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Research Article

Effects of Graded Crude Protein Diet on Serum Biochemical Parameters of African Giant Rat (*Cricetomys gambianus*) Reared in Ibadan, Nigeria.

Olawuwo, O. S.[1,2], *Olaogun, S. C.[3,4], Azeez, O. I.[1] and Oyewale, J. O.[1]

Departments of [1]Veterinary Physiology and Biochemistry and [3]Veterinary Medicine Faculty of Veterinary Medicine, University of Ibadan. Ibadan, Nigeria.

Departments of [2]Paraclinical Science and [4]Production Animal Studies, Faculty of Veterinary Science, University of Pretoria, Onderstepoort 0110, Pretoria, South Africa.

ABSTRACT

The domestication of African giant rats (AGRs) to supplement animal protein needs in Nigeria and its potential as a laboratory animal model for biomedical research have not been fully exploited. Thirty AGRs divided into 5groups (A-E) were used for the experiment. The rats were fed with feed containing graded protein at 9.83%, 14.79%, 21.21% (control), 23.93% and 27.84% crude protein in feed for a period of 10weeks. They were then sampled on day 28 and day 56 by collecting 5mls obtained from the orbital sinus of the AGRs into lithium heparinized (20u/ml) tubes for serum biochemical analysis. On day 28 the levels of sodium, potassium, urea and creatinine at 23.93% CP when compared with the corresponding values in those other groups. The serum protein level revealed significant differences in the levels of albumin and globulin being higher than the others at 27.84% CP with 4.34±0.13g/dl and 2.76±0.11g/dl respectively. Serum liver enzymes showed that the level of ALT was highest at 9.83%CP with 9.50±0.61iu. Significant increase was also observed in the level of Triglycerides (74.80±4.21) at 27.84% CP. On day 56, there was significant increase in the level of urea (47.00±2.52mg/dl) at 14.79%CP. Albumin /globulin ratio was significantly higher with 1.60±0.29 at 9.83%CP. There was a significant increase in the level of alkaline phosphatase (ALP) with 40.00±1.53iu at 9.83%CP. In conclusion, to the best of our knowledge, the data from this study provide complete biochemical reference data that would be useful in clinical evaluation and management of AGRs. These will also be useful in achieving an appropriate diseases management and domestication plan for this species of animal

Keywords: *African giant rat, biochemical parameters, crude protein, diet*

**Author for correspondence: Email: charle.sunday@yahoo.com;* Tel: *+234-7056556098*

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INTRODUCTION

The African giant rat or the Gambian pouched rat (*Cricetomys gambianus*) is a large fossorial, muroid and nocturnal rodent with poor eye sight but very good sense of hearing and smell. These rats are commonly found in bushes, pits and forest, although they have been found to thrive in urban and suburban settings as well (Chapman & Bennet 1975). There are many economic benefits of this animal, these includes source of animal protein consumed, especially by rural dwellers (Olude *et al*., 2013); insect predators thereby keeping insect population under control and also act as seed dispersal agents (Mbaya *et al*., 2011). They are useful in biomedical research (Audu *et al*., 2008) and have been used to detect diseases such as (tuberculosis) and land mines in Mozambique due to their high sense of smell (Maggie, 2003). The aforementioned economic potentials necessitate domestication of this wild animal. One of the most important aspects of domestication of any wild species of animal is having appropriate understanding of its nutritional requirement.

The physiology of farm animal is affected by several factors, with nutrition playing the most essential role. The dietary protein to energy ratio in animal diets is of great importance, since dietary protein and energy do not only influence the growth but also the composition of the body. The influence of different crude protein diets on metabolites, digestive enzymes activities have been previously established

in different species of fish (Yamamoto *et al*., 2000; Okorie *et al*., 2007).

There are conflicting reports on the crude protein requirement in AGRs. Ajayi and Tewe, (1983) reported an improvement in the growth performance of AGRs with increase in dietary protein level from 10 to13%, whereas Cooper, (2008) recommended minimum of 20% crude protein as the dietary requirement for AGRs. Serum biochemical component have been used to predict pathological processes in the vital internal organs of the body such as the pancreas, liver, heart and kidney. These parameters can help to reveal the nature and extent of a disease process itself (static, progressive or regressive). (Stockham and Scott, 2008).

Olayemi and Adeshina, (2002) have made efforts in domesticating AGRs as pet and to use them as laboratory animal for experiment. The attempt is still not yet successful, this may be related to inadequate understanding of the biology of AGRs, lack of veterinary care and other management procedures, especially appropriate diet in term of crude protein and other nutrient to replace natural diet in the wild. Although, Nssien *et al*., (2002) compared some serum biochemical parameters in two generation of AGRs with no significant changes observed among different ages and sexes, but they did not factor in the influence of diet especially crude protein on those parameters. Igbokwe *et al*., (2017) also evaluated the haematological and serum biochemical profile of juvenile wild African giant rat and determined the influence of sex on the haematological and serum biochemistry parameters. But their work is limited as they did not make any reference to diets. There is paucity of information on basic production parameters for efficient economic exploitation of African giant rats. This same paucity of information had even been previously described in grass cutter as well by Adu *et al*., (2005). To the best of our knowledge, the influence of different crude protein diet on biochemical parameters vis-a vis establishment of an appropriate crude protein % of diet for optimal growth and productive performance have not been established for this species of animal. Influence of graded crude protein diets on glucose, electrolytes, metabolites, protein, enzymes and lipids of AGRs have not been previously established.

We therefore sought to determine the effects of different crude protein diet on these biochemical parameters in AGRs in Nigerian tropical environment.

MATERIALS AND METHODS

Location of the study area: The study was conducted at the African giant rats Research Unit in the Department of Veterinary Physiology and Biochemistry, University of Ibadan, Nigeria. (Latitude 7° 23^1 28.19"N and Longitude 3°54^1 59.99"E). The experiment which lasted for ten weeks begun on 15th April 2015 to 30th June 2015. The mean temperature and annual rainfall of 26.5°C and 1311mm respectively were recorded during the experimental period (Google Earth, 2012).

Ethical statement: The protocol was approved by the Animal Care and research Ethics Committee (ACUREC) of the University of Ibadan, Ibadan, Nigeria with approval reference number UI-ACUREC/App/12/2016/04.

Experimental animal and management: Apparently healthy thirty adult wild African giant rats comprisingu of males and females were purchased from a local market in Ibadan, Nigeria. They were each housed separately in the animal house of the Department of Veterinary Physiology, Biochemistry and Pharmacology, University of Ibadan, Nigeria. The rats were fed on a commercially available diet of pelletized growers feed (15% crude protein; 7% fat; 10% crude fibre; 1.0% calcium; 0.35% phosphorus; 2,550 kcal/kg metabolizable energy, Vital Feeds Limited, Jos, Nigeria). The feeds and water were provided *ad libitum*. The rats were placed on Neomycin-Oxytetracycline HCL® (Neimeth Inter. Pharm Plc, Lagos) and dewormed with piperazine hydrochloride (Wormazine®) (Alfasan International BV344AB Woerden, Holland) at 1g/l of water 2 weeks before the commencement of the study

Proximate Analysis: Dry matter (DM) was determined by drying at 80°C for 48 h; ash was measured in a muffle furnace at 510°C for 18 h. Crude protein of samples was determined by the Kjeldahl method and the ether extract by a Soxhlet apparatus. Other analysis was carried out according to the methods outlined by the Association of Official Analytical Chemists (DeVries, 2004). We took group A with crude protein of 21.21% as our standard (control) based on the recommendation by Cooper (2008) who recommended 20% crude protein as minimum requirement for African giant rats.

Experimental Design: Five semi purified diets were formulated with graded protein levels of A (21.21%) (Control) according to Cooper (2008), group B (27.84%) and group C (23.93%), group D (14.79%) and group E (9.83%). Each diet was fed at 5gm/100gm body weight to the different rat groups for 60 days.

Blood collection: Each rat was pre-anaesthetized in a desiccator using chloroform. 5mls of blood collected into plain tubes, centrifuged at 3000rpm for 15min with a clinical table centrifuge and sera harvested within 1hr of collection on day 28 and day 56 of the experiment.

Determination of serum glucose, electrolytes and metabolites level: Glucose was determined using glucose-oxidase method according to Ekun *et al*., (2018). The concentration of serum creatinine and urea were determined using the method of Tietz (1994) as outlined in Randox kits, UK. Serum chloride (CL) level was determined using mercuric nitrate method as described by Schales and Schales (1971). Plasma sodium (Na) and potassium (K) levels were determined by flame photometry method using flame photometer (Model 410 Sherwood Scientific Ltd, Cambridge, UK) as used by Mannapperuma *et al*., (2017). Bicarbonate determination in the serum was done using Acid-Base titration (Titrimetry method) (Tietz and Shuey, 1986). Total and conjugated bilirubin (TB and CB) levels were evaluated by colorimetric (Diazo) method as described by Jendrassik and Grof (1983).

Determination of serum protein levels: Total protein (TP) was estimated by Biuret method as described by Koller and Kaplan,1984. The manual dye binding method using bromocresol green (BCG) was used in the determination of the serum albumin as described by Tietz and Shuey (1986).

Determination of enzymes levels: Plasma aspartate amino-transferase (AST) and alanine amino-transferase (ALT) were determined by Colorimetric method (Reitman and Frankel, 1957) as recently described by (Igbokwe *et al*., 2017). Alkaline phosphatase (ALP) levels were evaluated by kinetic method as described by (Edress *et al*.,2017). Gamma glutamate aminotransferases (GGT) was also determined by colorimetric method.

Determination of lipid profile: Total cholesterol (TC) was determined after enzymatic hydrolysis and oxidation using Fero-Ham method (Embert, 1980). The estimation of triglycerides was done by end point method of McGowan *et al*., (1983). The estimation of plasma (High density lipoprotein) HDL-cholesterol was done by precipitation method of Lopez-Virella *et al*., (1979). The estimation of (Low density lipoprotein) LDL-cholesterol was determined by using formula of Friedwald *et al*. (1972).

Statistical analysis: Data was expressed as mean ± SEM. The One- way analysis of variance, (ANOVA) was used to test significance between groups while the Tukey's post-hoc test was used to compare means of all samples using GraphPad Prism, version 4; Chicago, IL, USA. Where applicable, Student's t- test was also used to compare two sample means. $P < 0.05$ was considered significant.

RESULTS

Feed composition: Table 1 shows gross composition in (%) of varied crude protein experimental diets (A-E) for the African giant rats. The feed ingredients used were maize, soya meal, palm kernel cake, wheat offal, fish meal (72%) and Daram Vitamix^{R} premix (at 2.5 kg/ton of feed).

Table 1:
Gross composition (%) of experimental diets for the giant rats

Ingredients	A (control)	B	C	D	E
Maize	62	50	43	76	81
Soya meal	22	33	38	9	1
Palm kernel cake	5	8	3	3	3
Wheat offals	5	4	3	9	14
Fish meal (72%)	5	8	12	4	-
Grower premix	1	1	1	1	1
Total	100	100	100	100	100

Daram Vitamix^{R}(Daram Nig.Ltd) was added in a proportion of 2.5 kg/ton of feed. This provides additional vitamins and minerals

Proximate analysis: Table 2 shows proximate analysis of chemical composition (%) of the graded experimental diets (A-E) for the giant rats. The feed compositions based on proximate analysis are crude protein, dry matter, ash, crude fibre, crude fat, moisture content and carbohydrate. Group B feed had the highest crude protein (27.84%) while group E had the least crude protein (9.83%).

Glucose and electrolyte levels: Shown in Table 3 are the Serum glucose, electrolyte and metabolite levels of the adult AGRs 28 days post feeding. Findings reveal that plasma glucose level was highest in rats fed 27.84% crude protein. This value was significantly higher ($P<0.05$) than that of the control rat fed 21.21% crude protein.

Table 2:
Chemical composition (%) of experimental diets for the giant rats

Composition (%)	A (control)	B	C	D	E
Crude protein	21.21	27.84	23.93	14.79	9.83
Dry matter	90.82	91.38	91.59	90.96	90.87
Ash	6.41	6.56	6.49	6.33	6.28
Crude fibre	4.13	3.97	4.35	4.46	4.54
Crude fat	3.62	8.19	3.65	3.72	3.68
Moisture content	9.98	8.19	8.63	9.05	9.13
Carbohydrate	55.45	49.70	52.95	61.67	66.55

Table 3:
Variations in Serum glucose, electrolytes and metabolite levels of the adult African rats (*Cricetomys gambianus*) 28 days post feeding with graded crude protein diets

Crude protein (CP) diet	n	Glucose (mg/dl)	Sodium (mmol/l)	Potassium (mmol/l)	Chloride (mmol/l)	Bicarbonate (mmol/l)	Urea (mg/dl)	Creatinine (mg/dl)	Bilirubin (mg/dl)	
									Total	**Conjugated**
21.21% CP Control	6	62.5 ±2.63^{a}	138.67 ±1.36^{a}	3.90 ±0.11^{a}	104.17 ±1.54	22.83 ± 0.71	34.00 ±5.29^{a}	0.78 ±0.06^{a}	0.47 ±0.04	0.22 ±0.05
27.84% CP	5	83.2 ±4.39^{b}	140.80 ±0.52	4.00 ±0.13	105.00 ±1.42	22.80 ± 0.52	37.40 ±1.35^{a}	0.76 ±0.04^{a}	0.42 ±0.03	0.20 ±0.03
23.93% CP	4	73.25 ±5.09a	142.75 ±0.41^{b}	4.35 ±0.11^{b}	108.75 ±1.08	21.00 ±0.35	48.00 ±4.49^{b}	0.98 ±0.07^{b}	0.55 ±0.06	0.30 ±0.08
14.79% CP	6	78.83 ±8.30a	137.83 ±0.64^{a}	3.83 ±0.09^{a}	103.33 ±1.53	23.50 ±0.39	27.00 ±1.03^{c}	0.70 ±0.03^{a}	0.43 ±0.05	0.18 ±0.03
9.83% CP	6	74.67 ±6.79a	136.83 ±1.23^{a}	3.73 ±0.13^{a}	103.33 ±2.27	24.00 ±0.71	22.83 ±0.93^{c}	0.58 ±0.03^{c}	0.50 ±0.05	0.22 ±0.03

Values are means ± SEM; n= Number of animals

Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Table 4:
Serum protein levels in adult African giant rats (*Cricetomys gambianus*) 28 days post feeding with graded crude protein diets

Crude protein (CP) diet	n	Albumin (g/dl)	Globulin (g/dl)	Total Protein (g/dl)	Albumin/Globulin ratio
21.21% CP Control	6	3.98 ±0.06[a]	3.15±0.04[a]	7.13±0.07	3.28±1.27
27.84% CP	5	4.34 ±0.13[b]	2.76±0.11[b]	7.00±0.12	1.58±0.08
23.93% CP	4	4.20 ±0.14[a]	3.13±0.07[a]	7.35±0.09	2.84±1.23
14.79% CP	6	4.07 ±0.10[a]	2.98±0.03[a]	7.05±0.09	1.36±0.04
9.83% CP	6	4.07 ±0.11[a]	2.90±0.08[a]	6.97±0.13	1.41±0.06

Values are means ± SEM; n= Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Table 5:
Serum liver enzymes of adult African giant rats (*Cricetomys gambianus*) 28 days post feeding with graded crude protein diets

Crude protein (CP) diet	n	Aspartate amino transferase (I.U)	Alanine aminotransferase (I.U)	Gamma glutamate transferase (I.U)	Alkaline phosphatase (I.U)
21.21%CP Control	6	10.50±0.77	7.17±0.71[a]	5.50±0.50	39.83±4.04[a]
27.84% CP	5	10.20±0.44	8.00±0.28[a]	6.20±0.52	37.40±1.22[a]
23.93% CP	4	11.75±0.74	8.00±0.61[a]	5.50±0.75	30.75±3.09[a]
14.79% CP	6	11.33±0.65	8.50±0.39[a]	6.67±0.66	38.67±3.69[a]
9.83% CP	6	12.17±0.55	9.50±0.61[b]	6.17±0.44	28.83±0.93[b]

Values are means ± SEM; n= Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Table 6:
Serum lipid profiles of adult African giant rats (*Cricetomys gambianus*) 28 days post feeding with graded crude protein diets

Crude protein (CP) diet	n	Total Cholesterol (mg/dl)	Triglycerides (mg/dl)	High Density Lipoprotein (mg/dl)	Low Density lipoprotein (mg/dl)
21.21% CP Control	6	150.00±4.80	60.83±3.08[a]	41.33±2.41[a]	88.33±7.94[a]
27.84% CP	5	147.00±5.48	74.8.0±4.21[b]	46.40±1.31[a]	124.20±6.61[b]
23.93% CP	4	146.00±8.87	60.75±6.20[a]	46.50±1.35[a]	115.00±8.89[b]
14.79% CP	6	139.17±5.73	55.83±2.38[c]	41.00±1.50[b]	99.00±5.26[a]
9.83% CP	6	138.17±6.43	61.83±1.73[a]	39.17±1.15[b]	89.83±7.20[a]

Values are means ± SEM; n= Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

The plasma glucose level in the other groups of rats fed 23.93%, 14.79% or 9.83% crude protein diet were not significantly different from the control level nor from each other.

The rats fed 23.93% crude protein diet showed significantly higher (P<0.05) plasma Na, K, Urea and creatinine levels than in the control rats fed 21.21% crude protein. The Cl^- and HCO_3^- however were similar to those found in the control rats. The Na^+, K^+,Cl^- , HCO_3^-, Creatinine levels in rats fed 27.84% or 14.79% crude protein diet did not differ significantly (P>0.05) from the corresponding values in the control rats, except the level of urea in rats fed 14.79% which was significantly lower (P<0.05) than the value in the control rat. Whereas, the levels of Na^+, K^+, Cl^- and HCO_3^- in rats fed 9.83% crude protein were similar to those of the control rats, the urea and creatinine levels were significantly lower (P<0.05) than the control values.

The levels of Cl^- and HCO_3^- in the rats fed 27.84%, 23.93%, 14.79% and 9.83% crude protein did not differ significantly (P>0.05) from the corresponding values in the control rats fed 21.21% crude protein nor from each other (Table 3).

Serum protein: Table 4 shows the Serum protein levels in adult African giant rats 28days post feeding. Serum albumin level was highest in rats fed 27.84% crude protein. This value was significantly higher (P<0.05) than that of the control rat that received 21.21% crude protein. The plasma albumin level in the other groups of rats fed 23.93%, 14.79 or 9.83% protein diet were not significantly different from the control group.
The rats fed 27.84% crude protein showed significantly lower (P<0.05) plasma globulin than in the control rats and not significantly (P>0.05) different from other groups of rats fed 23.93%, 14.79 or 9.83% protein diet. The levels of TP and ALB/GLB ratio in the rats fed 27.84%, 23.93%, 14.79% and 9.83% crude protein did not differ significantly (P>0.05) from the corresponding values in the control rats fed 21.21% crude protein nor from each other (Table 4).

Liver enzymes: In Table 5 the Serum liver enzymes of adult African giant rats (*Cricetomys gambianus*) 28 days post feeding are presented. The ALT level was highest in rats fed 9.83% crude protein. The value was significantly higher (P<0.05) than that of the control (fed 21.21% crude protein) whereas the levels of ALT in the rats fed 27.84%, 23.93% or

14.79% crude protein were similar to the value in the control group rats(fed 21.21% crude protein)while ALP value in the rats fed 9.83% crude protein was significantly lower (P<0.05) than the value in the control group(fed 21.21% crude protein) whereas the levels of ALP in the rats fed 27.84%, 23.93%, or 14.79% crude protein were similar to the value in the control group(fed 21.21% crude protein). The levels of AST and γGT in the rats fed 27.84%, 23.93%, 14.79% or 9.83% crude protein did not differ significantly (P>0.05) between the different treatment groups and from the values in the control rats(fed 21.21% crude protein (Table 5).

Lipid profile: Serum lipid profiles of adult African giant rats (*Cricetomys gambianus*) 28days post feeding are shown in Table 6. Serum TG levels was highest in rats fed 27.84% crude protein, which was significantly higher (P<0.05) than the corresponding value in the control group (fed 21.21% crude protein). The plasma HDL levels in the rats fed 14.79% and 9.83% crude protein were each significantly lower (P<0.05) from the value in the control rats(fed 21.21% crude protein) whereas the level was highest in rats fed 23.93% crude protein but not significantly (P>0.05) different from the value in the control group(fed 21.21% crude protein). Also, the plasma LDL levels in the rats fed 27.84% and 23.93% crude protein were each significantly (P<0.05) higher than the corresponding value in the control rats (fed 21.21% crude protein). While the plasma TC levels in the rats fed 27.84%, 23.93%, 14.79% or 9.83% were not significantly different (P>0.05) from the corresponding values in the control group (fed 21.21% crude protein) (Table 6).

Serum glucose, electrolyte and metabolite levels in adult African giant rats 56 days post feeding (**Table 7):** Result sreveal no significant differences in the values of plasma glucose, Na^+, K^+, Cl^- , HCO_3^- and TB for the African giant rats in the different treatment groups compared to the control group on day 56. However, the values of serum urea in the rats fed 14.79% crude protein was significantly higher than the value in the control group while other treatment groups were similar to the control group. Also, the creatinine and CB in the rats fed 23.93% and 9.83% respectively were significantly (P<0.05) lower than the values in the control group (fed 21.21% crude protein) while the values of other treatment groups were similar to the control values.

Serum protein levels in adult African giant rats 56days post feeding (**Table 8):** There were no significant differences in ALB, GLB and TP observed on 56 days from the rats in control group (fed 21.21% crude protein) and the other treatment groups. However, the ALB/GLB ratio in the rats fed 23.93% and 9.83%crude protein were significantly higher (P<0.05) than the corresponding values in the control group (fed 21.21% crude protein) (Table 8).

Table 7:
Variations in Serum glucose, electrolytes and metabolite levels of the adult African rats (*Cricetomys gambianus*) 56 days post feeding with graded crude protein diets.

Crude protein (CP) diet	n	Glucose (mg/dl)	Sodium (mmol/l)	Potassium (mmol/l)	Chloride (mmol/l)	Bicarbonate (mmol/l)	Urea (mg/dl)	Creatinine (mg/dl)	Total Bilirubin (mg/dl)	Conjugated Bilirubin (mg/dl)
21.21%CP Control	4	91.75 ±8.26	139.25 ±0.41	3.83 ±0.10	103.75 ±2.07	23.00 ±0.61	36.25 ±3.68^a	0.68 ±0.02^a	0.50 ±0.07	0.23 ±0.04^a
27.84% CP	5	77.00 ±2.93	140.00 ±0.63	3.82 ±0.10	105.00 ±2.01	21.60 ±0.73	33.80 ±2.52^a	0.64 ±0.05^a	0.38 ±0.03	0.20 ±0.05^a
23.93% CP	4	78.00 ±1.42	137.00 ±1.42	3.85 ±0.18	0.00 ±0.00	25.50 ±0.35	39.50 ±3.20^a	0.55 ±0.04^b	0.55 ±0.04	0.30 ±0.07^a
14.79% CP	4	86.50 ±1.48	140.00 ±0.35	4.00 ±0.06	107.50 ±1.25	21.75 ±0.41	47.00 ±2.52^b	0.70 ±0.03^a	1.10 ±0.55	0.20 ±0.04^a
9.83% CP	5	88.00 ±7.90	140.60 ±1.94	3.94 ±0.04	116.00 ±1.68	22.00 ±0.63	31.20 ±1.91^a	0.68 ±0.04^a	0.46 ±0.05	0.16 ±0.02^b

Values are means ± SEM
n = Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Table 8:
Serum protein levels in adult African giant rats (*Cricetomys gambianus*) 56 days post feeding with graded crude protein diets.

Crude protein (CP) diet	n	Albumin (mg/dl)	Globulin (mg/dl)	Total Protein (mg/dl)	Albumin/Globulin ratio
21.21%CP Control	4	3.95±0.09	3.05±0.06	7.00±0.06	1.29±0.05^a
27.84% CP	5	3.84±0.10	2.98±0.10	6.82±0.16	1.29±0.05^a
23.93% CP	4	3.95±0.11	2.80±0.07	6.75±0.04	1.41±0.07^b
14.79% CP	4	3.73±0.10	3.13±0.04	6.85±0.08	1.19±0.04^a
9.83% CP	5	4.82±0.87	3.00±0.06	6.82±0.12	1.60±0.29^b

Values are means ± SEM; n = Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Table 9:
Serum liver enzymes of adult African giant rats (*Cricetomys gambianus*) 56 days post feeding with graded crude protein diets.

Crude protein (CP) diet	n	Aspartate aminotranseferase (I.U)	Alanine aminotransferase (I.U)	Gamma glutamate transeferase (I.U)	Alkaline phosphatase (I.U)
21.21% CP Control	4	11.00±0.94	8.50±0.75[a]	7.00±0.61	36.75±3.19[a]
27.84% CP	5	12.80±0.33	9.80±0.44[a]	7.40±0.46	31.60±2.90[a]
23.93% CP	4	10.00±0.71	7.50±0.35[b]	5.50±0.35	39.00±4.23[a]
14.79% CP	4	11.75±0.22	8.00±0.50[a]	6.00±0.50	37.50±2.19[a]
9.83% CP	5	10.40±0.46	8.00±0.40[a]	6.20±0.34	40.00±1.53[b]

Values are means ± SEM; n = Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Table 10:
Serum lipid profiles of adult African giant rats (*Cricetomys gambianus*) 56 days post feeding with graded crude protein diets.

Crude protein (CP) diet	N	Total Cholesterol (mg/dl)	Triglycerides (mg/dl)	High Density lipoprotein (mg/dl)	LowDensity Lipoprotein (mg/dl)
21.21% CP Control	4	145.75±4.31[a]	73.75±3.00[a]	40.00±1.27	117.00±2.57[a]
27.84% CP	5	152.20±4.51[a]	62.80±3.65[b]	43.40±2.98	119.40±4.32[a]
23.93% CP	4	112.50±5.32[b]	59.00±4.26[b]	34.50±1.77	93.50±3.19[b]
14.79% CP	4	155.75±4.60[a]	65.75±2.48[b]	42.00±0.92	122.25±5.03[a]
9.83% CP	5	155.80±3.62[a]	59.80±1.95[b]	40.20±2.33	119.80±1.64[a]

Values are means ± SEM; n = Number of animals
Mean values with the same superscript letter in the same column are not significantly different (p> 0.05) Mean values with different superscript letters in the same column are significantly different (p< 0.05).

Serum liver enzymes of adult African giant rats 56 days post feeding: Finding shows that 56 days after consuming the crude protein diet, there were no significant differences (P>0.05) from the control values(fed 21.21% crude protein) in the serum levels of AST and GGT in giant rats fed 9.83% ,14.79%, 23.93% or 27.84% crude protein diet. However, the plasma levels of ALT and ALP in the rats fed 23.93% and 9.83% respectively were significantly (P<0.05) higher than the control group (fed 21.21% crude protein) while other treatment groups were similar to the control values (fed 21.21% crude protein). Table 9:

Serum lipid profile of adult African giant rats 56 days post feeding: Finding shown in Table 10 indicates the serum lipid profiles of the adult giant rats 56 days after receiving graded levels of dietary crude protein. The rats fed 23.93% crude protein showed significantly lower (P<0.05) values for TC and LDL compared to the control group (fed 21.21% crude protein) but HDL values are similar between treatment groups and the control group (fed 21.21% crude protein).The TG level was significantly lower (P<0.05) in rats fed 27.84%, 23.93%, 14.79% and 9.83% diets compared to the control values (fed 21.21% crude protein).

DISCUSSION

The African giant rats is an extremely interesting and entertaining exotic pet which lives for a longer time than the domestic rat. Findings from this present study revealed two out of the five feed groups analyzed (groups D&E) agreed with (Ajayi and Tewe, 1983) and other three groups of feed agreed with Cooper (2008) recommendation of 20% crude protein as the three groups have more than 20% crude protein. The serum biochemistry parameters of great relevance include serum enzyme tests (aspartate aminotransferase (AST), alanine aminotransferase (ALT) and alkaline phosphatase (ALP)), total bilirubin, cholesterol, total proteins, albumin, globulin, blood urea nitrogen (BUN) and creatinine (Stockham and Scott, 2013). The significant level of serum glucose in 27.84% crude protein diet observed in this study is in agreement with the reports of (Soronikpoho *et al*. 2013) who also observed a similar trend in the level of glucose in the biochemical profile of grasscutter in cote divoire. This high glucose level may be associated with production of glucose from non-carbohydrate source (gluconeogenesis) as this was observed in the group with the highest CP. The increased plasma glucose level in AGRs fed with high crude protein (27.8%) diet agrees with similar report in cats where Morris and Rogers (1978) found increased plasma glucose level following feeding with high protein diet for 40 days

The levels of serum sodium, potassium, urea and creatinine which were observed to be significantly high at 23.93% CP but within the normal reference values are similar to what have been described by (Ajagbonna *et al*., 1999). This similar observation was observed by Soronikpoho *et al*. (2013) who also reported significant differences in the level of potassium, calcium and phosphorus between two treatment groups in their study.The mean BUN value recorded in the present study is comparable to what have been reported in AGRs but higher than that reported by Onwuka *et al*. (2003). Lack of significant difference observed in this present study reflects that there was no kidney damage that may be due to any anti-nutrients in the diets.

Ranjhan (2001) affirmed that in a diet deficient in amino acid, the available amino acid will be deaminated and hence results in an increase in the excretion of urea.

The relatively high creatinine is not in tandem with the results of Ahamefule *et al*. (2006) who had no significant difference in their report values but fell within normal physiologic values.This suggests that there was no wasting or catabolism

of muscle tissues and that the animals were not surviving at the expense of the body reserve (Ahamefule *et al*., 2006). In cats, high protein diet decreased the creatinine level but increased the urea level (Backlund *et al*., 2011). However, we found that creatinine level in AGRs was not altered by high or low crude protein diet. It is possible that the increased urea level observed with high crude protein diet in AGRs resulted from a more efficient metabolism of high protein diets.

Serum total protein level was higher in the studied rat than that reported for juvenile laboratory rat, and may be attributed to diet; as laboratory rat are fed standard diet in the experimental animal house, while the wild rat has difficulty in accessing food (protein) (Madjdzadeh *et al*., 2011). The present study shows lack of significant changes in the total protein level of AGRs fed with low or high crude protein diet. This disagrees with the observation in mice where low protein diet elicited a decrease in total plasma protein level (Cintria *et al*., 1998). The increased albumin level in AGRs on high crude protein diet is similar to the finding of Backlund *et al*. (2011) in cats, who suggested that the observation could be due to increased production of albumin from high protein diet. Although Cintria *et al*. (1998) found that low protein diet fed for 28 days to mice lowered the plasma albumin level, the present study with AGRs, which are wild rodents, revealed that low crude protein diet fed for the same duration did not alter the plasma albumin level.

The mean values recorded for most of the enzymes in this present study is generally lower than that reported by Onwuka *et al*., (2003) in their work on further study on serum biochemistry of AGRs. Also the values of AST, ALT and ALP as seen in this study were generally lower than that reported by (Igbokwe *et al*. 2017) in their work on serum biochemistry profile of the juvenile wild African giant rat. These differences observed may be due to difference in age of AGRs used and differences in the diets used in feeding the rats in the two studies. Muramatsu and Ashida (1962) also reported increased ALP level in laboratory rats fed low protein diet for 29 days. However, increased ALP level was found in AGRs fed with high protein diet in this study. Colombo *et al* (1992) recorded an increase in plasma ALT of laboratory rats fed high protein diet for 15 days. In contrast, no alteration was seen in the ALT level of AGRs when they ingested high crude protein diets (27.8%) in this study.

The values of total cholesterol, triglycerides, high density lipo-protein and low density lipo-protein observed in this present study are within the normal reference range as reported in wild adult African grasscutter by (Opara *et al*.2006) and (Byanet *et al*. 2008) in young African grasscutter. The relatively high cholesterol generally observed compared to values obtained in previous studies is in agreement with the findings of Kilic *et al*. [2006] who reported that enzymes significantly [P<0.05] influenced fat deposition in broilers. This was contradicted by the report of Adesehinwa *et al*. [2011] who recorded lower cholesterol in pigs given fermented and farmazyme supplemented cassava peal meal (CPM) diet.

In conclusion, this study shows that most blood values of African giant rats (AGRs) were altered by level of dietary crude protein. The glucose, electrolytes, metabolites, protein, enzymes and lipids were observed to be better at 27.84% CP diet compared to other crude protein diet groups.

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