

Original Research Article

Performance and Carcass Characteristics of Rabbits Fed Bamboo (*Bambusa arundinacea*) as a Replacement for *Tridax procumbens* Leaves

ABSTRACT

Aim: To evaluate performance and carcass characteristics of rabbits fed bamboo (*Bambusa arundinacea*) leaves as a replacement for *Tridax procumbens* leaves.

Study design: completely randomized design.

Place and Duration of Study: The experiment was carried out at the rabbitry unit, Department of Animal and Environmental Biology, Adekunle Ajasin University between May 2016 and July 2016 and lasted for a period of 70-days.

Methodology: 36 weaned mixed sex rabbits of heterogeneous stocks with an average weight of 1075g were randomly assigned to six dietary treatments at 6 rabbits (3 does and 3 bucks) per treatment. Freshly harvested *B. arundinacea* and *T. procumbens* were offered to the animals at 2% of their live weights at the ratio of 0:0 (T_1), 100:0 (T_2), 75:25 (T_3), 50:50 (T_4), 25:75 (T_5) and 0:100 (T_6) of *B. arundinacea* and *T. procumbens* respectively in addition to the concentrate feed offered to the animals. Proximate analysis of experimental leaves and concentrate diets were carried out at the end of the trial. Also performance (final live weight (g), weight gain (g/d) and feed conversion efficiency (gain/intake)), dry matter intake of experimental leaves and concentrate diets were assessed.

Results: Forage diets had no significant effect ($P>.05$) on final live weight, total dry matter intake and Feed Conversion Efficiency (FCE). Significant effect ($P<.05$) was observed in total weight gain and average weight gain of rabbits on forage diets. Non-significant effect ($P>.05$) was observed in slaughter weight and dressing percentage between control (T_1) and T_2 (100% bamboo leaves) diets. The liver, kidney and heart were non-significant ($P>0.05$) between T_2 and T_6 . Combinations of concentrate and varied ratio of forages were non-significant on the rabbits' Head, Blood and Pelt.

Conclusion: It can be concluded from this study that bamboo leaves, when combined with *tridax* leaves, up to 50% inclusion levels could be utilized as forages for feeding grower rabbits. Giving the perennial nature of bamboo leaves.

Keywords: rabbits, bamboo, *tridax*, carcass, performance, forage leaves

1. INTRODUCTION

The state of nutrition of the Nigerian populace is grossly marked by inadequate intake of protein both in quality and quantity. Animal protein consumption is very essential for meeting protein requirement of man. The average daily protein intake per adult is still far less than the 35g per adult per day recommended by [1]. Therefore, efforts are being directed towards exploring all reasonable options to meet the recommended level at an affordable price [2]. In order to maximize food production and meet protein requirements, viable options need to be explored and evaluated [3]. Among such alternatives is the use of livestock species most especially rabbit which are yet to play a major role in animal production in the country. Rabbit production has proven to be a veritable means of alleviating animal protein deficiency [4]. The rabbit has immense potentials and good attributes which include high growth rate, high efficiency in converting forage to meat, short gestation period, high prolificacy, relatively low cost of production and high nutritional quality of rabbit meat which includes low fat, sodium and cholesterol levels. It also has a high protein level of about 20.8% and its consumption is bereft of cultural and religious biases [5]. Domestic rabbits (*Oryctolagus cuniculus*) are ubiquitous,

providing protein, fibre, research models, and companionship. These qualities confer on rabbits a potential to bridge the shortage of animal protein in developing countries, where grain can only be justified for human use [6,7].

Rabbit production is suitable because as monogastric herbivores, they do not compete directly with man for both cereal and legume grains and can subsist on green as basal diets. In spite of the various attributes of rabbits over other livestock, the cost of production is still high due to the ever increasing cost of concentrate formulated feeds. It is reported however that a non-conventional feedstuff (NCF) offer the best alternative for the reduction in feed cost which ultimately leads to reduction in the prize of animal products [8]. In achieving this production- cost reduction, such non-conventional feed stuff must be available all year round and must also lend itself to easy procurement and processing if necessary.

Rabbits could utilize forages [9], which helps in reducing the cost of feeding compared to poultry which competes with man for cereal and legume based feed resources. [10] advanced that the development of high quality forage based diets with simple supplements is a priority research areas in developing countries. Although rabbits can survive on virtually all forage diets, optimum performance can only be ensured in a mixed feeding regime involving forage and formulated feeds [11, 12]. Bamboo is a woody grass belonging to the subfamily Bambusoideae of family (Gramineae). It is recorded to be the fastest-growing plant on earth since culms of some species, in just 4 months, can reach 40m in height and 30cm in diameter [13]. It is estimated that worldwide there are over 1200 species under 87 genera of bamboo with a natural distribution across a broad range of environments (humid, tropical, subtropical and temperate region) on all continents except Europe and Antarctica [14,15]. In addition bamboo is an adaptable plant, some species being deciduous, others are evergreen [16]. Bamboos leave contain flavonoids and bioactive compounds, and are used in folk medicine [17, 18]. The leaf of *B. arundinaceae* is reported to have anti-inflammatory and anti-ulcer properties [19]. The chemical composition of different species of bamboo leaf holds a lot of promise as potential forage in rabbit diet. The crude protein and fibre of four different bamboo species (*B. vulgaris vittata*, *B.vulgaris vulgaris*, *B. ventricosa* and *O.abyssinica*) range from 18.39 to 19.39% and 25.88 to 33.19% respectively [20]. This CP exceeds the 11.95% for *Penisetum purpureum* and 5.5% for *Panicum maximum* [21] and 12.80% for the legume, *Leucaena* [22]. The crude fibre is also appreciably higher than 18.10% of *Gliricidia sepium* [23]. Various species of bamboo leaves have reportedly been used to feed livestock/ruminants; *Arundinaria racemosa* in the Himalayas [24] and *Arundinaria tecta* (cane breaks) in North Carolina [25] have been evaluated for use as cattle fodder. Numerous bamboos are fed to horses, cattle and sheep worldwide [25]. However, the nutrition of rabbits in Nigeria is primarily based on *Tridax procumbens* and/ or *Centrosema pubescens* leaves whose growth and availability in the dry season cannot sustain all year rabbit production [26]. Therefore, this study was carried out to evaluate performance and carcass characteristics of rabbit fed Bamboo leaves as a replacement of *Tridax procumbens* leaves

2. MATERIAL AND METHODS

1.1. Site

The experiment was conducted at the Rabbitry Unit of the Department of Animal and Environmental Biology, Adekunle Ajasin University, Akungba, Ondo State

1.2. Experimental Animals, Diets and Management

Thirty six (36) weaned rabbits of local breeds comprising of heterogeneous stocks of the three common breeds found in Nigeria (New Zealand White, California White and Chinchilla) and mixed sexes, purchased from peasant farmers in Akungba were used for the experiment. The ages of the 36 rabbits ranged from 5-6 weeks while their weights ranged from 1.0kg to 1.15kg. The rabbits were housed individually in hutches made of wood and galvanized iron measuring 40x60x70 cm in dimension, equipped with windows for proper ventilation. Each hutch was equipped with a drinker and a trough to prevent feed wastage. During the first week in the cage, the rabbits were allowed to acclimatize and Vitalyte (Phoenix pharmaceuticals U.S.A) which is an anti-stress was administered. An antibiotic was also used for the treatment of external and internal parasites.

Fresh, young *Bambusa arundinacea* foliage leaves were harvested from trimmed branches of bamboo trees on plantation alongside *Tridax procumbens* leaves within Adekunle Ajasin University. The leaves were washed and chopped into smaller pieces and fed to the animals. Freshly harvested *Bambusa arundinacea* and *Tridax procumbens* leaves were offered to the animals at the ratios of 0:0 (T_1), 100:0 (T_2), 75:25 (T_3), 50:50 (T_4), 25:75 (T_5) and 0:100 (T_6) of *B. arundinacea* and *T. procumbens* respectively.

Basal concentrate which made up 50% of the diets was also fed. The animals were offered 4% of their body weight on dry matter basis daily (2% concentrate and 2% forage). Table 1 shows the ingredient and nutrient composition of experimental basal diet.

After the 5-day pre-experimental period with the basal concentrate diet, the rabbits were randomly assigned to the six dietary treatments at 6 rabbit per treatment in a completely randomized design. Water was provided *ad-lib*. Other routine management procedures as practiced at the rabbit farm unit (Adekunle Ajasin University, Akungba-Akoko) were strictly followed. Proximate analysis of diets (concentrate and forage) was carried out according to the procedure described by [27] and shown in Table 2. Feed intake and weight gain were recorded weekly during the experimental period. At the end of the 70-day experimental period, 4 rabbits per treatment (males and 2 females) were randomly selected for determination of carcass and organ characteristics.

1.3. Statistical Analysis

Data were analyzed using the one-way ANOVA procedure of SAS software (16). When dietary treatment was significant ($P < 0.05$), means were compared using Duncan's multiple comparison procedure of the same statistical package

3. RESULTS AND DISCUSSION

Variations between the analysed nutrient composition (Table 2) and basal diet (Table 1) were very marginal in terms of protein. Chemical composition of experimental leaves showed marginal variations per dry matter in comparison except for ash and crude protein with an approximate difference of 4% in favour of bamboo leaves and tridax leaves respectively. Mineral percentages of experimental leaves assayed (Table 3) were comparatively higher in tridax leaves as compared to bamboo leaves.

The performance of rabbits fed experimental diets is shown in Table 4. Final live weights of rabbits fed experimental leaves were not significantly different ($P > 0.05$) from each other. Total weight gain and average weight gain of rabbits on tridax leaves and concentrate alone (T₆) significantly dropped ($P < 0.05$) and differs with other rabbits on different ratio of experimental leaves. Feed intake and feed conversion ratio were not significantly influenced by the varying ratio of experimental leaves. Gradual increase in the levels of bamboo leaves up to 50% combination with tridax leaves resulted in improved performance numerically in final live weight, total weight gain and average weight gain. Rabbits on diet T₄ (50% bamboo leaves + tridax leaves) performed better numerically, though statistically not significant, than all other dietary experimental leaves. This indicates that bamboo leaves could combine effectively with tridax leaves. Percent increase in bamboo levels beyond 50% combination resulted in gradual decrease numerically in performance. This could be attributed to the concomitant increase in anti-nutrients present with increased bamboo levels. The control diet (T₁) was significant ($P < 0.05$) for feed intake, final live weight, total weight and average weight gain when compared to other experimental leaves diet. This is expected considering the fact the control diet had only concentrate containing all the required nutrients in the right proportion. Feed conversion efficiency was poor for all the treatments and control. Crude protein intake was higher in the control than other experimental leaves diet. The variations could be attributed to imbalance in the nutrient composition of the experimental leaves used for the study.

The carcass, organ and by-products of rabbits fed experimental diets are shown in Table 5. Rabbits on experimental leaf diets compare with each other favourably ($P > 0.05$) in slaughter weight, Hot carcass weight and dressing percentage. Treatment T₂ (100% bamboo levels) and treatment T₁ (control) were not significantly different ($P > 0.05$) from each other. There were significant difference ($P < 0.05$) among animals fed experimental diets in fore-leg and hind leg. Animal fed experimental leaves had significant ($P < 0.05$) higher kidney and lung weight than the control. Rabbits on diet T₂ (100% bamboo leaves) were not significant with rabbit on diet T₆ (100% tridax leaves) in the heart, trachea, liver, lung and kidney weights. This indicates that bamboo leaves can replace tridax leaves. The experimental diet did not significantly influence the rabbits' by-products (head, blood and pelt).

Table 1: Ingredient and Nutrient Composition of Experimental Basal Diet

Ingredients	Quantity
Maize	47.24
Wheat Bran	38.00
Soya Bean Meal	12.49
Bone Meal	1.12
Periwinkle	0.58
Salt	0.35
Premix*	0.15
Total	100
Calculated Composition	
Crude Protein %	16.02
ME (Kcal/Kg)	2400.00
Energy : Protein	150:1
ME=Metabolizable Energy; Premix* supplied per type kg diet: Vit. A, 100,00 IU; Vit. D 2,000,000 IU; Vit. E, 23,00mg; Vit K3 2,000mg; Vit. B, 3,000 mg; Vit. B2, 6,000 mg;Niacin, 50,00 mg; Calcium. 800 mg; Panthotenate, 10,000 mg; Vit. B6, 5,000 mg; Vit B12, 250 mg; Folic acid, 100 mg; Biotin 10 mg; choline chloride,40,000 mg; Selenium, 120 mg; Anti oxidant, 120,00 mg	

Table 2: Proximate Composition of Experimental Diets (DM)

Diets	MC (%)	Ash(%)	EE(%)	CF(%)	CP(%)	NFE(%)
Concentrates	8.77	6.96	5.05	3.27	17.08	67.64
<i>B.arundinacea</i>	11.82	15.29	2.71	13.79	21.85	34.54
<i>T.procumbens</i>	11.60	11.77	2.92	15.32	25.25	33.14

MC=Moisture Content; EE= Ether Extract; CF=Crude Fibre; CP=Crude Protein; NFE=Nitrogen free extract; DM=Dry Matter

Table 3: Mineral Composition of Experimental Leaves

Diet	Na(ppm)	Ca(ppm)	K(ppm)	Fe(ppm)	Mg(ppm)	Zn(ppm)
BL	20.10	51.40	38.40	3.95	4.52	0.37
TL	36.70	70.30	40.00	5.39	7.68	1.20

BL=Bamboo leaf; TL=Tridax leaf; Na=Sodium; Ca=Calcium; K=Potassium; Fe=Iron; Mg=Magnesium; Zn=Zinc

Table 4: Performance of Rabbits Fed Experimental Diets

^{abc} = Means with different superscripts within the same row are significantly (P<0.05) different. T₁=100% concentrate/formulated feed which serve as the control; T₂=50% concentrate with 50% (100% Bamboo leaf meal (BLM)); T₃=50% concentrate with 50 % (75% BLM and 25% Tridax leaf meal (TLM)); T₄=50% concentrate with 50% (50% BLM + 50% TLM); T₅=50% concentrate with 50% (25% BLM+75%TLM); T₆=50% concentrate with 50% (100% TLM).

Treatment	Initial weight (g)	Final live weight (g)	Total weight gain(g)	Weight gain (g/d)	FCE (gain/intake)
T ₁	1090.00	1760.00 ^a	669.00 ^a	9.13 ^a	0.107 ^a
T ₂	1100.00	1322.50 ^b	221.50 ^b	3.30 ^{bc}	0.050 ^b
T ₃	1090.00	1372.50 ^b	272.50 ^b	3.33 ^{bc}	0.045 ^b
T ₄	1100.00	1407.50 ^b	307.50 ^b	4.63 ^b	0.065 ^b
T ₅	1040.00	1287.50 ^b	247.50 ^b	3.83 ^{bc}	0.058 ^b
T ₆	1080.00	1237.50 ^b	157.50 ^c	2.38 ^c	0.040 ^b
SEM	28.09	36.18	32.54	0.46	0.005

BLM and 25% Tridax leaf meal (TLM); T₄=50% concentrate with 50% (50% BLM + 50% TLM); T₅=50% concentrate with 50% (25% BLM+75%TLM); T₆=50% concentrate with 50% (100% TLM). SEM: Standard Error of Mean

Table 5: Dry matter intake (g/d) of rabbit fed *B.arundinacea* as a replacement for *T. procumbens*

Dry matter	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	SEM
Concentrate	89.62 ^a	35.80 ^b	37.07 ^b	34.62 ^b	35.16 ^b	34.03 ^b	3.55
<i>B.arundinacea</i>	-	33.23 ^a	27.87 ^b	17.02 ^c	8.73 ^d	-	1.99
<i>T. procumbens</i>	-	-	9.38 ^d	17.05 ^c	26.17 ^b	33.72 ^a	2.05
Total	89.62 ^a	69.03 ^b	74.30 ^b	72.9 ^b	70.02 ^b	67.75 ^b	2.18
CP intake	16.78	14.20	15.55	14.65	15.24	15.03	

^{abc} = Means with different superscripts within the same row are significantly (P<0.05) different. T₁=100% concentrate/formulated feed which serve as the control; T₂=50% concentrate + 50% (100% Bamboo leaf meal (BLM)); T₃=50% concentrate + 50 % (75% BLM and 25% Tridax leaf meal (TLM)); T₄=50% concentrate + 50% (50% BLM + 50% TLM); T₅=50% concentrate + 50% (25% BLM+75%TLM); T₆=50% concentrate + 50% (100% TLM). SEM: Standard Error of Mean

Table 6: Carcass, Organ and By-products of Rabbits Fed Experimental Diets

Parameters	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆
Carcass Characteristics						
SW	1685.00±59.16 ^a	1432.50±257.86 ^{ab}	1332.50±253.95 ^b	1322.50±256.56 ^b	1240.00±95.92 ^b	1175.00±148.21 ^b
HCW	1130.00±50.33 ^a	800.25 ±54.77 ^b	781.75 ±75.33 ^b	844.50 ±194.59 ^b	871.75±122.51 ^b	776.00±79.28 ^b
Dres.(%)	64.22±2.57 ^{ab}	60.54 ±1.33 ^{ab}	60.54 ±1.33 ^{ab}	58.40 ±4.41 ^b	67.21 ±7.50 ^a	62.91 ±3.31 ^b
Foreleg (%)	5.29 ±0.13 ^b	7.37 ±0.21 ^a	6.90 ±1.52 ^a	6.45 ±0.88 ^{ab}	7.76 ±1.54 ^{ab}	7.89 ±1.34 ^a
Hind leg (%)	7.08 ±0.13 ^c	9.22 ±0.48 ^a	8.69 ±1.18 ^{ab}	8.18 ±0.61 ^b	8.84 ±0.35 ^a	9.23 ±0.37 ^a
Linear Measurements						
DL (cm)	31.75±0.50	31.38±1.49	31.13±1.03	30.50±1.00	30.75±1.71	33.00±4.32
LCL(cm)	15.25±2.87 ^{ab}	16.50±1.29 ^a	15.50±0.58 ^{ab}	14.63±1.25 ^{ab}	12.13±3.17 ^b	14.00±2.45 ^{ab}
Internal Organs						

Heart (%)	0.17±0.01 ^c	0.23±0.02 ^{ab}	0.26±0.05 ^{ab}	0.22±0.04 ^c	0.27±0.05 ^{ab}	0.28±0.03 ^a
Trachea (%)	0.17±0.01 ^b	0.24±0.08 ^{ab}	0.18±0.04 ^b	0.20±0.03 ^{ab}	0.27±0.05 ^a	0.22±0.06 ^{ab}
Liver (%)	2.49±0.08 ^{bc}	2.99±0.31 ^a	2.31±0.05 ^c	2.62±0.29 ^b	3.03±0.07 ^a	3.04±0.19 ^a
Lung (%)	0.40±0.01 ^b	0.56±0.10 ^a	0.45±0.09 ^{ab}	0.50±0.12 ^{ab}	0.57±0.07 ^a	0.53±0.08 ^{ab}
Kidney (%)	0.52±0.02 ^c	0.66±0.02 ^{ab}	0.58±0.06 ^{bc}	0.61±0.13 ^{bc}	0.76±0.08 ^a	0.63±0.10 ^{ab}
Stomach(%)	2.72±0.13	2.82±0.39	2.63±0.50	2.55±0.28	2.61±0.69	2.57±0.45
Carcass By-Product						
Head (%)	6.54±0.19	6.91±1.02	6.95±1.61	6.51±0.75	7.04±0.98	7.12±0.93
Blood (%)	0.43±0.10	0.35±0.07	0.30±0.087	0.43±0.19	0.37±0.037	0.51±0.24
Pelt (%)	12.37±1.45	12.35±1.61	13.47±0.68	12.51±1.31	13.74±0.99	12.01±0.68

^{abc}= Means with different superscripts within the same row are significantly (P<0.05) different. T₁=100% concentrate/formulated feed which serve as the control; T₂=50% concentrate with 50% (100% Bamboo leaf meal (BLM); T₃=50% concentrate with 50 % (75% BLM and 25% Tridax leaf meal (TLM); T₄=50% concentrate with 50% (50% BLM + 50% TLM); T₅=50% concentrate with 50% (25% BLM+75%TLM); T₆=50% concentrate with 50% (100% TLM). SW=Slaughtered weight; HCW=Hot carcass weight; Dress= dressing %; DL=Dorsal length; LCL=lumbar circumference.

The crude protein of *B. arundinacea* (21.85%) is higher than other species of bamboo leaves (*B. vulgaris vittata* 18.75%; *B. vulgaris vulgaris* 18.39%, *B. ventricosa* 19.02% and *O. abyssnica* 19.39%) [20]. However the CP content of bamboo leaf used in this study is lower than that recorded for cassava (*M. utilisima*) leaves, which contain 24.85% and 31.00% for *T. Triangulare* [28,29]. The high crude fibre (13.79%) suggests that animals will prefer them less to alternatives that have lower crude fibre such as *P. Purpureum*, which has 9.09% [30]. This support the findings by [25] who reported that bamboo leaves can impart superior physical tone and stamina to horses since fibre speeds up the process of digestion by improving peristalsis. It has long been established that dietary fibre supply also plays a major role in the prevention of digestive troubles in growing rabbits [31]. Fibre is known to promote caecal fermentation in fattening rabbits [32,33,34]. A sufficient level has been linked with improved digestive health [33,35,36] and especially under epizootic rabbit enteropathy circumstances an increased dietary fibre level has been proven to reduce mortality in growing rabbits [37,38]. Investigations made by [39] and [40] revealed that high crude fibre content could be instrumental in preventing colon cancer and gastrointestinal disorders. The bamboo leaves used in this study contains little amount of crude fat as well as low moisture content. Low moisture content make bamboo leave decay resistant, as these would limit the growth of decay micro-organisms and prolong their storage lives [41]. The crude fat content of the bamboo leaves (2.71%) is low compared to 5.90% reported for *T. Triangulare* and 4.80% for *Amaranthus hybridus* [28,29]. The ash content of the bamboo leaves (15.29%) is lower than 18.18% reported for *P. purpureum* [28]. The ash content in the bamboo leaves is higher than that of Tridax leaves (11.77%) and both suggest their possession of a large deposit of minerals [42]. The ash contents of plant are directly related to the mineral composition of the soil, that is, their growth sites. This situation is proven by the fact that previous figures for various bamboo species collected from different part of the world by [43] ranged from 3.3% especially for *Arundinaria canna viera* collected in Brazil to 16.9% for *B. vulgaris* collected in Jamaica [44]. Studies have reported significant decrease in total feed intake of rabbits fed concentrate and forages [45,46,47]. However the non- significant effect (P>.05) in total feed intake of rabbits fed concentrate and

different forage combination in this study could be attributed to the feed restriction trial adopted. Non significant effect of forage diet combinations on weight gain of rabbits observed in this study (T_2 - T_5) agrees with the report of [47] who fed varying levels (100, 75, 50 and 25%) of concentrate and forage to grower rabbits. [48] also reported a non-significant difference in weight gain of rabbits fed different inclusion levels of *Alchornea cordifolia* leaves. Treatment T_2 (100% inclusion level of bamboo leaves) had better weight gain numerically than T_6 (100% inclusion level of Tridax leaves). This suggests that rabbit can thrive well if fed solely on bamboo leaves or in combination with other forages. This is in support of the findings of [49] who stated that rabbits are pseudo-ruminants and as such are able to utilize forages as well as concentrates. There are significant differences in daily weight gain of rabbits fed varying levels of bamboo and tridax leaves (2.38 to 3.33g/d) and the all concentrates control (9.13g/d). This is similar to the findings of [46] who reported significant differences in daily weight gain of weaner rabbits fed varying levels of concentrate, cynodon and centrosema combinations (10.13-6.51g/d) and the all concentrate control (19.22g/d). The daily weight gain reported in this study (except T_6) are similar to those reported by [46] and [47,50] but lower than that reported by [45] and [51]. Differences in body weight and rate of gain of rabbits can be attributed to differences in the nutrient composition of forages offered and the restricted feeding trial adopted in this study. The low feed conversion efficiency obtained in this study is similar to that reported by [50] who fed rabbits different combinations of concentrate, grass and legume. The low FCR can be attributed to the high fibre content of the forage diets and the nature of the feeding trial. The non-significant differences in FCR of rabbits fed the different forage combination (bamboo and tridax leaves) shows that rabbits responded similarly in terms of feed utilization.

Changes in organ/carcass weights of the rabbits fed concentrates and varying levels of forages (bamboo and tridax leaves) are shown in Table 6. The non-significant difference ($P>0.05$) observed in carcass characteristics of rabbits fed varying levels of bamboo and tridax leaves agrees with [52] who observed a non-significant difference in the dressing percentage of rabbits fed *Stylosanthes guianensis* and Lablab purpureus forage. It also agrees with the findings of [53] who reported non-significant difference in carcass characteristics of rabbits fed Gliricidia leaf meal (GLM). The significant difference obtained in hindleg, forelimb agrees with the report of [54] who observed significant difference in thigh and loin of rabbits fed carrot leaf meal at 0, 15, 30, 45 and 60% inclusion levels. Variations in heart, lung, liver and kidney weights were significant for the different dietary combinations. The weight of internal organs like the liver and kidney are commonly used in animal feeding experiments as evidence of toxicity [55]. Increase metabolic rate of the organs in attempt to reduce toxic or anti-nutritional factors in livestock feeds to non-toxic metabolites may cause abnormalities in their weights [56]. It is obvious in this study that the weight of organs such as liver, heart and kidney were significantly higher in rabbits fed T_2 (100% bamboo leaves inclusion levels) and T_6 (100% tridax leaves inclusion levels) when compared to the all-concentrate diet. This could be attributed to the anti-nutrient present in leaves as both bamboo and tridax leaves used in this study contains some anti-nutritional factors such as condensed saponins, tannins and alkaloids. These agree with the work of [57] who reported that diets containing more than 1% mimosine and tannin impair growth performance and have deleterious effects on the liver of rabbits. However, the organ weights of rabbits on diet T_2 (100% bamboo leaves inclusion levels) was not significantly ($P>0.05$) higher than rabbits on diet T_6 (100% tridax leaves inclusion levels) and as such implies the safety of bamboo leaves to the health of the rabbits. This result is similar to the report of [58] who observed non-significant lung, kidney, heart and pancreas weights in rabbit fed sorghum offal-based diets. Values reported for the various organs in this study agrees with those reported for rabbits fed concentrates, *Aspilia africana* and *Tridax procumbens* [59], rabbits fed Mucuna utilis leaf meal [60] and rabbits fed boiled pigeon pea leaf meal [61]. The levels of anti-nutrients in the leaves used in this study are within bearing threshold of the animals since no death were recorded all through the 70 days feeding trial. The carcass by-products were not significantly influenced by the various forage combinations and concentrates.

Conclusion

It can be concluded from this study that bamboo leaves, when combined with tridax leaves, up to 50% inclusion levels could be utilized as forages for feeding grower rabbits. Giving the perennial nature of bamboo leaves, it could help in reducing the overdependence on concentrate thereby reducing the cost of production especially during the dry season.

Ethical Approval

All authors hereby declare that 'Principles of laboratory animal care were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

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