (Wiseman, 1987). Increased dietary lignin content resulted in short transient retention period of caecal digesta, hence low nutrient digestion and utilization. The mean retention time of caecal digesta in rabbits was reported to increase from 14 to 21 hours when the dietary fibre is lowered (Gidenne, 1994).

The linear increase in feed intake as dietary inclusion of BLM increased could be due to the decline in resultant energy content of the diets (with increased BLM inclusion). Rabbit is able to adjust its digestible energy (DE) intake to meet requirement hence increased dietary fibre resulted in a proportional increase in the voluntary feed intake (Gidenne, 1995). Although, in cases of excess dietary fibre intake, energy intake and performance is seriously compromised (Chao and Li, 2007). Fibre has been reported as a major component in rabbit nutrition (Villamide and Fraga, 1998), hence rations fed to intensively reared rabbits should contain the minimum content of fibre required to prevent digestive disorders (Maertens, 1992). Depending on the dietary composition of the fibre source, increased dietary fibre levels have been reported to cause increased (Champe and Maurice, 1983) or decreased (De Blas *et al.*, 1986 and Maître *et al.*, 1990) growth response in rabbits. It was concluded that inclusion of 10% BLM in diets for weaner rabbits supported improved growth and nutrient digestibility.

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