Nigerian J. Anim. Sci. 2020 Vol 22 (3): 139-146 (ISSN:1119-4308)

Comparative evaluation of three different energy sources on performance, carcass characteristics, hematology and serum biochemistry of rabbits

[*]Ibitoye, E.B., Jimoh, A.A., Hussaini, A. and Sanni, B.S.

Department of Theriogenology and Animal Production, Faculty of Veterinary Medicine Usmanu Danfodiyo University, Sokoto

***[*]Corresponding author:** eb.ibitoye@gmail.com; +234 7038 2282 00*

***Target audience:** Rabbit farmers, feed producers, researchers.*

Abstract

This study examined the effect of maize, sorghum and millet as three different energy sources on growth performance, carcass characteristics, hematology and serum biochemistry of rabbits. Eighteen seven-weeks old male rabbits were randomly distributed into three groups A, B and C each consisting of six rabbits, managed on deep litter and were given maize, sorghum and millet-based diets respectively as their sources of energy and were fed for a period of five weeks before data collection and analysis. Results obtained showed that the dietary treatments significantly ($p<0.05$) affected the growth performance of rabbits, but not the carcass characteristics, hematology and serum biochemistry. Nevertheless, in all treatments, the red blood cells ranged from 3.52 to 4.61 $\times 10^6/mm^3$ and fell below the normal range ($5 – 8 \times 10^6/mm^3$), while the alkaline phosphatase ranged from 182.67 to 218.57 U/L, and was above the normal range (4 – 20 U/L). It is therefore concluded that the test materials were not toxic to the muscle, kidney and liver of rabbits at 52.21% inclusion level. This implies that sorghum or millet can completely replace maize in rabbit diet with no adverse effect on the hematology and serum biochemistry parameters of rabbits but it may compromise growth.

***Keywords:** Animal protein consumption, Carcass, Energy sources, Growth performance, Hematology and Rabbits.*

Description of Problem

Assessment of accessible data on food supplies consumed in different part of developing countries including Nigeria indicates that the per caput protein intake is comparatively low (1). This low level of animal protein being consumed in Nigeria is about 20% short fall from the 45% recommended requirements (2). According to Adekunmi *et al.* (3), poor and inadequate protein has been incriminated for most of the malnutrition problems among all age groups especially in children and infants. As reported by World Health Organization, 35.3% and 40.0% of children in Nigeria between the ages of about 6 months and 6 years in urban and rural areas respectively, are malnourished and underweight (3). This has been linked to decline in total protein supply and or intake as well as inferior dietary protein quality available for consumption as against those consumed in developed countries (4). Furthermore, this negative trend has been attributed to high cost of animal products due to high cost of production and low level of animal productivity. Inadequate supply of feeds, nutritionally poor rations, adulterated feeds and feed ingredients or stale feeds are some of the factors responsible for the low supply and decline in the quality of animal protein as a result of low productivity of livestock in tropics (5). Conventionally, cattle, sheep, goats, pigs and poultry are the sources of animal protein, particularly for urban dwellers, but their demand is far above supply in Nigeria (6). However, rabbits are beginning to gain popularity as promising food animal in many developing countries. The domestic rabbit when compared with other livestock is characterized by early sexual maturity, high prolificacy, relatively short gestation period, short generation interval and rapid growth. In addition, they have better ability to utilize forages and fibrous plant materials and agricultural by-products. They are efficient feed converters, have low cost per breeding female and are profitable for small-scale system of production and in backyards (7; 8). Moreover, the rabbit meat is nearly white, fine grained, palatable, mildly flavored and high in good quality protein content. They are however low in fat and caloric contents, with a higher percent of minerals than other meats, nearly of the same nutritive value as beef and comparable to that of broiler chicken. Rabbit yields good meat-to-bone ratio and is generally acceptable in most countries of the world (9). Therefore, special attention should be paid to adequate rabbit nutrition in order to enhance its production for the provision of rabbit meat. The livestock industry consumes over a third of global grains, particularly maize (10). Maize has remained the chief source of dietary energy in compound feed and constitutes about 50 – 60% in most food animal nutrition. Despite its worldwide production, a stiff competition for the usage of maize by humans, livestock and other industries persist. This is simply because, maize is high in energy and forms the standard (100) against which other cereals grains is compared (11). The ever-increasing competition between man and animals for available grains (12), maize is increasingly being used for human food and other industrial purposes including biofuel production (13), the inadequate production to meet the needs of man and his livestock (14), and ever-increasing cost of maize had made it necessary to critically re-evaluate some other grains like sorghum and millet as alternative energy sources in livestock production. This study was conducted to evaluate the effect of completely replacing maize with sorghum or millet on the performance, carcass, some hematological and some biochemical traits of rabbits.

Materials and Methods

Study area

The study was carried out at the Laboratory Animal Unit of the Veterinary Teaching Hospital, Usmanu Danfodiyo University Sokoto, Sokoto State, Northwest part of Nigeria between 5º and 6º E and between 13 and 14ºN with an average annual temperature of 40℃ and mean annual rainfall of 300mm – 1200mm (15). The study was undertaken for a period of 35 days.

Experimental diets

The experimental diets were formulated and compounded using white maize, white millet and red sorghum; fish meal, soya bean meal, wheat bran, bone meal, salt and premix. Diet 1 is maize base diet, while sorghum and millet completely replaced maize in diets 2 and 3 respectively. (Table 1).

Experimental animals

Eighteen seven weeks old male rabbits comprised of 13 New Zealand White and 5 Dutch black breeds were randomly selected and used for this study. They were randomly divided into 3 groups (Groups A, B and C) of 6 rabbits per group and each rabbit is a replicate. The rabbits were raised on deep litter and were allowed to acclimatize to the environment for 14 days. Water and experimental diets 1, 2 and 3 were provided *ad libitum* and were fed to rabbits in groups A, B and C respectively, throughout the experimental period of 35 days.

Data collection

At the commencement of the study, body

weight of animals was taken using kitchen weighing scale (Advanced mechanical spring kitchen weighing scale, Model: LC-m14, Liangsu, China) as the initial body weight, while body weight, difference in body weight, feed intake and feed conversion ratio were recorded weekly.

At the end of feeding trial (35 days), three rabbits were chosen at random, they were weighed, slaughtered, eviscerated and selected organs (liver, heart, kidney and lungs) were immediately harvested and weighed, while the carcass was also weighed.

From the slaughtered rabbits, 2 ml of blood was collected into labelled sterile vacuum tube containing EDTA which was used for hematological analysis and another 3 ml of blood was collected into labelled sterile sample bottles without anticoagulant and used for the serum biochemical analysis. The RBC counts, total WBC counts, hemoglobin (Hb) concentration and PCV parameters were determined as described in Ewuola and Egbunike (16). Blood constants, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) were determined using appropriate formulae as follows:

Mean corpuscular volume (MCV) = PCV × 10/RBC

Mean corpuscular hemoglobin (MCH) = Hb × 10/RBC

Mean corpuscular hemoglobin concentration = RBC × 100/PCV.

Liver function test (i.e. alkaline phosphates (ALP), alanine amino transferase (ALT), aspartate amino transferase activity (AST) were measured using the colorimetric method of Reitman and Frankel (17), and total protein (TP), albumin was determined using Bromocresol Green (BCG) method as described by Peter *et al*. (18). Total bilirubin and direct bilirubin were determined using spectrophotometric method. Also, the creatinine and blood urea nitrogen were determined by biuret reaction (19).

Table 1: Composition of the experimental diets

Ingredients (kg)	Diet 1	Diet 2	Diet 3
Maize	52.21	-	-
Sorghum	-	52.21	-
Millet	-	-	52.21
Fish meal	4.45	4.45	4.45
Soya bean meal	13.34	13.34	13.34
Wheat bran	26	26	26
Bone meal	3	3	3
Salt	0.5	0.5	0.5
Premix	0.5	0.5	0.5
Total	100	100	100
		Calculated	
CP (%)	17.38	18.47	19.58
CP (%)	5.01	4.64	6.99
ME (kcal/kg)	2569.48	2477.59	2571.34

CP = Crude protein, CP = crude fibre and ME = Metabolizable energy

Table 2: Performance of experimental rabbits fed three different energy sources

Performance parameters	Treatment groups			p-values	SEM
	Group A	Group B	Group C		
Initial body weight (kg)	0.98	0.96	0.93	0.00	0.02
Final body weight (kg)	1.40[a]	1.33[b]	1.29[b]	0.00	0.03
Body weight gain (kg)	0.41[a]	0.37[a, b]	0.36[b]	0.03	0.02
Total feed intake (kg)	2.36[a, b]	2.24[b]	2.39[a]	0.03	0.05
Feed conversion ratio	5.73[b]	6.14[a, b]	6.72[a]	0.01	0.29

Means in the same row with different superscripts a, b and c are significant ($p<0.05$)

Statistical analysis

Results were subjected to one-way Analysis of variance (ANOVA), with Least Significant Difference as post-hoc test using the Statistical Package for the Social Sciences (SPSS Version 22.0) to determine significant difference between the three groups at $p<0.05$.

Results

The performance of experimental rabbits (Table 2) indicated that the dietary treatments significantly ($p<0.05$) affected the growth of rabbits. The final body weight (1.40 kg) of rabbits in group A was significantly ($p<0.05$) higher than other treatment groups (B and C). The least final body weight was recorded in the group C (1.29 kg), although not different ($p>0.05$) from those in group B (1.33 kg). Rabbits under millet-based diet (group C) significantly ($p<0.05$) had the poorest growth performance in terms body weight gain (0.36 kg), consumed highest of feed (2.39 kg) with poorest feed conversion ratio (6.72), when compared with the control (group A). On the other hand, animals under sorghum-based diet (group B) compared favorably with the control (group A) in their body weight gain (0.37 kg), feed intake (2.24 kg) and feed conversion ratio (6.14).

Table 3 shows no significant ($p>0.05$) differences in the carcass and organs traits of experimental rabbits. However, group A had the heaviest carcass weight (717.67 g), sorghum group (group B) had the highest live weight (1.47 kg), while and both live (1.38 kg) and carcass (706.67 g) weights were least in millet group (group C). However, rabbits fed millet-based diet (group C) had the numerically largest percentage weighs of liver (3.25%), kidney (0.78%), heart (0.29%) and lungs (0.65%), while these parameters were least in the group A, except kidney.

As shown in Table 4, the dietary treatments had no significant ($p>0.05$) effect on the hematology of experimental rabbits however, the RBC was observed to be lower in all groups. MCHC was below normal in groups A and C, while Hb and MCV were also lower than normal for group C. In addition, a decrease in the neutrophils was observed in rabbits under groups B and C. However, rabbits under group A had the highest values for PCV (37.67%), Hb (10.34 g/dl), MCV (94.33 fl) and neutrophils (25.00%), with lowest values for MCHC (27.45 g/dl) and lymphocyte (74%). Group of rabbits fed sorghum-based diet (group B) had the highest MCH (28.46 pg), MCHC (30.39 g/dl), lymphocyte (83.00%) and monocyte (2.00%), while it had the lowest readings for RBC (3.52 $\times 10^6/mm^3$), WBC (5.73 $\times 10^3/mm^3$) and neutrophils (15.00%). On the other hand, rabbits in group C were highest for RBC (4.61 $\times 10^6/mm^3$) and eosinophils (1.00%), while least for Hb (9.72 g/dl), MCV (71.54 fl) and MCH (21.08 pg). A PCV of 33.00% was recorded for both groups B and C.

Table 3: Carcass and Organs Characteristics of Rabbits Fed Three Energy Sources

Parameters	Group A	Group B	Group C	SEM
Live weight (kg)	1.43	1.47	1.38	0.03
Carcass weight (g)	717.67	707.67	706.67	3.512
Carcass %	50.18	48.14	51.21	0.15
Percentage organ weight				
Liver	3.11	3.16	3.25	0.04
Kidney	0.70	0.68	0.78	0.03
Heart	0.21	0.23	0.29	0.03
Lungs	0.47	0.59	0.65	0.05

Table 4: Mean hematology of experimental rabbits fed three different energy sources

Parameters	Group A	Group B	Group C	SEM	Ref. ranges
PCV (%)	37.67	33.00	33.00	1.56	30 – 50
Hb (g/dl)	10.34	10.03	9.72	0.18	10 – 15
RBC (×10^6/mm^3)	3.99	3.52	4.61	0.32	*5 – 8
MCV (fl)	94.33	93.67	71.54	7.49	78 – 95
MCH (pg)	25.89	28.46	21.08	2.17	[#]19 – 22
MCHC (g/dl)	27.45	30.39	29.46	0.87	[#]30 – 35
WBC (×10^3/mm^3)	8.75	5.73	8.30	0.94	4.5 – 11
Neutrophils (%)	25.00	15.00	20.00	2.89	[!]22 – 38
Lymphocytes (%)	74.00	83.00	78.00	2.60	40 – 80
Monocytes (%)	1.00	2.00	1.00	0.33	1 – 4
Eosinophils (%)	0.00	0.00	1.00	0.33	0 – 4
Basophils (%)	0.00	0.00	0.00	0.00	1 – 7

Reference range: Adapted from: * Merck Sharp and Dohme Corporation (22); Etim *et al.* (23); [#]Medirabbit.com (http://www.medirabbit.com/EN/haematology/bloodchemistry.htm) [!]Ajuogu *et al.* (24).

Table 5: Mean serum biochemical analysis of experimental rabbits fed three different energy sources

Parameters	Group A	Group B	Group C	SEM	Ref. ranges
Creatinine (mg/dl)	1.67	1.66	1.63	0.01	0.5 – 2.2
Urea (mmol/l)	4.63	3.76	4.63	0.29	
Total Protein (g/dl)	6.10	6.10	6.00	0.03	*5.4 – 7.5
Albumin (g/dl)	3.67	3.46	3.27	0.12	[#]2.43 – 4.5
Total Bilirubin (mg/dl)	0.88	0.98	0.92	0.03	0 – 1
Direct Bilirubin (mg/dl)	0.11	0.11	0.14	0.01	
AST (U/L)	52.57	62.03	45.57	4.77	*35 – 130
ALT (U/L)	55.33	44.90	55.57	3.52	*45 – 80
ALP (U/L)	202.00	182.67	218.57	10.37	4 – 20

*Melillo (25); [#]Mitruka *et al.* (26).

Table 5 shows the biochemical analysis of rabbits fed three different energy sources. These feeding trials had no significant (p>0.05) effect on the serum biochemistry of experimental rabbits. It was however observed that group C had the least creatinine (1.63 mg/dl), total protein (6.00 g/dl), albumin (3.27 g/dl) and AST (45.57 U/L) but highest values for direct bilirubin (0.14 mg/dl), ALT (55.57 U/L) and AST (218.57 U/L). Urea (3.76 mmol/l), ALT (44.90 U/L) and ALP (182.67 U/L) were least in group B, while total bilirubin (0.98 mg/dl) and AST (62.03 U/L) were highest in this group. Group A had the lowest total bilirubin (0.88 mg/dl) and highest creatinine (1.67 mg/dl) and albumin (3.67 g/dl).

Discussion

The final body weight of rabbits fed maize as energy source (group A) was significantly higher than those fed sorghum (group B) and millet (group C) as energy sources. This may be because rabbits in group A were more able to convert feed taken into product in terms of weight gain. Rabbits fed millet (group C) as energy source consumed the highest amount of feed but had the least body weight gain and the poorest feed conversion ratio. This might be due to the presence of some antinutritional factors such as phytic acid polyphenol and tannins which have been reported to be responsible for decreases in growth rate, feed efficiency and protein digestibility in experimental animals (20). Tannins have been found to reduce or impair nutrient digestibility and nitrogen retention thus causing growth depression (20). The lowered feed intake and depressed feed conversion ratio of group fed sorghum-based diet (group B) in this study might be attributed to high tannin content in sorghum grain which causes reduction in voluntary feed intake due to reduced palatability, diminished digestibility and utilization of nutrients as reported by Atteh (11) and Kumar (21) Tannins reduce protein digestibility through the formation of complexes and the inhibition of activities of proteolytic enzymes in digestive secretions (21). Rabbits in group A had the best body weight gain, total feed intake and feed conversion ratio in this study, this might be because of the palatability and good digestibility of the feed.

This study revealed that all experimental diets had no significant effect on the hematology of experimental rabbits. This is an indication that neither of maize, sorghum nor millet at 52.21% had any negative impact on the haemopoietic centers of rabbit. Nevertheless, the red blood cells in all treatments fell below the normal range as reported by Merck Sharp & Dohme (22). This may be due to incidence of mange encountered in all the animals at the early stage of the experiment. White blood cell counts are a rough indication of immune status of an animal. It was observed that the WBC of all experimental rabbits was within normal range and it signifies that the maize, sorghum and millet had no depressing effect on the immune response of rabbits. However, the neutrophils of animals under groups B and C fell below normal, although not significant. This may indicate an underlining bacterial infection (22).

The serum biochemical indices and especially the liver function test of experimental rabbits fed three different energy sources were within normal ranges except alkaline phosphatase which is above normal range. This signifies that the test materials were not toxic to the muscle, kidney and liver of rabbit at 52.21% inclusion level.

Conclusion and Applications

1. Growth performance and carcass characteristics of rabbit shows that complete replacement of maize with sorghum or millet has significant adverse effects on the body weight gain, feed

intake and feed conversion ratio as compared to maize diet.

2. However, replacing maize with sorghum or millet in rabbit diet had no negative effect on their hematological and serum biochemical parameters.

References

1. Abdulraheem, M.A., Muhammad-Lawal, A., Olasore, A.A. and Oni, O.O. (2016). Assessment of Animal Protein Consumption and Food Security Among Rural Households in Kwara State, Nigeria. *American Journal of Business and Society*, 1 (4): 233-245.
2. Food and Agriculture Organization (2009). Fisheries: the state of World Fisheries and Agriculture (SOFIA), PART I: World review of fisheries and agriculture; Fish consumption Pp. 58 - 65.
3. Adekunmi, A.O., Ayinde, J.O. and Ajala, A.O. (2017). An assessment of animal protein consumption patterns among rural dwellers in Osun state, Nigeria. *Ife Journal of Agriculture,* 29 (1): 84 – 94.
4. Brawn, J. V. (2005). "The World Food Situation: An Overview". International Food Policy Research Paper presented for CGIAR Annual General Food and Agriculture Meeting, Marrakech, Morocco, Dec 6th, 2007. Pp 1 – 18. DOI: 10.2499/0896295303
5. Ogundipe, S.O., Abeke, F.O., Sekoni, A.A., Dafwang, I.I. and Adeyinka, A.I. (2003). Effect of duration of cooking on the utilization of *Lab purpureus* by pullet chicks. In: Proceedings of the 28th Annual conference of the Nigerian Society for Animal Production held at Ibadan, Nigeria. Pp. 233-235.
6. Akinmutimi, A.H. and Onwukwe, C.C. (2002). Effect of cooking with various concentrated potash on nutrient composition of Lima beans. *Journal of Agriculture Biotechnology and Environment,* 1: 1-3.
7. Cheeke, P.R. (1986). Potentials of rabbit production in tropical and sub-tropical agricultural systems. *Journal of Animal Science,* 63 (5): 1581-1586.
8. Finzi, A. and Amici, A. (1991). Traditional and alternative rabbit breeding systems for developing countries. *Rivista di Agricultura Subtropicale Tropicale,* 6 (1): 103-125.
9. Reddy, N.V., Mo, D.R. and Chen, C.P. (1977). Comparative performance of rabbits and broilers. *Nutrition Reports International*, 16 (1): 133-137.
   Ref. ranges obtained from Medirabbit.com (http:// www. medirabbit. com/ EN/haematology/ blood chemistry. htm)
10. Thompson, S.A. and Weber, C.W. (1981). Effects of dietary fibre sources on tissue mineral level of chicks. *Poultry Science,* 60: 840-845.
11. Atteh, J.O. (2002). Principles and practice of livestock feed manufacturing. Adlek Printers. Ilorin Kwara State Nigeria, Pp: 13-17.
12. Egbunike, G.N. and Achibong, I.O. (2002). Performance and serum chemistry of growth: stimulated broiler finisher cassava peel based diet. Proc. of the 7th Annual Conference of the Animal Sci. Association of Nigeria (ASAN), Pp: 44-46.
13. Herbert K. D. (2017). Assessment of Maize (*Zea mays*) as Feed Resource for Poultry. *Poultry Science,* 1-32. dx.doi.org/10.5772/65363
14. Babatunde, G.M., Pond, W.G. and Red, E.R. Jr. (1990). Nutritive value of rubber seed (*Hevea brasilensis*) meal utilization by growing pigs fed semi-purified diets in which rubber seed racal partially replaced soybean meal. *Journal of Animal Science*, 68:392-397.
15. Abdulrahim, M. A., Ifabiyi, I. P. and

Ismaila, A. (2013). Time series analyses of mean monthly rainfall for drought management in Sokoto, Nigeria. *Ethiopian Journal of Environmental Studies and Management*, 6 **(5**): 461-470.

16. Ewuola, E.O. and Egbunike, G.N. (2008). Haematological and serum biochemical response of growing rabbits bucks fed different levels of dietary fumonisin B1. *African Journal of Biotechnology*, 7: 4304-4309.
17. Reitman, S. and Frankel S. (1957). A colorimetric method for the determination of serum glutamic oxalacetic and glutamic pyruvic transaminase. *American Journal of Clinical Pathology*, 28 (1): 56-63.
18. Peter, T., Biamonte, G.T. and Doumas, B.T. (1982). Protein (total protein) in serum, urine and cerebrospinal fluid; albumin in serum. In: Selected method of clinical chemistry. Volume 9 (Paulkner WR, Meites S Eds) American Association for clinical chemistry, Washington, D.C.
19. Meyer, D.J., Coles, E.H. and Rich, L.J. (1992). Introductory to laboratory medicine. In: Veterinary Laboratory Medicine. Meyer D.J., Harvey, J.W. (eds.). (1st ed.) WB Saunders, Philadelphia, USA.
20. Chung, K.T., Wong, T.Y., Wei, C.I., Huang, Y.W. and Lin. Y. (1998). Tannins and human health: a review. *Critical Reviews in Food Science and Nutrition*, 38: 421- 464.
21. Kumar, R. and D'Mello, J.P.F. (1995). Anti-nutritional Factors in Forage Legumes. In: D'Mello JPF. and Devendra C (eds). Tropical Legumes in Animal Nutrition. CAB International, Wallingford, Oxon, UK, pp. 95 – 133.
22. Merck Sharp and Dohme Corporation (2011). The Merck Veterinary Manual. Retrieved 19/02/2013 from http://www.merckvetmanual.com/mvm/ htm/bc/tref6.htm
23. Etim, N.A.N., Williams, M.E., Akpabio, U. and Offiong, E.E.A. (2014). Haematological parameters and factors affecting their values**.** *Agricultural Science*, 2 (1): 37-47.
24. Ajuogu, P.K., Ironkwe, M.O., Timi, S., Wekhe, S.N., Yahaya, M.A. and Ere, E.R. (2015). The haematological profile of adult buck rabbits exposed to graded levels of *Cyathula prostrata* (Pasture Weeds) In Southern Nigeria. *International Journal of Livestock Research*, DOI: 10.5455/ijlr.20150125014531
25. Melillo, A. (2007). Rabbit Clinical Pathology. Journal of Exotic Pet Medicine, 16: 135-145.
26. Mitruka, B.M. and Rawnsley, H.M. (1977). Clinical, Biochemical and Haematological References Values in Normal Experimental Animals, Masson Publishing, USA. Inc. New York, pp. 83-109.