**EFFECTS OF PELLETIZED CASSAVA PEEL ON SERUM BIOCHEMISTRY OF GROWING RABBITS**

ABSTRACT

In recent years, there has been a growing interest in exploring the potential use of cassava peels as a dietary component for livestock, particularly in rabbits. The objective of this study was to examine how different levels of pelletized cassava peel in the diets of growing rabbits affect their serum parameters. The research followed a completely randomized design, with twenty rabbits distributed randomly into four dietary groups, each consisting of five replicates. The dietary groups included a control diet with no cassava peel (0%), as well as diets with 10%, 20%, and 30% cassava peel inclusion, while maize remained the primary source of energy. The study spanned eight weeks, during which serum samples were collected and subjected to analysis for various biochemical parameters. The results revealed significant differences (p < 0.05) in serum indices among the different dietary treatments. Particularly noteworthy was that rabbits fed diets containing 10% and 20% cassava peel exhibited higher levels of albumin, with values ranging from 38.50 g/dl to 34.50 g/dl, compared to those on the control diet. Total protein values ranged from 76.50 g/l (control) to 79.50 g/l (30% cassava peel inclusion). Creatinine levels varied from 66.60 mg/dl (20% 20% inclusion) to 79.60 mg/dl (30% 30% inclusion). Furthermore, aspartate aminotransferase (AST) and alanine aminotransferase (ALT) values also displayed significant differences, with the highest AST level (10.50 IU/l) observed in the 30% cassava peel group and the lowest ALT level (6.50 IU/l) in the 10% inclusion group. Blood glucose levels ranged from 4.20 (30% cassava peel) to 5.80 (control), and chloride levels ranged from 98.50 (20% cassava peel) to 104.50 (10% cassava peel). In conclusion, incorporating cassava peel at inclusion levels of 10% to 20% in rabbit diets can have a positive impact on serum parameters without any adverse effects.

**Keywords:** Cassava peel, Rabbit feed, Serum indices

**INTRODUCTION**

Rabbit farming is a significant aspect of small-scale animal husbandry, providing a valuable source of protein-rich meat and other products in many regions around the world (Dalle Zotte 2014). As with any livestock production, ensuring optimal growth and health of rabbits is crucial to maximizing productivity and economic returns (Gadde *et al.,* 2017). Nutrition plays a pivotal role in the growth and well-being of these animals, and innovative strategies for utilizing locally available feed resources can enhance the sustainability and efficiency of rabbit farming (Cunha, 2012).

Cassava (*Manihot esculenta*) is a widely cultivated tuberous root crop known for its high carbohydrate content and adaptability to diverse agro-ecological conditions. The cassava plant serves not only as a staple food source for millions of people but also a potential feed ingredient for livestock due to its abundance in some regions (Ngiki *et al.,* 2014). However, cassava roots contain cyanogenic glycosides, which can release toxic cyanide upon enzymatic degradation, making them unsuitable for direct consumption in significant quantities by most animals, including rabbits (Apata and Babalola, 2012). The utilization of cassava peels as a feed ingredient for rabbits carries the potential for economic and environmental sustainability. With abundant availability in many cassava-producing regions, cassava peel holds promise as a cost-effective and sustainable feed resource. Cassava peels are a rich source of energy, fiber, and certain nutrients, including vitamins and minerals. By incorporating cassava peels into rabbit diets, we may effectively reduce feed costs for rabbit farmers, thereby enhancing the economic viability of rabbit production while also aligning with the broader goal of achieving sustainable livestock farming practices.

However, they also contain anti-nutritional factors, such as cyanogenic glycosides (Bayata, 2019), which need to be addressed to make cassava peels a suitable feed ingredient for rabbits. By conducting serum biochemistry analyses, we can evaluate how pelletized cassava peel affects nutrient utilization and overall health of growing rabbits. Understanding the effects of cassava peel on serum biochemistry can provide valuable information about its impact on rabbit health. For instance, assessing parameters like serum glucose, lipid profiles, and liver enzymes can indicate how well rabbits are digesting and utilizing the nutrients from cassava peel-based diets. This knowledge can help optimize dietary formulations to promote the growth and well-being of rabbits (Folorunso et al., 2017). This study was therefore designed to determine the effects of pelletized cassava peel on serum biochemistry of growing rabbits

**MATERIALS AND METHODS**

**Experimental site**

This research was conducted at the University Farm of Olusegun Agagu University of Science and Technology (OAUSTECH), Okitipupa, Ondo State, with a temperature of 27oC and humidity of 56 mmHg.

**Experimental materials**

Selected fresh cassava peel of good quality and maize used in formulating the diet were purchased from Okitipupa Local Government in Ondo State within the school premises and other conventional feed ingredients such as wheat offal, bone meal and palm kernel cake were sourced from a reputable feed mill industry. The milling of the experimental diet was carried out in a reputable feed mill in Ijebu-Ode Ogun, State. During the process of grinding, the peel was passed into the hammer mill and was ground to a particle size of 3mm

**Experimental diets**

Experimental diets were formulated for the growing rabbits to meet their nutritional requirements. Four diets were formulated in which pelletized cassava peel was used to replace maize at various inclusion levels. The diets were diet 1, maize as the main energy source, diet 2 contains 20% cassava peel, diet 3 contains 30% cassava peel, and diet 4 contains 40% cassava peel as the main energy source. All were prepared by mixing the ingredients in Table I at the feed mill in Ijebu-ode Ogun State.

**Experimental animals and management**

A total of 20 growing rabbits with an average weight of 500g -600g were purchased from the Federal College of Education Osiele, Abeokuta Ogun, State. Before their arrival and to the commencement of the experiment, the rabbit cages were thoroughly washed and efficiently disinfected with Izal to prevent any contamination and infection. The feeding and watering troughs were washed, disinfected and fixed on the cages. Also, the cage stands were inserted into a concentrated solution of engine oil to prevent the interference of crawling insects, termites, soldier ants and snakes. The rabbits on their arrival were made to undergo a week adaptation period to allow them to adjust to the new environment. Also, they were administered coccidiostat and antibiotics to prevent them from coccidiosis and bacterial infections. The rabbits were then intensively managed in individual compartments in the cage with a size (45cm x 40cm x 45cm) and were introduced to their experimental diets according to their treatments after the adaptation period.

**Experimental design**

Following weighting balancing the rabbits were randomly distributed into four treatments and five replicates per treatment. The experimental design was a completely randomized design. Feed and water were offered daily to them ad libitum during the 8-week experimental period, and all the rabbits were kept under the same hygienic and environmental conditions.

**Serum collection**

Three milliliters (3.0 mL) of blood was collected from the external ear vein of each rabbit using a sterilized disposable syringe and needle between 7.00 and 7.45 am into a labelled sterile sample bottle without anticoagulant and used to determine the serum biochemical components. The blood samples were taken to the laboratory for biochemical analysis.

**Proximate Analysis of Experimental Diets**

The experimental diet underwent proximate analysis, including the determination of dry matter, nitrogen, ash, crude fiber, ether extract, and nitrogen-free extract (NFE) using AOAC (2002) procedures. Key steps involved in the analysis included moisture content determination through oven-drying, crude protein determination through digestion, distillation, and titration, determination of crude fiber through a sequential process of boiling with H2SO4 and NaOH, determination of ether extract involving extraction with n-hexane, and determination of ash through muffle furnace treatment.

**Serum Biochemistry Analyses**

The serum biochemistry analyses included ALT, AST, total protein, and albumin, each with specific principles and procedures outlined for accurate measurements.

Alanine Aminotransferase (ALT)

ALT levels were determined following the principles outlined by Reitman and Frankel (1957) using the procedure provided by RANDOX. The assay involved the catalysis of amino group transfer from L-alanine to alpha-oxoglutarate, leading to the formation of pyruvate, and subsequent measurement of the concentration of pyruvate hydrazone.

Asapartate Aminotransferase (AST)

AST levels were determined based on the procedure by Reitman and Frankel (1957) with the method provided by RANDOX. The assay monitored the concentration of oxaloacetate hydrazone formed with 2,4-dinitrophenylhydrazine.

Total Protein

The total protein content was determined by the interaction of copper ions with proteins, producing an intense violet-blue complex color in an alkaline medium. The intensity of the color was proportional to the amount of protein present in the sample.

Albumin

Albumin concentration was measured through quantitative binding to the bremocresol green (BCG) indicator. The absorbance of the albumin-BCG complex was read at 578 nm, and the concentration of albumin in the sample was directly proportional to the absorbance.

**Statistical Analysis**

All data collected were subjected to one-way analysis of variance (ANOVA). Where there was significance, Duncan’s Multiple Range Test (DMRT) was employed to separate the means.

**Table I: Gross composition of experimental diets**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Ingredients | Diet 1 | Diet 2 | Diet 3 | Diet 4 |
| Maize | 48 | 47.5 | 45 | 41 |
| Soya bean meal | 18.5 | 16.5 | 14 | 11 |
| Wheat offal | 30 | 22.5 | 17.5 | 14.5 |
| Cassava peel | 0 | 10 | 20 | 30 |
| Bone meal | 2 | 2 | 2 | 2 |
| Salt | 0.25 | 0.25 | 0.25 | 0.25 |
| Premixes | 0.25 | 0.25 | 0.25 | 0.25 |
| Lysine | 0.1 | 0.1 | 0.1 | 0.1 |
| Methionine | 0.1 | 0.1 | 0.1 | 0.1 |
| Total | 99.2 | 99.2 | 99.2 | 99.2 |

**RESULTS**

Theserum biochemistry parameters as influenced by the experimental diets are presented in Table II. The observed parameters were significantly influenced (P < 0.05) by treatments. Albumin, creatinine, and aspartate aminotransferase values were significantly different (p < 0.05) among treatments with value ranges of 34.50 – 38.50 g/dl, 66.60 – 79.60 mg/dl and 6.50 – 10.50 U/L. Rabbits fed diets 2 and 3 had significantly (p < 0.05) higher (38.50 g/dl) albumin compared to rabbits fed diet 1 (34.50). Rabbit fed diet 4 recorded the highest (79.50) value of total protein, while diet 2 recorded the least value (73.50). Also, Rabbits fed diet 3 had significantly (p < 0.05) higher creatinine values than those of diet 2, but their values were comparable to those of the other diets. Aspartate aminotransferase varied across the treatments, with rabbits fed diet 4 having significantly (p < 0.05) higher value (10.50) than those fed diet 1 (6.50). The highest value (5.80) of blood glucose was recorded for the rabbit fed diet 1, while diet 4 had the least (4.20) value. Highest value (42.50) of globulin was recorded for the rabbit fed diet 1, while diet 2 had the least (33.50) value. Rabbit fed diet 4 recorded the highest value (12.50, 22.50) for alanine aminotransferase and alkaline phosphatase, while rabbit fed diet 2 had the least value (6.50) for alanine aminotransferase and diet 3 (19.50) for alkaline phosphatase. The highest value (4.90) of urea was recorded for the rabbit fed diet 4 while diet 2 had the least (3.40) value. Chloride recorded the highest value (104.50) for rabbit fed diet 2 while diet 1 recorded the least (101.50) value.

**Table II: Effect of the varying inclusion levels of pelletized cassava peel on the serum indices of growing rabbits**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameters | Maize | 10% cassava peel | 20% cassava peel | 30% cassava peel |
| Total protein (g/l) | 76.50c ± 0.29  | 73.50d ± 0.29  | 78.50b ± 0.29  | 79.50a ± 0.29  |
| ALT (IU/l) | 9.50b ± 0.29  | 6.50d± 0.29  | 8.50c± 0.29  | 12.50a±0.29  |
| AST (IU/l) | 6.50c ± 0.29  | 9.50b ± 0.29  | 9.50b ± 0.29  | 10.50a ± 0.29  |
| ALB (g/l) | 34.50b ± 0.29  | 38.50a ± 0.29  | 38.50a ± 0.29  | 37.50a ± 0.29  |
| ALP (IU/l) | 21.50b ± 0.29  | 20.50c± 0.29  | 19.50d ± 0.29  | 22.50a ± 0.29  |
| Globulin | 42.50a±0.29  | 33.50c ±0.29  | 40.50ab ±0.29  | 42.30a ±0.29  |
| Creatinine | 77.50b± 0.29 | 66.60d±0.29  | 79.60a±0.29 | 73.90bc±0.29 |
| Urea | 3.80b±0.29  | 3.40b±0.29  | 4.00ab±0.29  | 4.90a±0.29  |
| Chloride | 101.50C ± 0.29  | 104.50a±0.29  | 98.50d±0.29  | 102.50b±0.29  |
| Glucose | 5.80a±0.29  | 5.30a±0.29  | 5.40a±0.29  | 4.20b±0.29  |

a,b,c = Means in rows with different superscript indicate significant difference (p < 0.05)

**DISCUSSION**

Serum biochemical parameters analysis is an important method for evaluating visceral organ damage in rabbits, particularly the liver and kidneys (Jurcik *et al*., 2007; Melillo, 2007; Jenkins, 2008). The serum levels of total protein, albumin, glucose, creatinine, AST and ALT determined in this study were found to be within the range of reference values reported in previous studies for rabbits (Yazar *et al*., 2004; Silva *et al*., 2005; Elmas *et al*., 2006; Melillo, 2007). Abnormal serum albumin usually indicates an alteration of normal systematic protein utilization (Apata,1990) and low dietary protein intake (Onifade and Tewe, 1993). Deviation from normal range for specie results in conditions such as low albumin (hypoalbuminemia). This may be caused by liver disease, mal-absorption, malnutrition or chronic blood loss. High albumin (hyperalbuminemia) is caused by dehydration (Rastogi, 2007). The cholesterol values recorded for the rabbits were within the normal range described by Elmas *et al*. (2006) and Silva *et al*. (2005) and compared favorably with values reported by Alagbe and Oluwafemi (2019). Creatinine level of rabbits fed 10% inclusion cassava peel diet that was observed to be lower than those fed 20% inclusion cassava peel diet, might be attributed to a poor kidney function in rabbits fed 10% conventional cassava peel diet. Elevated serum creatinine levels are a more sensitive indicator of renal failure (Rastogi, 2002). Elevated glucose levels in rabbits have been associated with various stress factors (Lepitzki and Woolf, 1991; Melillo, 2007; Jenkins, 2008), and the serum glucose levels determined in this study fell within the normal range reported in some studies (Jurcik *et al*., 2007; Jenkins, 2008) but were lower than in another (Silva *et al*., 2005). Chloride is one of the essential electrolytes in the body, playing a crucial role in maintaining proper osmotic balance, acid-base equilibrium, and nerve function. Any significant deviations in chloride levels could potentially disrupt electrolyte balance, leading to adverse health effects (McNulty *et al*., 2001). Higher chloride in diet 2 could lead to electrolyte imbalance. Electrolyte imbalances can have profound effects on animal health. In rabbits, disturbances in electrolyte balance can lead to conditions such as dehydration, metabolic acidosis, and disturbances in neural and muscular function, which can negatively impact overall health and performance (Aro and Ajao, 2011). Elevated globulin level in diet 4 could due to the potential immunomodulatory effects of cassava peel as reported by Chikwendu *et al*. (2020) The serum enzymes activities assessed (ALT, AST and ALP) of rabbits fed moringa diets were within the normal range reported by CCAC (1980). This result corroborates with the report of Ewuola et al. (2011). However, in this study, all ALT values fell within the normal range (7 to 56 units per liter (U/L)) reported by Ozkan *et al*. (2012).

**CONCLUSION**

The results from this study revealed that cassava peel can serve as a suitable alternative feed ingredient that can be processed into different physical forms that are acceptable to rabbits, leading to optimal utilization and productivity. The varying inclusion levels of pelletized cassava peel had a notable impact on the serum indices of growing rabbits. Diet 2 (10% inclusion) and Diet 3 (20% inclusion) showed promising results in terms of maintaining or improving certain serum parameters without adverse effects, while Diet 4 (30% inclusion) had distinct effects, particularly on protein and ALP levels.

**REFERENCES**

Abu, O. A., Onifade, A. A., Abanikannda, O. T. F., & Obiyan, R. I. (2008, June). Status and promotional strategies for rabbits production in Nigeria. In 9th World Rabbit congress (pp. 10-13).

Action for Food Production (1974). Rabbits. Technical information service circular. C-52. N. D. South extension part 2, New Delhi 49, India.

Aduku, A.O. and Olukosi, J.O. (1990): Rabbit Management in the Tropics: Production, Processing, Utilization, Marketing, Economics, Practical training, Research and Future Prospects, Living Book Services, G.U. Publications, Abuja.

Ahmad, G. and Latifinezhad, H. (2013). Introduction of serum proteins and immunoglobulin's in Oncorhynchus mykiss and Ctenopharyngodon idella.

Ajagbe, A. D., Oyewole, B. O., Abdulmumin, A. A., & Aduku, O. P. (2020). Nutrient digestibility and nitrogen balance of growing West African Dwarf (WAD) goat fed nitrogen supplemented cassava peel meals. *IOSR J. Agric. and Vet. Sci*, *13*(1), 42-47.

Akinbola, E. T., Aromoye, R. A., Oladimeji, S. O., & Tewe, O. O. (2019). Growth Performance, haematology and serum biochemistry of rabbits fed varying levels and forms of cassava peel. *Tropical Animal Production Investigations*, *22*(2), 35-45.

Akinfala, E.O. and Tewe, O.O. (2001). Utilization of whole cassava plant in the diets of growing pigs in the tropics. Livestock Resources for Rural Development (LRRD). www.cipav.org.co/irrd/irrd13/5/akin135.htm.

Akuyam, S., Abubakar, A., Lawal, N., Yusuf, R., Aminu, S., Hassan, A. and Okafor, P. (2017). Assessment of biochemical liver function tests in relation to age among steady state sickle cell anemia patients*. Nigerian Journal of clinical practice.* 20(11): 1428-1433.

Alagbe, J. O., and Oluwafemi, R. A. (2019). Heamatology and Serum Biochemical Indices of Growing Rabbits Fed Diet Supplemented with Different Level of Indigofera zollingeriana Leaf Meal. *IJAR*, *4*, 28.

Allen, C. E. (1983). New horizons in animal agriculture: Future challenges for animal scientists. *Journal of Animal Science*, *57*(suppl\_2), 16-27.

Amata, I. A., Jokthan, G. E., Mubi, T. A., Ehoche, O. W., & Mbap, S. T. (2018). Growth performance and nutrient digestibility of West African Dwarf sheep fed diets containing different levels of cassava peel-based pellets. Tropical Animal Health and Production, 50(1), 177-182.

Apata, D. F. (1990). Biochemical, nutritional and toxicological assessment of some tropical legume seeds. *PhD Tehsis. University of Ibadan*.

Apata, D. F., & Babalola, T. O. (2012). The use of cassava, sweet potato and cocoyam, and their by-products by non-ruminants. *International journal of food science and nutrition engineering*, *2*(4), 54-62.

Apata, D. F., & Babalola, T. O. (2012). The use of cassava, sweet potato and cocoyam, and their by-products by non-ruminants. *International journal of food science and nutrition engineering*, *2*(4), 54-62.

Aro S. O. (2008) Improvement in the nutritive quality of cassava and its by-products through microbial fermentation. *African Journal of Biotechnology* Vol. 7 (25), pp. 4789-4797.

Aro, S. O., & Ajao, A. O. (2011). Effect of dietary electrolyte balance on growth performance, carcass characteristics, and blood constituents of broiler chickens during the hot-dry season. Asian Journal of Animal Sciences, 5(4), 264-273.

Azevêdo, J.A.G., Valadares F.S.C., Pina D.S., Valadares, R.F.D., Detmann, E., Paulino, M.F., Diniz, L.L. and Fernandes, H.J. (2011). Intake, total digestibility, microbial protein production, and the nitrogen balance in ruminant diets based on agricultural and agro-industrial by-products. Arq. Bras. Med. Vet. Zootec., 63 (1): 114-123.

Bayata, A. (2019). Review on nutritional value of cassava for use as a staple food. *Sci J Anal Chem*, *7*(4), 83-91.

Behnke, K.C. (1994). Processing factors influencing pellet quality. AFMA Matrix. Animal Feed Manufacturers Association. South Africa. Available at http://www.afma.co.za.

Brahmantiyo, B., Raharjo, Y. C., & Prasetyo, L. H. (2018). Production performance of HyCole, New Zealand White Rabbits and its reciprocal. *Jurnal Ilmu Ternak Dan Veteriner*, *22*(1), 16-23.

Canadian council on animal care, CCAC (1980). Guide to the care and use of experimental animals. CCAC, 182-90.

Cereda, M. P., & Mattos, L. M. (2016). Cassava biology and physiology. Plant Molecular Biology, 53-84.

Chikwendu, C. I., Olukosi, O. A., & Adewole, D. I. (2020). Effects of dietary cassava peel meal on haematological and serum biochemical parameters of broiler chickens. *Brazilian Journal of Poultry Science*, 22(4), 1-10.

Cunha, T. J., & Cheeke, P. R. (2012). *Rabbit feeding and nutrition*. Elsevier.

Dalle Zotte, A. (2014). Rabbit farming for meat purposes. *Animal Frontiers*, *4*(4), 62-67.

De Blas, C., Wiseman, J. (2003). The Nutrition of the Rabbit. *CABI Publishing, Oxon, UK*

Di Ciaula, A., Garruti, G., Baccetto, R. L., Molina-Molina, E., Bonfrate, L., Portincasa, P., and Wang, D. Q. (2018). Bile acid physiology. *Annals of hepatology*, *16*(1), 4-14.

Elmas, M., Yazar, E., Uney, K., and Karabacak, A. (2006). Pharmacokinetics of flunixin after intravenous administration in healthy and endotoxaemic rabbits. *Veterinary research communications*, *30*(1), 73.

El-Sharkawy, M. A. (2006). Cassava biology and physiology. Plant Molecular Biology, 53-84.

Eruvbetine, D, Tajudeen, I.D., Adeosun, A.T., Olojede, A.A. (2003). Cassava *(Manihot esculenta)* leaf and tuber concentrate in diets for broiler chickens. Bio-resource technology 86: 277-281

Ewuola E.O., Sanni K.M., Oyedemi O.M., Alaba O., Lawal T.J., 2011. Serum biochemical response of gestating and lactating does administered graded moringa leave extract. Proc. of 16th Annual Conference of Animal Science Association of Nig. (ASAN) held at Kogi State University Ayingba on 12th -16th 2011. 158-162.

Fagan, J. (2018). The Ultimate Guide to Raising and Caring for Rabbits. Rockridge Press.

Fajemisin, A.N, Omotoso, O.B, Fadiyimu, A.A and Shuaibu, A.Y. (2012): Nutrients intake and utilization by West African Dwarf goats fed cassava peels substituted with *Cajanus cajan* hay. In: Agricultural Transformation: Strategies and policies for livestock development in Nigeria. ASAN-NIAS Proceedings of the 17th Annual Conference, 2012. International conference centre. Opp. Radio House, Area 8, Abuja. 9th – 13th September, 2012. Pp 636 – 639.

Falade, K. O., & Akingbala, J. O. (2010). Utilization of cassava for food. *Food Reviews International*, *27*(1), 51-83.

FAO (1995). Commodity review and outlook, 1994-95. Economic and Social Development Series. Food and Agriculture Organization, Rome Italy.

FAO (2002). FAOSTAT statistics database. (http://aps.fao.org) Production Yearbook 2002, vol. 44.

Folorunso, O. F., Osunlaja, A. A., & Osunlaja, I. A. (2017). Effects of dietary inclusion of cassava peel meal on serum lipid profile of growing rabbits. Journal of Animal Science Advances, 7(5), 1807-1812.

Gadde, U., Kim, W. H., Oh, S. T., & Lillehoj, H. S. (2017). Alternatives to antibiotics for maximizing growth performance and feed efficiency in poultry: a review. *Animal health research reviews*, *18*(1), 26-45.

Gidenne, T. (2015). Dietary fibres in the nutrition of the growing rabbit and recommendations to preserve digestive health: a review. *Animal*, *9*(2), 227-242.

Halls, A. E. (2010). Nutritional requirements for rabbits. *Retrieved September*, *21*, 2014.

Isidahomen, C. E., Njidda, A. A., and Olatunji, E. A. (2012). Heat tolerant traits among local and exotic chickens in southern Nigeria (2012). *IOSR. Journal of Agriculture and Veterinary. Science*, 1(6), 31–36. doi:10.9790/2380-0163136.

Iyayi, E.A. and Losel, D.M. (2001). Changes in carbohydrate fractions of cassava peel following fungal solid state fermentation. *Journal of Food Technology Africa*. 6(3):101-103.

Jenkins, J. R. (2008). Rabbit diagnostic testing. J Exot Pet Med., 17 (1): 4-15.

Jithendran, K. P. (2000). Nutritive value of rabbit meat. *Envis Bulletin. Himalayan Ecology and Development*, *8*(1), 9-11.

Jurcik, R., Suvegova, K., Hanusova, E., Massanyi, P., Ryban, L., and Chrenek, P. (2007). Evaluation of haematological, biochemical and histopathological parameters of transgenic rabbits. *Journal of Veterinary Medicine Series A*, *54*(9), 527-531.

Kakengi, A. M. V., Mhango, A. J., Mutayoba, S. K., & Shem, M. N. (2007). Feed intake, digestibility and live weight gains of rabbits fed on diets containing cassava leaves, sweet potato vines or mixture of the leaves and vines. Livestock Research for Rural Development, 19(10), Article #142.

Kamide, K. (2005). *Cellulose and cellulose derivatives*. Elsevier.

Karmen, A., Wroblewski, F. and Ladue, J. (1955). “Transaminase activity in human blood”. *The Journal of Clinical Investigations.* 34(1): 126-131.

Lepitzki, D. A., and Woolf, A. (1991). Hematology and serum chemistry of cottontail rabbits of southern Illinois. *Journal of wildlife diseases*, *27*(4), 643-649.

Mailafia, S., Onakpa, M. M., & Owoleke, O. E. (2010). Problems and prospects of rabbit production in Nigeria-A review. *Bayero Journal of pure and applied sciences*, *3*(2), 20-25.

Martin, Elizabeth A., ed. (2007). Concise Medical Dictionary (7th ed.). Oxford, England: Oxford University Press. ISBN 978-0-19-280697-0. Retrieved 8 September 2009.

McGraw Hill. (2015). Complete Pet Owner's Manuals: Rabbits. McGraw Hill.

McNulty, N. P., Smith, T. K., & Elliott, K. E. C. (2001). Seasonal variations in the blood chemistry of free-living, adult, wild European rabbits (Oryctolagus cuniculus). Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology, 129(1), 209-216.

Melillo, A. (2007). Rabbit clinical pathology. *Journal of exotic pet medicine*, *16*(3), 135-145.

Morgan, N. K., & Choct, M. (2016). Cassava: Nutrient composition and nutritive value in poultry diets. *Animal Nutrition*, *2*(4), 253-261.

Napasirth, V., Rukkwamsuk, T., Parker, D. S., & Molee, A. (2014). Evaluation of pelletized cassava pulp as an alternative energy source in growing-finishing pig diets. Tropical Animal Health and Production, 46(6), 1015-1020.

Ndibalema, V., Ndunguru, G., & Mbega, E. R. (2021). Evaluation of chemical composition, energy and anti-nutritional factors in cassava (Manihot esculenta Crantz) root peels. American Journal of Food Technology, 16(2), 96-106.

Ngiki, Y. U., Igwebuike, J. U., & Moruppa, S. M. (2014). Utilisation of cassava products for poultry feeding: a review. *The International Journal of Science and Technoledge*, *2*(6), 48.

Ngiki, Y. U., Igwebuike, J. U., & Moruppa, S. M. (2014). Utilisation of cassava products for poultry feeding: a review. *The International Journal of Science and Technoledge*, *2*(6), 48.

Nworgu, F.C. (2007). Economic importance and growth rate of broiler chicken served fluted pumpkin (Telfaria occidentalis) African Journal of Biotechnology, 2:6 34-39.

Ogbuewu, I. P., & Mbajiorgu, C. A. (2023). Utilisation of cassava as energy and protein feed resource in broiler chicken and laying hen diets. *Tropical Animal Health and Production*, *55*(3), 161.

Ogunwande, I. O. (2023). Measurement of Technical Efficiency of Rabbit Production among Urban Farmers in Southwest Nigeria. *Nigerian Journal of Animal Science and Technology (NJAST)*, *6*(1), 139-151.

Omole, A. J., O., Omueti, and O.J., Ogunleke, (2005). ‘’Performance characteristics of Weaned rabbits fed graded levels of dry cassava peel fortified with soy corn Residue based diet’. *Journal of Farm Agriculture and Environment* 3: 36-38.

Omole, T. A., & Aduku, A. O. (2015). Growth performance, carcass and organ characteristics of broiler chickens fed varying levels of cassava peel meal. International Journal of Agriculture and Biology, 17(2), 329-334.

Onifade, A., & Tewe, O. O. (1993). Alternative tropical energy feed resources in rabbit diets: growth performance, diet's digestibility and blood composition. *World rabbit science*, *1*(1).

Owen, O.J., Alawa, J.P., Wekhe S.N., Isirimah N.O., Chukuigwe E.C., Aniebo, A.O., Ngodigha, E.M. and Amakiri A.O. (2008): Incorporating poultry litter in animal feed: a solid waste management strategy. Egyptian Journal of Animal Production (In press).

Oyebimpe, K., Fanimo A.O., Oduguwa O.O., Biobaku W.O. (2006). Response of Broiler chickens to cassava peel and maize offal in cashewnut meal based-diets. Arch. Zootec. 55(211): 301-304.

Özkan, C., Kaya, A., and Akgül, Y. (2012). Normal values of haematological and some biochemical parameters in serum and urine of New Zealand White rabbits. *World Rabbit Science*, *20*(4), 253-259.

Prebble, J. (2014). Nutrition and feeding. In *BSAVA manual of rabbit medicine* (pp. 27-35). BSAVA Library.

Rajeshwari, Y. B. (2011). *Handbook Of Rabbit Production And Management*. New India Publishing Agency.

Rastogi, P. N. (2000). Sustaining enterprise competitiveness–is human capital the answer?. *Human Systems Management*, *19*(3), 193-203.

Rastogi, S. C., (2007). Essentials of Animal Physiology. New age International Publishers Limited. 4th edition, pp 221 – 239.

Salvador, E. M., Steenkamp, V., & McCrindle, C. M. E. (2014). Production, consumption and nutritional value of cassava (Manihot esculenta, Crantz) in Mozambique: An overview.

Sanchez‐Monge, R., Lopez‐Torrejón, G., Pascual, C. Y., Varela, J., Martin‐Esteban, M., and Salcedo, G. (2004). Vicilin and convicilin are potential major allergens from pea. *Clinical & Experimental Allergy*, *34*(11), 1747-1753

Silva, T. D. O., Kreutz, L. C., Barcellos, L. J. G., Borella, J., Soso, A. B., and Souza, C. (2005). Reference values for chinchilla (Chinchilla laniger) blood cells and serum biochemical parameters. *Ciência Rural*, *35*, 602-606.

Sugio, S., Kashima, A., Mochizuki, S., Noda, M., & Kobayashi, K. (1999). Crystal structure of human serum albumin at 2.5 Å resolution. *Protein engineering*, *12*(6), 439-446.

Tewe, O.O. (2004). The global cassava development strategy: cassava for livestock feed in Sub-Saharan Africa. IFAD and FAO, pp. 2-4.

Tewe, O.O. and Iyayi, E.A. (1995). Utilization of cassava peels in small holder pig and small ruminant production systems in Nigeria. Paper presented at the 6th Triennial symposium of the ISTRACAR Lilongwe. Malawi, 22-28 October, 1995.

Teye, G. A., Boamah, F. O., Badu, P. O., & Agyare-Tetteh, G. (2018). Growth performance, nutrient utilization and economics of production of rabbits fed cassava leaf meal. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems, 8(1), 67-78.

United States Department of Agriculture (USDA) (1972): Selecting and Raising Rabbits, Agricultural Information Bulletin No. 358.

Wanjala, F. N., Wanyoike, M. M., & Gachuiri, C. K. (2016). Performance of New Zealand White, California White and their cross under two feeding regimes. *International Journal of Development and Sustainability*, *5*(4), 199-212.

Weil, C. (1999). *Secondhand chic: Finding fabulous fashion at consignment, vintage, and thrift shops*. Simon and Schuster.

Xianghong, Q. (2013). Free energy surface for bronsted acid-catalyzed glucose ring-opened in aqueous solution. *The Journal of Physical Chemistry B*. 1117(9): 11460-11465.

Xu, C., Li, C., Zhang, R., & Zhao, X. (2019). Cassava foliage and peels as protein-enrichment sources in animal feeding: A review. Animal Nutrition, 5(4), 317-323.

Yakubu, M. T., & Bukoye, B. B. (2009). Abortifacient potentials of the aqueous extract of Bambusa vulgaris leaves in pregnant Dutch rabbits. *Contraception*, *80*(3), 308-313.

Zanuzo, M. R., Ribeiro, A. M. L., Araujo, L. F., Nascimento, G. A. J., & Lima, L. R. S. (2019). Performance and economic evaluation of broiler chickens fed diets containing different levels of cassava peel meal. Brazilian Journal of Poultry Science, 21(2), 1-8.

Zigo, F., Pyskatý, O., Ondrašovičová, S., Zigová, M., Šimek, V., & Supuka, P. (2020). Comparison of exterior traits in selected giant and medium rabbit breeds. *World Rabbit Science*, *28*(4), 251-266.