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BIOCHEMICAL COMPOSITION OF MEAT FROM HETEROGENEOUS RABBIT POPULATION REARED UNDER SMALLHOLDER FARMS IN SOUTHWESTERN NIGERIA

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Abstract

The biochemical composition of meat from heterogeneous rabbits raised under smallholder units in five different locations – Iwo, Ejigbo, Ede, Osogbo, and Ife – in southwestern Nigeria was investigated in this study. Thirty adult rabbits – fifteen bucks and fifteen does were used. Animals were sacrificed and samples were taken to the laboratory for biochemical analyses. Atomic Absorption Spectrophotometer (AAS) AA-6800® was used to analyze the samples. Further data processing was done with Statistical Package for Social Sciences (SPSS, ver. 27.0) and for separation of means was used Duncan New Multiple range test. The proximate analysis of rabbit meat revealed 57.19% moisture, 20.78% crude protein, 2.02% fat, and 2.69% Ash. The analyses provided also the content (mg/kg) of calcium, sodium, magnesium, potassium, zinc and iron (essential mineral elements), and arsenic, cadmium, lead and manganese (non-essential/heavy metals). There were no significant differences ($p>0.05$) between the non-essential minerals and two of the essential minerals (iron and zinc) across all the locations. However, there were significant differences ($p<0.05$) in calcium, magnesium, sodium and potassium of the rabbit meat from different locations. The content of lead (0.04 ±0.003mg/kg) in the analyzed meat samples was lower than 0.1 mg/kg that is toxic to humans, making rabbit meat under smallholder units in southwestern Nigeria safe and healthy for consumption.

Keywords: rabbit meat**,** biochemical analysis, smallholder farms, heterogeneous rabbit

INTRODUCTION

Stadnik (2024) noted that meat and its products are among the most nutrient-dense food consumed by humans. Such products provides energy and other essential nutrients which are used for many metabolic processes. In developing countries, rabbit meat is one of the meat sources that can improve protein consumption and livelihood of people. Apart from its many positive attributes its production can contribute to food security and poverty alleviation among urban and peri-urban farmers. Rabbit has a high reproductive potential, short generation interval, high prolificacy, and ability to subsist under marginal nutritional and housing conditions which define the low investment cost for rabbit farming (Moto, 2024; Mukaila, 2023; Haque et al., 2016). (Sherief and Doaa, 2018; Wang et al., 2020). Nutritionists recommended rabbit meat as healthy and cheaper compared to red meats. In southwestern Nigeria, the population and production of heterogeneous rabbits are higher in smallholder units. Such units are characterized by limited land, low capital and labour resources (Lukefahr, 1992; Onukwru et al., 2022). Rabbit is efficient in meat production though with

small body size (Haque et al., 2016). The available studies carried out on mixed bred or heterogeneous rabbit population in south-western Nigeria are focused on heritability and genetic correlations (Ajayi et al., 2014), growth performance and hematological parameters (Odeyinka et al., 2014), behavioral response to diurnal temperature (Popoola et al., 2014), and reproductive characterization (Oseni et al., 2008, Oseni & Ajayi, 2010). However, there are paucity of information on biochemical analysis of meat from heterogeneous rabbit population. Several authors reported nutritional content of rabbit meat of different breeds at different locations. Baiony & Hassanien (2011) reported nutritional value of meat samples from rabbit's breed New Zealand White (NZW) and Californian (CAL) in Egypt. Sethukali et al. (2023) revealed that factors like nutritional composition, carcass and quality of rabbit meat, in terms of different breeds and muscle types, are important in production and processing. Nkosi et al. (2021) noted that, globally, the occurrence and presence of toxic metals and their control remains a concern for the authorities. Nutritional composition, however, can differ from one production environment to another due to heterogeneity of breed.

The biochemical analysis of fresh rabbit meat from smallholder farming system in some selected locations in southwestern Nigeria was carried out. The current study examined the mineral content of rabbit meat from different locations and reports its safety, which is recognized globally as an important factor that determines meat quality.

MATERIALS AND METHODS

The experiment was carried out in the Teaching and Research Farm and Meat Science Laboratory of Osun State University, College of Agriculture, (Ejigbo campus), Osun State. Thirty adult heterogeneous rabbits (three bucks and three does from each location), at ages between five and six months, with live weights between 1.3-2.44 kg (mean=1.83 kg), were purchased from smallholder backyard keepers from selected locations (Ejigbo, Iwo, Ede, Osogbo and Ife). Three males and three females were purchased from each location to make thirty rabbits in all. The experimental animals were fed different feeds which included chicken growers feed in mash and pelleted forms, forages: *Tridax procumbents*, *Ipomea batatas* (Sweet potato vines) collected from the keepers' environments. Cowpea testa, yam and plantain peels (kitchen wastes) were also fed to the rabbits. The experimental animals were kept at the location of study for a period of two weeks before sacrificing. The animals were stunned and slaughtered after being starved for eight hours, but they were given clean, cool water. All meat samples were collected on the same day and by same person in order to avoid sampling error.

Cadaveric muscles from the thigh muscle of slaughtered rabbits were collected in a polythene bag and immediately taken for biochemical and proximate analysis in the laboratory. The meat proximate analysis was done according to the methods of AOAC (2003). Analysis of calcium, sodium, magnesium, potassium, zinc and iron (essential mineral elements), and arsenic, cadmium, lead and manganese (non-essential/heavy metals) were done with Atomic Absorption Spectrophotometer (AAS) AA-6800.

The generated data were analyzed using (SPSS) version 27.0 in order to obtain means and other descriptive statistics variables under consideration. All data were subjected to One-way Analysis of Variance (ANOVA) and separation of means was done using Duncan New Multiple range test.

RESULTS AND DISCUSSION

A proximate composition of fresh rabbit meat (in percentages) from five different locations is shown in Table 1. The moisture content (%) ranged from 51.27 to 62.15% with

a mean value of 57.19%. The value of 75.20% reported by Sherief & Doaa (2018) in Egypt, Fadlilah et al. (2020) on fresh New Zealand White rabbit meat in Batu, Indonesia and 67.90% stated by the USDA (1963) were higher than the range obtained in the current study. The ash content range of 2.21-3.47% with mean value of 2.69%. This value is within the range of 0.98%-2.53% reported by Ingweye et al. (2021), for meat from rabbits fed graded levels of 'Aidan' (*Tetrapleura tetraptera)* flour. The meat fat content in this study ranged between 1.93 and 2.13%, with the mean value of 2.02%. This value is lower than 10.2% fat content reported by USDA (1963). The crude protein - 20.78% obtained in the study was similar to the crude protein value reported by USDA (1963) - 20.8%, but lower than those reported by Ingweye et al. (2021) - 21.99-22.90%. On the contrary, the crude protein reported by Sherief & Doaa (2018) in Egypt for fresh rabbit meat was lower (19.81%) than the value obtained in the study. The value for crude protein in this study is within the range 20.35% reported by Baiomy & Hassanien (2011) and 20.40% in NZW and CAL rabbits, in Egypt, respectively. The differences in mean values could be due to differences in feed offered, since the nutrient content of meat is affected by the contents of the diets, dietary fat inclusion and its source, animals slaughter age and slaughter weight.

Table 1. Proximate composition (%) of rabbit meat samples in south-western Nigeria

Proximate (%)	N	Mean ±SE	Minimum	Maximum
Moisture content	30	57.19±0.27	51.27	62.15
Ash content	30	2.69±0.01	2.21	3.47
Fat	30	2.02±0.12	1.93	2.13
Crude protein	30	20.78±0.23	20.16	21.27

Legend: N is the number of samples; SE is the standard error.

The mineral composition of the fresh rabbit meat samples collected from different locations is presented in Table 2. The estimated lead contamination was 0.03-0.04 mg/kg with a mean of 0.04% which is far lower than 0.1 ppm that is toxic to humans. Cadmium was in the range of 0.01-0.02 with a mean value 0.02 mg/kg. The mean value for arsenic and manganese were 0.04 and 0.12 mg/kg, respectively. The essential mineral group considered in this study (calcium, sodium, magnesium, potassium, zinc and iron) had the following ranges: 0.03-0.09, 1.62-1.80, 1.17-1.62, 4.07-5.01, 0.11-0.12 and 0.01-0.02, respectively. The corresponding mean values are: 0.04, 1.71, 1.52, 4.46, 0.11 and 0.02, respectively.

The high content of potassium and low concentration of sodium make rabbit meat recommendable for hypertensive diets. However, rabbit meat provides less zinc and iron than meats of other species. The variations in value reported in this study in comparison with that of other authors could be due to differences in age, experimental methods, feeds, breeds and genotypes of the experimental animals. Furthermore, the consumption of the rabbit meat could be considered beneficial for health, since sodium (Na) and potassium (K) are needed for the maintenance of proper body fluid balance, nerve transmission and immune system functioning.

Other minerals in the meat like iron (Fe) helps in carrying oxygen in the body (hemoglobin), necessary for the energy metabolism, copper (Cu) and manganese (Mn) participate as cofactors in many enzymes. Zinc (Zn) is used during protein synthesis and proper genetic materials function, heals wound. It is necessary for normal fetal and growth development, production of sperm, immune system health and sexual maturation. There were no significant differences ($p>0.05$) in the non-essential minerals and two essential

minerals (iron and zinc) across all locations. However, there were significant differences ($p<0.05$) in calcium, magnesium, sodium and potassium of the rabbit meat from the different locations. Nkosi et al. (2021) noted that, there was sufficient evidence of the presence of toxic metals in meat produced for human and animal consumption and that cannot be underestimated. Bosch et al. (2016) and Lu et al. (2018) stressed that the presence of toxic metals in meat must be investigated and controlled to ensure the safety of meat products. However, the lead content (0.04 ±0.003mg/kg) estimated in the current study was lower than 0.1 mg/kg, making rabbit meat produced in the smallholder units in southwestern Nigeria safe for consumption.

Table 2. Mineral profile of meat from heterogeneous rabbit population from five locations in southwestern Nigeria in mg/kg

Location/ Parameters	Ejigbo	Iwo	Ede	Osogbo	Ife	Mean ±SE	Min.	Max.
Essential minerals								
Calcium (Ca)	0.03^{a} ±0.00	0.04^{a} ±0.00	0.05^{b} ±0.00	0.03^{a} ±0.00	0.03^{a} ±0.00	0.04 ±0.01	0.03	0.09
Sodium (Na)	1.69^{ab} ±0.06	1.73^{ab} ±0.07	1.69^{ab} ±0.05	1.80^{b} ±0.02	1.62^{a} ±0.00	1.71 ±0.13	1.62	1.80
Magnesium (Mg)	1.62^{c} ±0.02	1.42^{ab} ±0.02	1.37^{a} ±0.03	1.62^{c} ±0.02	1.51^{b} ±0.06	1.52 ±0.13	1.17	1.62
Potassium (K)	4.98^{b} ±0.19	4.07^{a} ±0.05	5.01^{b} ±0.32	4.90^{b} ±0.21	4.65^{ab} ±0.13	4.46 ±0.59	4.07	5.01
Iron (Fe)	0.01 ±0.00	0.02 ±0.00	0.02 ±0.00	0.02 ±0.00	0.01 ±0.00	0.02 ±0.00	0.01	0.02
Iron (Fe)	0.01 ±0.00	0.02 ±0.00	0.02 ±0.00	0.02 ±0.00	0.01 ±0.00	0.02 ±0.00	0.01	0.02
Non-essentials minerals								
Lead (Pb)	0.03 ±0.00	0.03 ±0.00	0.04 ±0.01	0.03 ±0.00	0.05 ±0.00	0.04 ±0.01	0.03	0.05
Cadmium (Cd)	0.01 ±0.00	0.01 ±0.00	0.02 ±0.00	0.02 ±0.00	0.02 ±0.00	0.02 ±0.00	0.01	0.02
Arsenic (As)	0.03 ±0.00	0.04 ±0.01	0.04 ±0.00	0.05 ±0.00	0.05 ±0.00	0.04 ±0.00	0.03	0.05
Manganese (Mn)	0.11 ±0.00	0.12 ±0.00	0.12 ±0.00	0.11 ±0.00	0.12 ±0.00	0.12 ±0.01	0.11	0.12

Legend: Means on the same row with different superscripts are significantly different ($p<0.05$)

CONCLUSION

It was concluded that, the biochemical analysis carried out showed that rabbit meat is high in crude protein, and the mineral content and non-essential minerals are within the permissible limits, thus, making rabbit meat products produced by smallholder units in southwestern Nigeria safe and healthy for consumption. Locations have significant effects in some of the mineral contents of the meats across the locations in this study. The result from this study may be useful for further studies on the potentials of heterogeneous rabbit population in contributing to food security in the developing parts of the world. This study suggests that, further biochemical analysis studies should be carried out on the liver and the kidney of rabbits from the smallholder units in southwestern Nigeria for further clarifications.

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REFERENCES

Ajayi, B. A., Oseni, S. O., & Popoola, M. A. (2014). Heritability estimates and genetic correlations of some reproductive traits inheterogeneous rabbit population in South- west Nigeria. *Tropical Animal Production Investigation*, 17(1), 65-70.

AOAC (2003). Official Methods of Analysis of the Association of Official's Analytical Chemists,17thedn, Association of Official Analytical Chemists, Arlington,Virginia.

Baiomy, A. A., & Hassanien, H. H. M. (2011). Effect of breed and sex on carcass characteristics and meat chemical composition of New Zealand White and Californian Rabbits under upper Egyptian environment. *Egyptian Poultry Science*, 31(2), 275-284.

Bosch, A. C., O'Neill, B., Sigge, G. O., Kerwath, S. E., & Hoffman, L. C. (2016). Heavy metals in marine fish meatand consumer health: a review. *J of Science Food Agric*., 96, 32-48.

Fadlilah, A., Rosyidi, D. & Susilo, A. (2020). Chemical Quality of Fresh New Zealand White Rabbit Meat in Batu, Indonesia. IOP Conf. Series: Materials Science and Engineering 811 (2020), 012024. http://doi.org/10.1088/1757-899X/811/1/012024

Haque, A. Rahman, M., & Bora, J. (2016). Effect of breed, weaning age and feeding regime on chemical composition of rabbit meat. *International Journalof Veterinary Sciences and Animal Husbandry*, 1(1), 12-13.

IBM Corp. (2020). IBM SPSS Statistics for Windows, version 27.0. Armonk, NY: IBM Corp.

Ingweye, J. N., Lamidi, A. A., & Uzodimma, D.O. (2021). Chemical Composition, Cholesterol Profile and Sensory Quality of Meat from Rabbits Fed Aidan (*Tetrapleura tetratera*) as Dietary Additive. *IOSR Journal of Agriculture and Veterinary Science*, 14(4), 14-19.

Lukefahr, S.D. (1992). The rabbit project manual. A Trainer's Manual for Meat Rabbit Development. A Heifer Project international Publication, 1-102.

Lu, J., Jiao, W. B., Qiu, H.-Y., Chen, B., Huang, X. X., & Kang, B. (2018). Origin and spatial distribution of heavy metals and carcinogenic risk assessment in mining areas at You'xi County southeast China. *Geoderma*, 310, 99-106.

Moto, E. (2024). Potentials, challenges and prospects of rabbit farming in urban and peri-urban areas of Dodoma city, Tanzania. *World Rabbit Science*, 32, 31-42. http://doi.org/10.4995/wrs.2024.20238.

Mukaila, R. (2023). Measuring the economic performance of small-scale rabbit production agribusiness enterprises. *World Rabbit Science*, 31, 35-46. http://doi.org/10.4995/wrs.2023.18660.

Nkosi, D. V., Bekker, J. L., & Hoffman, L. C. (2021). Toxic metal in the wild ungulates and domestic meat animals slaughtered for food purposes: A systematic review. *Food*, 10, 2853 http://doi.org/10.3390/foods10112853 .

Odeyinka, S. M., Oyedele, O. J., Olosunde, A.O., Segun-Olasantan, A. O., Asaolu , V. O., Ayeni K. S., & Onifade, C. B. (2014). Growth performance and haematological parameters of weaner rabbits fed dietary levels of soyabean

milk residue. *Nigerian Journal of Animal Science*, 16(1), 61-66.

Onukwru, A. U., Ingweye, J. N., & Lamidi, A. A. (2022). Concentrate diets fed sole to rabbits by smallholder farmers in Greater Port Harcourt City, might not satisfy their nutrient requirements. Nigerian Journal of Animal Science, 24 (1), 201-214.

Oseni, S.O., Ajayi, B.A., Komolafe, S.O., Siyanbola, O., Ishola, M. & Madamidola, G. (2008). Smallholder rabbit production in southwestern Nigeria: current status, emerging issues and ways forward. In: G. Xiccato, A. Trocino and S.D. Lukefahr (eds.). Proceedings of the 9th World Rabbit Congress, Verona, Italy, June 10 – 13, 2008, 1597 – 1601.

Oseni, S. O., & Ajayi, B. A. (2010). Characterisation of A heterogeneous population of rabbits for prolificacy, pre-weaning littertraits and kit survival. Bulletin for Animal Health and Production in Africa, 58, 352-357.

Oseni, S.O. & Ajayi, B.A. (2014). Morphological characterization and principal component analysis of body dimensions of adult heterogeneous rabbits. *Journal of Applied Agricultural Research*, 6(1), 145-153. ISSN 2006-750X. Published byAgricultural Research Council of Nigeria (ARCN).

Popoola, M.A., Oseni, S.O. & Ajayi, B. A. (2014). Behavioural response of heterogeneous population of rabbits to diurnal temperature. *Nigerian Journal of Genetics*, 28, 28-34.

Sethukali, A. K., Hye-Jim, K., Dinesh, D. J., & Cheorun, J. (2023). On-Farm and Processing Factors Affecting Rabbit Carcass and Meat Quality Attributes. *Food Science and Animal Resources*, 43(2), 197-219. https://doi.org/10.5851/kosfa.2023.e5 .

Sherief, M. S. A., & Doaa Mohammed A. E. (2018). Nutritional value and meat quality profile of fresh rabbit meat in Assiut city Egypt. *International Journal for Research in Agricultural and Food Science*, 4(7), 1-15.

Stadnik, J. (2024). Nutritional value of meat and meat products and their role in human health. *Nutrients*, 16 (10), 1-4. http://doi.org/10.3390/nu16101446 .

USDA (1963). Composition of foods: raw, processed, prepared. Agriculture Handbook No. 8 Agricultural Research Services, USDA, Washington, D.C. Cited in: Lukefahr, S.D. 1992. The rabbit project manual. A trainer's manual for meat rabbit development. A Heifer Project International Publication, 11.

Wang, Z., He, Z., Zhang, D., Li, H., & Wang, Z. (2020). Using oxidation kinetic models to predict the quality indices of rabbit meat under different storage temperatures. *Meat Science*, 162, 108042.