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Effect of *Cajanus cajan* (L.) Supplementation on Growth, Nutrient Digestibility and Biochemical Indices of Giant Rat (*Cricetomys gambianus* Waterhouse, 1840)

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EE and EF wrote the research, and revised the article. EO conceptualised the central research idea and provided the theoretical framework. OC and NI designed the research, supervised research progress while OG and HF anchored the review, revisions and approved the article submission.

Key words
***Cajanus cajan*, Digestibility, Growth performance, *Cricetomys gambianus*, Biochemical**

ABSTRACT

The effects of *Cajanus cajan* on growth, nutrient digestibility and biochemical indices of 54 Giant rats were studied for 42 days department of zoology laboratory of University of Nigeria, Nsukka. The rats were divided randomly into six groups of 0%, 10%, 20%, 30%, 40% and 50% *C. cajan* diet respectively, with a total of 9 giant rats in each group. The diets contained protein, fibre, ash, fat and sugar /energy. Feed efficiency increased in the rats fed on 30% and 50% *C. cajan.* Crude protein digestibility decreased ($P< 0.05$) with increased levels of *C. cajan*. The values of plasma total protein, albumin, Albumin/ Globulin ratio, glucose, total cholesterol and urea nitrogen revealed non- significant changes among the groups that received different dietary treatments ($P>0.5$). The activities of small intestine trypsin of rats fed on diet 20% were higher than those of other diets, ($p<0.05$). The rats fed on 50% diet had the highest relative weight of stomach while the ones fed on 0% diet had also the highest relative weight of small intestinal contents and caecum. Inclusion of *C. cajan* also increased ($P< 0.05$) the relative weights of kidney, liver and carcass cut parts. This study recommend that *C. cajan* be included in growing giant rats diets up to 25% of the dry matter.

INTRODUCTION

The inclusion of alternative feedstuffs in animal diets might be interesting in some circumstances such as relative price, feed quality, but it is limited because of the lack of information on their nutritive value ( ). Pigeonpea (*Cajanus cajan*) is a perennial member of the family Leguminosae. Other common names are red gram, Congo pea, Gungo pea, Gunga pea, and no-eye pea (Salunkhe *et al*., 1986). It is an important grain legume crop of rain-field agriculture in the tropics and subtropics. It is used in more diverse ways than other grains (Wu *et al*., 2009). The extracts or components of pigeonpea are commonly used all over the world for the treatment of diabetes, dysentery, hepatitis and measles, as well as a febrifuge to stabilize the menstrual period (Grover *et al*., 2002). As a traditional Chinese medicine, the leaves of pigeonpea have been widely used to arrest blood, relieve pain and kill worms. Currently, pigeonpea leaves are used for the treatment of wounds, aphtha, bedsores and malaria, as well as diet-induced hypercholesterolemia, etc. (Aiyeloja and Bello, 2006). Protective effects of extracts from pigeonpea leaf against hypoxic-ischemic brain damage and alcohol-induced liver damage has also been reported (Huang *et al*., 2006). Chemical constituent investigations have indicated that pigeonpea leaves are rich in flavonoids and stilbenes, which are considered responsible for the beneficial efficacies of pigeonpea leaves on human health (Duker-Eshune *et al*., 2004). These days it is the most essential ingredient of animal feed used in West Africa, especially in Nigeria, where it is also grown. Pigeon peas are very drought-resistant, so can be grown in areas with less than 650 mm annual rainfall. A number of processes have now been developed for converting the seed into various products such as food, feed, paste, fried ball, medicine, menstrual stabilizer, cough syrup etc. (Ekeh *et al*., 2013). Pigeon pea foliage is an excellent fodder with high nutritional value. One of the most significant factors, which determine the nutritive value of a feed is its

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digestibility.

Dietary protein, fibre and sugar levels are the three most important factors which affect giant rat growth performance, without neglecting moisture content, ash and fat levels. As a result, an attempt should be directed to detect the exact levels of protein, fibre and sugar without lowering the giant rat growth performance. The nutritional requirements for giant rats in various production functions (feeding, growth and digestibility) are limited (Yassein *et al*., 2011). Crude protein (CP) is the most common unit used to express nitrogen requirements and the nutritive value of feedstuffs. The dietary CP requirement of growing giant rats is about 15.5% (Carlos and Wiseman, 2010). The sugar concentration of giant rat diets varies widely. It has been reported that dietary CP contents of around 140 g kg^{-1} do not impair growth performance if the digestible protein (DP): digestible sugar ratio is maintained around 9.5-10 g MJ^{-1} and the amino acid supply is adequate (Carlos and Wiseman, 2010). On the other hand, an excess of protein content related to sugar increases environmental pollution (Carlos and Wiseman, 2010). Several studies (Carlos and Wiseman, 2010; Liu *et al*., 2012) have also observed that a reduction in dietary protein content or the use of highly DP sources decreases ileal protein flow and reduces the proliferation of pathogens and mortality during the fattening period.

Fibre plays a major role in the regulation of rate of passage of digesta, the control of gut flora and the maintenance of intestinal mucosa integrity (Carlos and Wiseman, 2010). It has also been observed that fibre is essential in the maintenance of gut health, stimulation of gut motility (insoluble fibre only), and reducetion of fur chewing (Irlbeck, 2001). Low-fibre diets result in gut hypomotility, reduced caecotrophe formation, and prolonged retention time in the hindgut (Irlbeck, 2001). Some investigators (De Blas *et al*., 1999; Liu *et al*., 2012) suggested increasing fibre level in giant rat diets in order to reduce gut disease. Many works have been done on digestibility, feed acceptance and growth performance on rabbit and other animal models (Liu *et al*., 2012), but there`s dearth of information on growth performance, nutrient digestibility and biochemical indices of giant rats. Hence the present study has investigated the response of giant rats to different protein, fibre and sugar levels on growth performance, digestibility level and the development of digestive organs in growing giant rats.

MATERIALS AND METHODS

Collection and preparation of C. cajan *feed*

Pigeon pea (*C. cajan*) collected from the feed processing unit of the Department of Food Science and Technology, University of Nigeria, Nsukka was sun-dried for 3 days, then oven-dried and ground in a hammer mill. The contents of crude protein (CP), crude fibre (CF), sugar, moisture, ash and fat were 31.08, 5.68, 63.29, 8.10, 2.50 and 3.35 mg/g dry matter, respectively. A basal diet was formulated with three other diets by substituting 10, 20,30, 40 and 50% of the diet with pigeon pea (Table I).

Table I. Ingredients and composition of experimental diets.

Ingredients	Levels of *Cajanus cajan* feed in diets (%)					
	0	**10**	**20**	**30**	**40**	**50**
Soya bean	18.0	17.0	16.0	15.0	14.0	13.0
Pigeon pea	0.0	21.0	19.0	18.0	17.0	16.0
Blood meal	2.0	2.0	2.0	2.0	2.0	2.0
Maize	45.0	45.0	45.0	45.0	45.0	45.0
wheat bran	28.6	20.5	16.7	13.8	11.6	8.8
Bone meal	1.0	1.0	1.0	1.0	1.0	1.0
Salt	0.2	0.2	0.2	0.2	0.2	0.2
Premix	0.3	0.3	0.3	0.3	0.3	0.3
Composition (%)						
Dry matter	69.0	69.8	69.6	70.4	70.8	71.2
Crude protein	18.51	18.60	18.68	18.76	19.15	19.18
Crude fibre	13.18	11.65	10.88	10.14	10.08	10.00
Gross energy/sugar (MJ/g)	11.34	10.39	10.45	10.50	10.48	10.50

Animals and diets

A total of 54 male giant rats (*Cricetomys gambianus*) with mean body weight 0.81±0.09kg were used in this study. The rats were divided randomly into six diet feeding groups *viz*., 0, 10, 20, 30, 40 and 50% with each group having 3 replicate of 3 rats each. The diets were formulated with protein, fibre and sugar/energy according to the requirements of growing giant rats, as in growing rabbits (Carlos and Wiseman, 2010). During the trials, the giant rats were housed in a closed and ventilated building in which the minimum and maximum temperatures were 15 and 28 °C respectively and the relative humidity ranged from 50% to 65%. A cycle of 12 h from 6:30 to 18:30 of light and 12 h of darkness was used throughout the trial.

Experimental procedures

Experimental period lasted for 42 days that is 7-days acclimatization period followed by a 35-days experimental period. Body weight, weight gain and feed/gain (F/G) ratio were measured weekly following the method of Li *et al*. (2002). After the experimental period, 3

giant rats from each group were slaughtered following the method of Zhang *et al*. (2011), and the weight of stomach, small intestine, caecum and their contents were measured. The activities of small intestine amylase, trypsin and lipase in giant rats were measured using the kits following the instruction (Nanjing jiangcheng Bioengineering Institute, China). Blood samples were collected from marginal ear vein of each treatment into heparinized tubes to determine some biochemical and hormonal studies following the method of Zhang *et al*. (2011). The biochemical parameters such as total protein, albumin, albumin/globulin ratio, glucose, total cholesterol and urea nitrogen (UN) were measured using kits according to the instruction (Nanjing jiangcheng Bioengineering Institute, China).

Assessment of growth performance parameters

The weight gain and specific growth rate (SGR) were calculated. SGR was calculated using SGR=logw_2-logw_1÷T_2-T_1 x 100/1, where W^2=weight at time T^2 (days), W^1=weight at timeT^1 (days) (Brown, 1975).

The feed intake was obtained by subtracting the quantity of feed remaining from the quantity of feed given for each day (Ingweye, 2015). The feed conversion ratio (FCR) was obtained by measuring the amount of feed consumed per unit weight gained (Ingweye, 2015). The feed efficiency ratio (FER) was determined as weight gain (b)/Feed intake (a), where feed intake (a)= feed eaten by the rat on a matter basis, weight gain(b)= a weight increase on dry matter basis (Ingweye, 2015). The apparent nutrient digestibility coefficients (ANDC) were calculated as described by Obun and Ayanwale (2006):

$$ANDC = \frac{\text{Nutrient in feed} - \text{Nutrient in faeces}}{\text{Nutrient in feed}} \times \frac{100}{1}$$

The cost benefit of *C. gambianus* was estimated using weight gain and specific growth rate against management and construction cost. The cost of feeding the rat was computed using (Lipton and Harnel, 2004):

C_{feed}= PxWaxFCR/1-[0.5(1-S)]

where C_{feed} is cost contribution of feed to produce a pound of giant rat, P is per pound price of giant rat, Wa is weight added from purchase of immature giant rats to mature size (mature size- immature giant rat weight), FCR is feed conversion ratio and S is percentage of giant rat surviving from immature to mature size.

Cost of stocking the different groups of rat was computed using: C_{seed}= P_{feed}/WxS (Lipton and Harnel, 2004).

where C_{seed} is cost of contribution for producing a pound of giant rat, P_{feed} is purchase price of feed (*Cajanus cajan* grain), W is average weight of matured giant rats, S is percentage of rats surviving from immature to matured size.

Management cost was computed using (Lipton and Harnel, 2004): $C_{variable}$ = C_{seed} x C_{feed}

Blood analysis and carcass trait measurement

Three rats per treatment were selected and bled before the morning feeding in the last week of the experiment. About 5 ml of blood was immediately collected from each giant rat into sample bottles containing Ethylene Diamine Tetra-acetic acid (EDTA) as anti-coagulant and into other bottles without EDTA for serum metabolites. The blood was analysed for haemoglobin, red blood cell, white blood cell, total protein, albumin, urea, creatinine, cholesterol, serum glutamic oxaloacete transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT). The blood chemistry data were obtained according to procedures reported by Onifade and Tewe (1993) and Onifade *et al*. (1999).

At the end of the feeding period, feed was withheld overnight and the giant rats slaughtered. The weights of the cut parts *viz*., hind and fore limbs, lumbar region, thoracic region and breast were determined, as well as the weights of the liver, kidneys, heart and lungs.

Carcass sensory evaluation

Lumbar region and hind limb muscle were evaluated one week after slaughtering. Frozen meat was thawed with the bone intact. The meat was cooked at 170 ° C in a conventional preheated gas oven for 20 mins. Cooked meat was removed from the oven, allowed to cool for 10 mins, deboned and muscles cubed A modified scoring scale was employed in assessing the meat (Williams and Damron, 1998).

Statistical analysis

Data collected were subjected to analysis of variance, (Daniels, 1995). When analysis of variance indicated significance for treatment effects, specific differences between means were detected by the New Duncan Multiple range test (Duncan, 1955).

RESULTS

Growth performance of rats fed Cajanus cajan *supplemented diet*

The growth performance of the giant rats fed *C. cajan* supplemented diet are shown in Table II. The only observed significant changes were on the final weight and feed efficiency ratio for the duration of the study.

From the graph on the progressive percentage weight, the percentage weight gain of the giant rats increased arithmetically from the first week to the last week for all the experimental units (Fig. 1). The weight of the giant rats fed supplemented diet however, improved much higher than the control ($p < 0.05$). All the groups fed graded *C. cajan* supplemented diet had gained significantly more

weight than the control ($p < 0.05$).

From the 7th day after feeding with *C. cajan* supplemented diet to the 42nd day, the FCR of all the G. rats fed *C. cajan* were significantly lower than that of the control ($p < 0.05$) (Fig. 2).

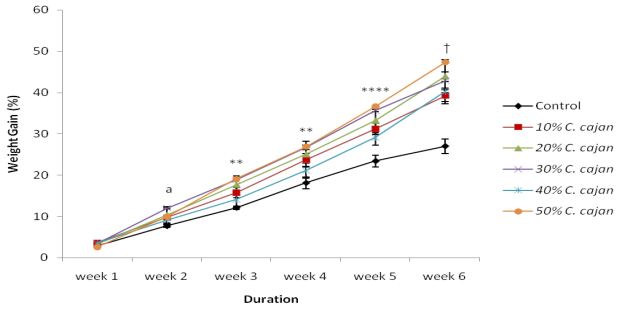

Fig. 1. Progressive change in percentage weight gain of rats fed *Cajanus cajan* supplemented diet. † All groups are significantly higher than control. All significant level at $p < 0.05$.

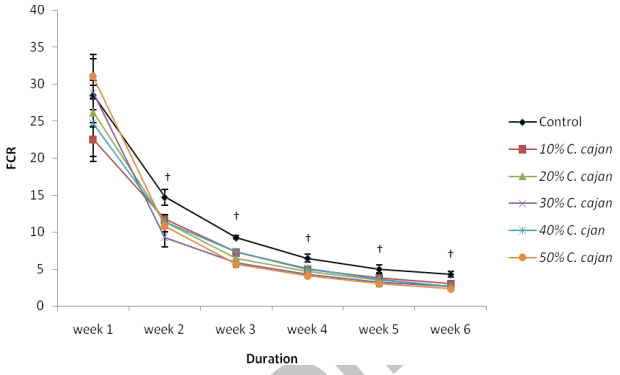

Fig. 2. Progressive change in feed conversion ratio of rats fed *Cajanus cajan* supplemented diet. FCR is feed conversion ratio. ‡All significantly lower than control. All significant level at $p < 0.05$.

The feed efficiency ratio (FER) of the giant rats had the same pattern as the percentage weight gain for the duration of the study; The FCR increased progressively in all the experimental units from the first to the last week of the study ($p < 0.05$) (Fig. 3).

The digestibility coefficients of the giant rats fed C. cajan *supplemented diet*

The digestibility coefficient for protein, carbohydrate/ sugar and fibre were in descending order and each value was significantly different from the other ($p < 0.05$) (Table III).

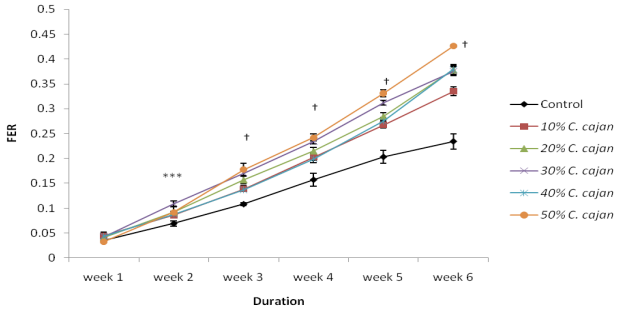

Fig. 3. Progressive change in feed efficiency ratio of giant rats fed Cajanus cajan supplemented diet. FER = feed efficiency ratio. ***All the graded percentages of C. cajan were significantly higher than control.† All significant level at $p < 0.05$.

Blood biochemical parameters

No differences ($P > 0.05$) were observed among the dietary groups for enzyme activities (SGPT, SGOT) and other blood metabolites except in cholesterol, which increased ($P<0.05$) with *C. cajan* inclusion in diets (Table IV).

The result of protein profile, glucose, total cholesterol, UN level and enzyme activities of giant rats in all groups were presented in Table V.

Table II. Growth performance of the giant rats feed *C. Cajan* supplemented diet.

Parametrs	Level of *C. cajan* in meal percentage					
	0	**10**	**20**	**30**	**40**	**50**
Initial weight(g)	70.5 ±1.23	70.22±3.48	70.62±3.25	61.30±1.70	66.72±0.45	64.00±3.65
Final weight(g)	71.55±1.22	75.02±3.62	76.56±2.37	78.25±2.07	82.13±0.60	83.66±35.64
Weight gain(g)	10.17±0.832	15.07±0.31	15.17±1.15	16.17±0.70	14.36±0.61	16.81±0.40
Weight gain (%)	15.55	15.65	15.64	15.66	15.64	15.67
Food intake (g)	178.50±0.00	178.50±0.00	178.50±0.00	178.50±0.00	1878.50±0.00	178.50±0.00
Food conversion ratio	10.25±0.37	7.73±0.48	8.12±1.02	8.01±0.38	8.12±1.08	8.40±0.63
Food efficiency ratio	0.12±0.006	0.17±0.004	0.18±0.008	0.21±0.008	0.22±0.009	0.24±0.006

Table III. Performance and apparent nutrient digestibility of giant rats fed increasing levels of *C. cajan* diet (Mean ±SEM).

Nutrients	Levels of *C. cajan* in diets (%)					
	0	10	20	30	40	50
Crude protein	58.03±0.57	53.25±0.98	52.58±1.00	50.64±0.80	48.67±0.64	40.98±0.74
CHO/sugar extract	64.51±0.37	62.84±0.42	60.21±0.54	58.80±0.32	59.89±0.88	56.68±0.97
Crude fibre	45.96±1.47	38.89±1.20	34.26±1.37	31.60±1.40	29.21±1.25	21.89±1.45
Fat extract	3.52±0.54	4.47±0.50	5.62±0.67	6.53±0.57	8.46±0.79	8.69±0.59

Values as mean ± S.E. Values with different alphabet superscript in a column were significantly different at $p < 0.05$.

Table IV. Mean values (with SEM) of blood biochemical indices of Giant rats fed increasing levels of *C. cajan.*

Biochemical indices	Levels of *C. cajan* in diets (%)					
	0	10	20	30	40	50
Haemoglobin (g/100ml)	11.00± 3.00	13.20± 0.20	12.70± 0.40	13.60±0.40	13.67±0.50	13.80±0.40
Red blood cell (mil/mm^3)	3.00± 0.50	3.70± 0.50	3.50± 0.22	4.00±0.50	4.01±1.01	4.17±1.03
White blood cells (no/mm^3)	4100±90.0	5000± 90.0	4100± 40.0	4300± 140	4500±138	4500±140
Total protein (mg/100ml)	47.00± 1.00	58.00± 4.00	55.00± 4.00	60.00± 2.00	58.00±4.00	60.00±4.00
Albumin (mg/100ml)	24.00± 0.05	30.00± 2.00	29.00± 0.05	31.00± 1.00	30.00±1.00	31.00±1.00
Urea (mg/100ml)	18.00± 4.00	23.00± 1.00	22.00± 2.00	24.00± 3.00	25.00±1.00	26.00±2.00
Creatinine (mg/100ml)	1.20± 0.10	1.25± 0.10	1.30± 0.10	1.40± 0.20	1.44±0.11	1.50±0.12
Cholesterol (mg/100ml)	155.00^c±0.50	177.00^b±1.00	178.00^b±0.50	198.00^a±1.00	202.00^a±2.00	204.00^a±2.00
SGOT (IU/litre)	26.00± 0.50	28.00± 1.00	27.00± 1.00	28.00± 0.50	27.00±0.50	28.00±0.50
SGPT (IU/litre)	25.00± 1.00	26.00± 1.00	26.00± 0.50	27.00± 0.50	26.00±0.50	28.00±1.00

abc: Mean values in row without letter in common are different at $P<0.05$, serum glutamic oxaloacete transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT).

Table V. Protein profile, glucose, total cholesterol, UN level and enzyme activities of giant rats fed on different dietary nutrition levels (*C. cajan*).

Parameters	Traits						MSE[1]	P Value
	0	10	20	30	40	50		
Total protein (g/L)	39.39	36.72	39.06	38.72	36.39	39.69	7.041	0.6602
Albumin (g/L)	13.22	15.06	18.00	17.06	16.22	17.00	2.981	0.3763
Albumin/Globulin	0.83	0.98	0.65	0.61	0.60	0.52	0.018	0.057
Glucose (mmol/L)	4.13	5.04	5.47	3.70	3.87	3.87	0.080	0.0801
Total cholesterol (mmol/L)	0.29	0.47	0.08	0.09	0.23	0.36	0.371	0.5730
Urea nitrogen (mmol/L)	7.45	8.50	6.52	8.82	14.53	9.78	2.577	0.0481
Enzyme activities (U/g)								
Amylase	0.3263	0.0054	1.3381	1.1210	0.0366	0.1212	0.076650	0.05643
Trypsin	50306^{ab}	20076^b	87614^a	40222^{ab}	23538^b	37750^b	15620	0.0244
Lipase	28620	46470	15126	22822	01202	01202	02032	0.0576

[1]MSE: root-mean-square error.

Effect of dietary nutrition levels of C. cajan *on digestive organs and their contents*

The relative weights of stomach, small intestine, caecum and their contents of giant rats were shown in Table VI. The relative weight of stomach of rats fed on diet 50% was higher than those of other diets, followed by diet 10, 0, 20, 40, and 30%, respectively. The small intestinal contents of giant rats fed on diet 0% was higher than other groups,

Table VI. The weight of digestive organs head, limbs, breast, lumbar region and several organs affected by different dietary nutrition levels of *C. cajan.*

Relative weight (g/Kg)	Level of *C. cajan* in carcass traits (%)						SEM[1]	P Value
	0	10	20	30	40	50		
Stomach	53.8^{ab}	55.1^{a}	42.6^{b}	41.2^{b}	42.4^{b}	61.3^{a}	7.068	0.0120
Stomach contents	14.3	14.5	15.2	14.0	13.8	15.0	0.800	0.1835
Small intestine	74.3	53.8	55.6	44.0	62.1	58.1	10.60	0.0545
Small intestinal contents	46.0^{a}	34.2^{bc}	45.0^{a}	32.4^{c}	40.7^{ab}	36.2^{bc}	3.073	0.0002
Caecum	98.2^{a}	64.2^{c}	67.4^{c}	86.5^{ab}	66.3^{bc}	84.2^{ab}	6.077	0.0001
Caecum contents	17.3	15.4	14.1	16.0	14.4	14.0	1.265	0.0765
Head	6.44 ± 0.06^{b}	6.34 ± 0.13^{b}	7.55 ± 0.13^{a}	7.85 ± 0.03^{a}	7.85± 0.02^{a}	8.00±0.13^{a}		
Hind limb	10.28±0.12	12.12±0.12^{b}	15.05 ± 0.12^{a}	14.77 ± 0.12^{a}	15.05±0.12^{a}	16.00±0.12^{a}		
Fore limb	8.60 ± 0.12^{b}	7.00 ±0.12^{c}	10.06 ±0.12^{a}	8.65 ± 0.12^{b}	10.06±0.12^{a}	10.20±0.12^{a}		
Breast	0.57 ±0.12^{b}	1.212± 0.12^{a}	1.3625± 0.12^{a}	0.53 ± 0.12^{b}	0.53±0.12	1.30±0.12^{a}		
Lumbar region	9.878±0.12^{c}	9.87±0.12^{c}	15.04 ± 0.12^{a}	13.00 ± 0.12^{b}	15.15±0.12^{a}	16.05±0.12^{a}		
Heart	0.18 ± 0.05	0.18±0.05	0.20 ± 0.05	0.23 ± 0.05	0.24±0.05	0.25±0.05		
Lungs	0.31 ±0.06	0.46 ±0.06	0.56 ± 0.06	0.56 ± 0.06	0.47±0.05	0.56±0.06		
Kidneys	0.46 ± 0.06^{c}	0.67 ± 0.06^{b}	0.74± 0.06^{a}	0.74 ± 0.06^{a}	0.74±0.06^{a}	0.80±0.06^{a}		
Liver	2.01± 0.03^{c}	2.54± 0.06^{b}	2.83± 0.06^{a}	2.50± 0.04^{b}	2.85±0.04^{a}	2.87±0.06^{a}		
Visceral organs	16.34±0.06^{c}	26.40± .06^{b}	27.03 ± 0.06^{a}	14.00 ± 0.06^{d}	26.50±0.06^{b}	28.35±0.06^{a}		

abc: Mean values in rows without letter in common are different at P<0.05

while in that of caecum, giant rats fed on 0% diet was higher than other groups (Table VI). The relative weight of stomach of giant rats fed on 50% diet was higher than every other group.

Carcass traits and meat quality

No significant difference was observed for the weights of heart and lungs between treatments. The weights of kidneys and liver of giant rats fed *C. cajan* diets were significantly higher than those in the control diet (P< 0.05). There were no significant effects (P> 0.05) on juiciness, flavour, tenderness and overall acceptance among the meat samples from giant rats fed 0, 10, 20, 30, 40 or 50% *C. cajan* supplemented diet (Table VI).

DISCUSSION

The study showed that the weight gain of the experimental giant rats increased progressively from 10%. The measure of the increase in the weights of giant rats fed with graded levels of *C. cajan* was higher than that of the control. This shows that the nutrients of the supplemented diet *C.cajan* (protein, sugar, fibre) plays a vital role in growth, this is in agreement with the work of Alagbaoso *et al*. (2015).

The feed conversion ratio (FCR) for all the rats fed with *C. cajan* diet were lower than that of the control for the entire period of the experiment. The feed efficiency Ratio (FER) which is the reverse of FCR was increased progressively like the weight gain. The FCR and FER maintained the trend throughout the experiment and were indicative of the growth of the animals progressively across the different concentrations. Similar results have been demonstrated by Alagbaoso *et al*. (2015).

The digestibility coefficient of the protein decreased with increasing concentration. It implies that more the protein in the feed, the more the protein given out. The digestibility coefficient of fat was almost in the reverse order to that of protein. This showed that the more the fat consumed, the less the fat passed out and vice versa. This is in line with the findings of Dijkstra *et al*. (2005); which postulated that animals digest a lager percentage of the nutrients in their feed when fed restrictedly than when they receive full or abundant feed. The digestibility coefficient of carbohydrate and fiber appears to be in reverse order as that of protein (Fanimo and Oluseyi, 2003).

The result of the growth study showed that the growth rate increased progressively across the different concentrations of *C. cajan* in the feed and as such, *C. cajan* has positive effect on the growth performance of giant rats. This agreed with the works of Li *et al*. (2002) and Yassein *et al*. (2011) in similar studies with rabbit.

Productive performance result of average daily gain (ADG), average daily feed intake and F/G rate of giant rats is influenced by dietary protein, fibre and energy/sugar. No significant difference was detected for the average daily feed intake in all groups. Our results were similar to those reported by Dias *et al*. (2000), Li *et al*. (2002) and Yassein *et al*. (2011). The relative weight of stomach of giant rats fed on diet 50% was higher than those of other diets, while caecum of giant rats fed on control diet was higher than other groups. However, the relative weights of stomach contents, small intestine and caecum contents have no significant changes in all diets (P>0.05). The results showed that the amount of CF consumed as the optimal dietary fibre level was encouraging since the fibre is the most essential nutrient for giant rats. The results were similar to those reported by Tao and Li (2005) and Chao and Li (2008). The activities of small intestine amylase, trypsin and lipase in giant rats showed that the activities of small intestine trypsin of giant rats fed on 20% diet were higher than in other diets, while there were no significant changes in the activities of small intestine amylase and lipase. These results confirmed those of previous experimental results (Li *et al*., 2004). The protein profile, glucose, total cholesterol, UN level and enzyme activities of giant rats in all groups reflect the effect of dietary nutrient level on metabolism and absorption. It is evident that the values of plasma total protein, albumin, Albumin/Globulin ratio, glucose, total cholesterol and UN revealed non-significant changes between all groups (P>0.5). This result is closely associated with those previously recorded in rabbits by Yassein *et al*. (2011).

As shown in the digestibility study, the mechanisms directing the growth responses observed in the giant rats appear to be unrelated to nutrient digestibility. Although the growth rates of giant rats fed diets containing 20 and 30% *C. cajan* were better, there was no advantage in digestibility of *C. cajan* diets over the control. The superior performance of giant rats fed *C. cajan* diets was corroborated by the numerical increase in serum total protein and albumin. Total protein and albumin are good indices of the quality of dietary proteins. The cholesterol values for giant rats on the *C. cajan* diets were quite high. There were no significant differences in the blood urea concentration. According to Oduguwa *et al*. (2000), three factors influence blood urea concentration: the quantity of protein in the diet, the quality of fibre in the diet, and the time of sampling after feeding. These three factors were similar in the dietary treatments except the quality of the protein mixture. It is evident that the values of plasma total protein, albumin, Albumin/Globulin ratio, glucose, total cholesterol and UN revealed non-significant changes between all groups, even the enzymatic activities did not show any trend (P>0.5). This result is closely related with works previously recorded in rabbits by Yassein *et al*. (2011) and Liu *et al*. (2012), but none has been recorded in giant rats (*Cricetomys gambianus*). The hind limb and lumber region are the most economically important portions of the carcass and also provide the greatest portions of edible meat in giant rats. Inclusion of *C. cajan* supplemented diets consistently increased the relative weight of these two cut parts.

The observation that weights of lungs and heart in the giant rats were not significantly different further support the adequacy of the *C. cajan* diets. Green *et al*. (1986) demonstrated that growth of organs can be inhibited when insufficient protein and amino acids are available. In our study the protein digestibility of the diets was normal. Contrarily, feeding with *C. cajan* elicited higher (P< 0.05) weights of kidneys and liver.

Generally, the sensory evaluation ratings of the meat from giant rats on the treatments were similar, indicating no adverse effect of feeding *C. cajan* diet on giant rats.

CONCLUSION

This study showed that inclusion of *C. cajan* in giant rat dietary feed has no adverse effect on the performance, development of digestive organs, protein digestibility and carcass taste and quality and so recommended in giant rat feed supplement up to 25% dry matter.

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Statement of conflict of interest

The authors have declared no conflict of interest.

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