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Chemical, Carcass and Sensory Characteristics of Rabbit (*Oryctolagus cuniculus*) Meat Fed Different Plant Protein Source

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Abstract
A study was conducted to evaluate the carcass, chemical and sensory characteristics of meat from rabbits fed different plant protein sources. Twenty (20) rabbits of mixed breeds and sex with an average initial weight of 847.20 g were allocated to four dietary treatments (groundnut cake as T1, Moringa leave meal as T2, cowpea husk as T3 and groundnut haulms as T4) with five rabbits per treatment each standing as a replicate in a completely randomized design (CRD). Experimental diets were formulated such that groundnut cake, moringa leave meal, cowpea husk and groundnut haulms were included at 30% on weight basis. Data were obtained on carcass characteristics (live weight, slaughter weight, dressing percentage, body length, rack, loin, shoulder, thigh, heart, lungs, liver, kidney, spleen, head, caecum length, caecum weight, large intestine length, large intestine weight, small intestine length, small intestine weight, stomach, fore feet, hind feet, shank, skin, and tail), sensory characteristics(palatability, juiciness, tenderness, colour, aroma, and acceptability) and chemical composition (water, protein, fat, fibre, and ash). There was a significant difference ($P<0.05$) in carcass characteristics among the treatments for live weight, slaughter weight, dressed weight, dressing percentage and body length. Prime cut and carcass by-products also revealed significant differences ($P<0.05$) however, heart, kidney, stomach and small intestine weight resulted in non-significant differences ($P>0.05$) among treatments. Chemical composition was determined according to standard methods. The basic chemical composition (water, protein, fat, fibre, and ash) of rabbit meat revealed significant differences ($P<0.05$) among treatments. Sensory characteristics showed a significant differences ($P>0.05$) among the treatments for palatability, tenderness, colour and aroma while Juiciness and acceptability indicated a non-significant differences ($P>0.05$) among treatments. Based on the performance of the animals, the diet containing 30% cowpea husk yields high live weight, slaughter weight and dressed weight while a diet containing 30% groundnut cake is preferred by the panellists in terms of organoleptic properties and yields high dressing percentage.
Keywords: Carcass, Chemical, Plant protein, Rabbit meat and sensory characteristics, Rabbit meat

Introduction

In developing countries like Nigeria; where especially rabbit meat preference has been on the increase because of its high protein, low fat and cholesterol content. Rabbit meat is characterized by a high protein level, and low fat and cholesterol contents and it is considered a healthful food product (Dalle Zotte, 2000), and has several advantages over other meats due to its fatty acids profile, several vitamins and minerals, and low cholesterol and sodium contents (Para *et al*., 2015). Most consumers' preferences for a product have determined the process of meat quality improvement. The sensory properties like colour or tenderness may have a significant impact on meat quality acceptability. These qualities of meat are one of the primary factors influencing consumers' satisfaction. However, rabbit meat has low consumption per capita and consequently, production is low. There are some problems associated with rabbit production, including the cost of feed, as well as digestive complications, especially with fattening rabbits, which affect productive parameters, e.g., daily gain, and feed intake, among other factors (Zepeda-bastida *et al.,* 2019). The use of plants in feed is an area that has been gaining interest over the past few years about, concerning rabbit production research, as plants contain bioactive compounds that can improve carcass and meat quality (Cardinali *et al*., 2015 and Kone *et al*., 2016).

In Nigeria, as in most developing countries, the daily dietary intake of animal protein (4.5g) falls grossly short

of the recommended 35 g of animal protein per person/day (FAO, 2001) This observed low animal protein consumption may be attributed to the declining animal production occasioned by high cost of feeds which usually accounts for up to 70% of the total cost of production (Ijaiya and Fasanya, 2002). A possible and most appropriate remedy for the shortage of animal protein for human consumption lies in the production of fast-maturing animals like rabbits; this is because livestock like cattle, pigs, goats and sheep take longer periods to mature. This study will seek to evaluate the carcass, chemical and sensory characteristics of meat from rabbits fed different plant protein sources under semi-arid conditions.

Materials and Methods

Experimental site

The experiment was conducted at the Slaughter House of the Livestock Teaching and Research Farm of the Department of Animal Science, University of Maiduguri. The farm is located along Bama Road, Maiduguri, Borno State. Maiduguri is situated between latitude 11° 46' 18" N and 11° 53' 21" N and longitude 13° 02' 23" E and 13° 14'19" E, it has an average relief ranging between 300m and 600m above sea level (Friday *et al*., 2020). Generally, the mean monthly temperature is always above 20°C but the daily extremes vary reaching up to 47°C in April (Jimme *et al*., 2016).

Source of experimental materials and experimental diets

Feed ingredients were purchased from an open market within Maiduguri while rabbits were obtained from smallholder rabbit farmers within Maiduguri Metropolitan Council. Maize, Maize offal, fish meal, a plant protein source (groundnut cake, *Moringa* leaves, cowpea husk and groundnut haulm), limestone, bone meal, vitamin premix, lysine and methionine were used to formulate a 13% crude protein diet. The plant protein source was use as treatment in which groundnut cake as treatment 1 (T1), *Moringa* leaves as treatment 2 (T2), Cowpea husk as treatment 3 (T3) and groundnut haulm as treatment 4 (T4). The experimental diet contains 12-13% crude protein.

Management of experimental animals and design

Twenty (20) growing rabbits of mixed breed and sex with an initial weight of 847.20 g were randomly allotted to four dietary treatments (Groundnut cake meal as T1, *Moringa* leave meal as T2, Cowpea husk as T3 and groundnut haulm as T4) with five rabbits per treatment each standing as a replicate. A completely randomized design was used in the experiment. The rabbits were housed in individual cages which is raised 19cm above the ground, measuring 15cm×14cm×17cm (width× length × height). The cages were provided with wire mesh floors which permit faeces and urine to drop. The rabbits were allowed a two-weeks acclimatization period. The rabbits were provided with a feeder and drinker in each cage compartment. Each drinker was attached to the wire mesh to prevent wastage and wetting of the feed. The feeders, drinkers and pen were cleaned daily. The rabbits were weighed to know their initial weight at the onset and weekly to the end of the feeding trial which lasted for 12 weeks.

Chemical analysis

The milled samples of the experimental diets, and fresh rabbit meat were taken to the Department of Animal Science laboratory, University of Maiduguri for proximate analysis. These samples were determined according to the procedure of the Association of Official Analytical Chemists (AOAC, 2005). The following parameters were determined dry matter (%DM), crude protein (%CP), crude fibre (%CF), ether extract(%EE), Ash and Nitrogen free extract (% NFE). % NFE was calculated as; % NFE = 100 - (% CP + % CF + % EE + % Ash).

Carcass characteristics

At the end of the 12 week feeding trial, three rabbits from each treatment were selected, weighed, starved overnight to clear the gut, stunned and slaughtered under hygienic conditions by severing the jugular vein. During evisceration, the internal organs and other gut contents were weighed; the dressed carcass and internal organs were weighed and expressed as a percentage of the live weight (Aduku and Olukosi, 1990).

$$\text{Dressing \%} = \frac{\text{Dressed carcass weight}}{\text{Live weight}} \times 100$$

Meat processing (Meat floss)

A meat sample of about 500 g was taken from each of the three rabbits in each treatment to have four different samples of 1500 g per treatment. Meat floss (*Dambun nama*) was prepared differently by washing each sample of meat properly and adding chopped onions of 114 g, 28 g of ground Scotch bonnet, 12 g of cubes, 10 g of curry powder, 4 g of fresh chopped garlic,4 g of thyme, 1.3 litres of water, 8 tablespoons oil and 9 g of iodized salt was added to the meat. The season was marinated to the meat very well and it is then cooked until it becomes melt in the mouth tender. It was then continuously stirred and added 8 tablespoons of vegetable oil and was shredded into little pieces then it became fried, dried and crispy. Each of the samples was labelled for identification.

Sensory evaluation of processed meat (Meat floss)

Meat floss *(Dambun nama)* was subjected to sensory evaluation for its acceptance and other sensory attributes such as palatability, juiciness, tenderness, colour and aroma. Twenty untrained panellists, who declared themselves regular consumers of meat floss, were asked to rate the samples based on a 9-point hedonic scale anchored by: 1 = 'Dislike extremely'; 2 = 'Dislike very much'; 3 = 'Dislike moderately'; 4 = 'Dislike slightly'; 5 = 'Neither like nor disliked'; 6 = 'Like slightly'; 7 = 'Like moderately'; 8 = 'Like very much', and 9 = 'Like extremely' (Everitte, 2009). They were instructed to chew a sample from each treatment, and score based on parameters stated on the scoring sheets; Palatability, juiciness, tenderness, colour, aroma and acceptability. Bottled water and pure bliss biscuit was served to the panellists to rinse their mouths after tasting each sample to reduce flavour carryover.

Data analysis

The data collected were subjected to analysis of variance (ANOVA), using the General Linear Model Procedure of SAS (2005). The significant differences

among the treatment means were separated using the Duncan`s Multiple Range Test (Duncan, 1955) in the SAS Package.

Results and Discussion

Proximate Composition of Experimental Diet

The chemical composition of the experimental diets is presented in Table 1. The dry matter (DM) percentages of the experimental diets were numerically similar in composition. The crude protein values were numerically similar for groundnut cake and *Moringa* leaves meal thus adequate for maintenance as reported by Labes (1980) while cowpea husk and groundnut haulms are adequate for maintenance as reported by NRC (1977). The ether extract from *Moringa* leaves meal and cowpea husk were at par and adequate for maintenance as reported by NRC (1977) while that of groundnut cake and groundnut haulms were lower. The crude fibre of the diets was similar for groundnut cake and *moringa* leaves meal and higher in cowpea husk and groundnut haulms which are adequate for maintenance as reported by NRC (1977) and Labes (1980), the variation in fibre contents of the diets may be due to high fibre in cowpea husk and groundnut haulms of cowpea husk and groundnut haulms diets respectively. Alawa and Amadi (1991) reported that various by-products of fibre can affect voluntary feed intake depending on the nature of fibre. The Nitrogen-free extract (NFE) of the experimental diets range from (40.29-51.57). The Metabolizable energy of the diets was numerically similar in all the experimental diets and similar to the requirement for maintenance as reported by Labes (1980) (2200 kcal/kg). Rabbits, like most monogastric animals voluntarily adjust their feed intake to meet their energy requirements (NRC, 1977).

Carcass Characteristics of Rabbits Fed Diets Containing Different Plant Protein Sources

The carcass characteristics of rabbit fed diets containing different plant protein sources (Table 2) showed a significant ($P<0.05$) effect of dietary treatment on the carcass characteristics of rabbits. Higher live weight ($P<0.05$) was observed for rabbits fed cowpea husk (1597.7g) followed by groundnut haulms (1381.0) which was at par with that of groundnut cake (1380.7g) and *Moringa* leave meal (1185). Similarly, slaughter weight was heaviest ($P<0.05$) for rabbits fed cowpea husk (1425.0g) which was at par with that of groundnut cake (1358.0g) and groundnut haulms (1346.0g), respectively, while the lowest ($P<0.05$) slaughter weight was recorded at *Moringa* leave meal. Dressed weight was (759.0g) with cowpea husk being the highest, groundnut cake (740.3g) is similar to groundnut haulms (673.0g) and the lowest was observed at *Moringa* leave meal (549.0) however, these values where lower than the values reported by Tsado *et al*. (2018). The highest dressing percentage of (52.88%) was recorded for groundnut cake, followed by groundnut haulms (48.56%) which is similar to *Moringa* leave meal (46.05%) and groundnut haulms (48. 56%) which are lower ($P<0.05$) than the values obtained by Tsado *et al*. (2018). The body length of rabbit-fed groundnut cake (27.33cm) and *Moringa* leaves meal (26.33cm) was at par with cowpea husk (27.67cm) while higher ($P<0.05$) body length (29.33cm) was observed at cowpea husk. Rabbits fed the cowpea husk diet have higher slaughter weight, dressed weight, dressing percentage and body length compared to the other diets while rabbits fed *Moringa* leave meal have lower dressed weight and dressing percentage (Table 4.2). Dressed weights and dressing percentages obtained in this study were lower than those reported by Tsado *et al*. (2018) as this may be attributed to variations in feed among other factors.

Prime Cuts of Rabbits Fed Diets Containing Different Plant Protein Sources

The prime cut of rabbit fed diets containing different plant protein sources is presented in Table 3. There was a significant ($P<0.05$) effect of dietary treatment on the prime cut of rabbits. A heavier weight of shoulder was obtained for rabbits fed cowpea husk (15.86g) followed by groundnut cake (14.21g) and *Moringa* leave meal (13.01g) which is similar to groundnut haulms (12.18g). Higher rack weight was observed at cowpea husk (8.03g), followed by groundnut cake (6.34g) which is at par with groundnut haulms (6.13g) and *Moringa* leave meal (6.03g). Lion weight of (14.15g) was observed at cowpea husk which was higher and groundnut haulms (10.41g) is similar to groundnut cake (10.08g) while the least weight was obtained in *Moringa* leave meal (8.32g). The higher weight of thigh was recorded in cowpea husk (24.54g), followed by groundnut cake (21.18g) which was at par with groundnut haulms (20.21g) while the least ($P<0.05$) was observed in *Moringa* leave meal (18.04g).

Edible and Inedible By-product of Rabbits Fed Diets Containing Different Plant Protein Sources

The result of edible and in-edible by-product components of rabbits fed diets containing different plant protein sources is presented in Table 4. The percentage yield of liver, lung, spleen, tail, caecum, Small intestine, large intestine, skin, fore feet, hind feet and shank showed significant ($P<0.05$) differences across dietary treatments. However, the percentage yield of heart, kidney and stomach was non-significant ($P>0.05$) across dietary treatments. Higher ($P<0.05$) lung weight was recorded for rabbits fed groundnut haulms (0.70) which is similar to *Moringa* leave meal (0.66) and groundnut cake (0.63) and the least ($P<0.05$) for rabbits fed cowpea husk (0.48). Groundnut cake, *Moringa* leaves meal and groundnut haulms weights are higher while cowpea husk is lower than those reported by Tsaro *et al*. (2018) (0.56-0.41). Weight of liver (3.43) was recorded for rabbits fed *Moringa* leave meal being the highest ($P<0.05$) which is similar to groundnut haulms (2.76), followed by ground cake (2.35) which is at par with cowpea husk (2.35). Higher ($P<0.05$) spleen (0.08) was recorded for groundnut cake while *Moringa* leaves meal (0.07) and groundnut haulms (0.06) are similar and lower ($P<0.05$) weight was observed at cowpea husk (0.05) which was at par with groundnut haulms. Higher ($P<0.05$) caecum weight was obtained at *Moringa* leave meal (7.34) which is at par with

groundnut haulms (7.33), followed by cowpea husk (7.16) and lastly groundnut cake (6.12). A large intestine length of (6.94) was obtained at cowpea husk being the highest which is at par with *Moringa* leave meal (6.65) and similar with groundnut haulms (6.21) and groundnut cake (5.79) being the least. Higher large intestine weight was recorded at cowpea husk (11.71) followed by groundnut haulms (9.69), groundnut cake (8.05) and *Moringa* leave meal (7.95) are similar. Small intestine length of (21.66) was obtained at groundnut haulms being the highest followed by *Moringa* leave meal (16.28) which is at par with cowpea husk (15.89) and groundnut cake (13.25) being the least. Higher ($P<0.05$) head weight was observed at cowpea husk (10.28) which is similar to *Moringa* leave meal (9.91) and groundnut cake (9.46) is also similar to groundnut haulms (8.77). Forefeet weight of (0.91) was obtained at cowpea husk which is at par with *Moringa* leave meal (0.89) this is followed by groundnut haulms (0.81) and lastly groundnut cake (0.71). Higher ($P<0.05$) weight of hind feet and shank was observed at *Moringa* leave meal (2.20) which is similar to cowpea husk (2.12) followed by groundnut cake (1.96) and at par with groundnut haulms (1.86). Skin weight of (9.67) was obtained at cowpea husk being the highest and groundnut cake (8.03), *Moringa* leave meal (7.92) and groundnut haulms (7.21) being at par. Tail weight showed it was high ($P<0.05$) at cowpea husk (0.53) which is at par with groundnut cake (0.48) and *Moringa* leave meal (0.41) and groundnut haulms (0.28) being the least.

Chemical Composition of Rabbit Meat

The chemical composition of muscles from rabbits differed significantly ($P<0.05$) across the dietary treatments. The established water content in groundnut haulms (67.40 %) is significantly ($P<0.05$) higher which is similar to groundnut cake (66.90 %) and *Moringa* leave meal (65.37 %) while the lowest value was obtained in cowpea husk (63.00 %). The % water contents obtained are similar to the 69.6% reported by Baiomy and Hassanien (2011). The protein level was (31.16%) in cowpea husk being the highest followed by *Moringa* leave meal (29.29%) and groundnut haulms (29.14%) which are at par while the lowest value was observed in groundnut cake (26.20%). The value obtained was higher with the findings of Metzger *et al*. (2003) (21.3 to 21.5%) and Skandro *et al*. (2008) (21.79 to 22.02%). The ether extract (fat) contents determined were higher in *Moringa* leave meal (6.67%) which is the same with cowpea husk (6.67%) and similar to groundnut haulms (5.67%) and lower content of fat in groundnut cake (4.67%). The values were higher than the 3.35% reported by Chrenek *et al*. (2012). Depending on the dressing methods, fat content was 1.49 to 3.58% (g/100g) according to Omojola and Adesehinwa (2006), and depending on the age of weaning and muscle type, it was 2.20 to 3.61% as reported by Bivolarski *et al*. (2011). The crude fibre contents of the meat show a higher percentage in groundnut haulms (24.50%), followed by cowpea husk (16.50%) which is at par with *Moringa* leave meal (10.00%) and the lowest value was observed in groundnut cake (6.82%). The Ash content obtained were higher in groundnut haulms (1.00%) and the same value was observed in groundnut cake (0.83%) and *Moringa* leave meal (0.83%) the lowest value was in cowpea husk (0.67%). The ash contents obtained in this study were close to the published results of Metzger *et al*. (2003) (1.29 to 1.31%), Skandro *et al*. (2008) (1.17 to 1.26%) and lower than the values reported by Mohamed (1989) (1.63%). Calculated Metabolizable energy values for groundnut cake to groundnut haulms are 1540.08 to 2521.16 kcal/kg.

Sensory Evaluation of Rabbit Meat Floss

The sensory evaluation of meat floss is shown in Table 6. The result revealed that the sensory properties of the meat floss differed significantly ($P<0.05$) across the dietary treatments. However, juiciness and acceptability were non-significant ($P>0.05$) across the dietary treatments. The palatability of the meat floss as affected by treatment showed that, it was higher ($P<0.05$) at groundnut haulms (8.40) being the most preferred which was similar to groundnut cake (8.25) and cowpea husk (8.05), respectively, while lower palatability index was observed at *Moringa* leave meal (7.70). The tenderness of meat floss at groundnut haulms (7.60) was more preferred which was at par with *Moringa* leave meal (7.10) and groundnut cake (7 7.00) while lower tenderness index was observed at cowpea husk (6.45). Similarly, the colour attribute of groundnut cake (8.35) was more preferred which was at par with *Moringa* leave meal (7.95) and *Moringa* leave meal is similar to groundnut haulms (7.70) and cowpea husk (7.40). Adam *et al*. (2010) observed that meat colour is considered an important parameter that attracts consumers to buy meat. Meat colour is also affected by the method of slaughter as the level of blood left in the carcass. Meat colour has a powerful influence on consumer acceptance of food products, especially meat products and serves as a visual indicator of meat quality (James, 1993). The aroma of the meat floss as affected by treatment showed that, it was high ($P<0.05$) at groundnut cake (7.80) which is similar to *Moringa* leave meal (7.65) and groundnut haulms (7.35) where cowpea husk (7.00) is the least.

Conclusion

Rabbits on cowpea husk diets yield higher live weight, slaughter weight and dressed weight followed by those on the *Moringa* leaves meal diet while the least are rabbits on groundnut cake and groundnut haulms. Meat from rabbits on a cowpea husk diet has higher protein compared to rabbits on groundnut cake. Inclusion of cowpea husk up to 30% level is effective for higher live weight, slaughter weight and dressed weight while the inclusion of groundnut cakes up to 30% level yield higher dressing percentage and is more preferred by the panellists in terms of organoleptic properties.

References

Adam, A. A. G., Atta, M. and Ismail, S. H. A. (2010). Quality and sensory evaluations of meat from Nilitic male kids fed on two different diets. *Journal of Animal and Veterinary Advances,* 9:2008-2012.

Aduku, A. O. and Olukosi, J. O. (1990). Rabbit Management in the Tropics: *production processing, utilization, marketing, economics, practical training research and prospects*. G.S, Publications, Abuja, Nigeria. 33-44.

Akıncı, Z., Poyraz, Ö., Akçapınar, H. and Evogliyan, N. (1998). The effects of genotype, sex and age on some slaughter traits and carcass characteristics of New Zealand White and California Rabbits. *Journal of Lalahan Livestock Research Institute*, (38): 84-102.

Alawa, J. P. and Amadi, (1991). Voluntary feed intake and digestibility of diets containing corn cobs, brewers dried grains and wheat bran by rabbits. *Journal of Animal Production Research,* 11: 9-20.

Arijeniwa, A., Otaikhian, S. O. and Maseun, J. A. (2000). Performance of weaner rabbits fed: grower supplement with different grass legumes rations. In: Proceedings of 5th Annual Conference of Animal Science of Association of Nigeria (ASAN), 103-105.

Association of Official Analytical Chemists, AOAC, (2005). Official Method of Analysis. International, Association of Official Analytical Chemists, 24th edition Washington D.C. USA. Pp 200-210.

Baiomy, A. A. and 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. *Egypt Poultry Science*, 31: 275-284.

Bivolarski, B. L., Vachkova, E. G. and Ribarski, S. S. (2011). Effect of weaning age upon the slaughter and physicochemical traits of rabbit meat. *Veterinarski Arhiye*, 81: 499-511

Cardinali, R., Cullere, M., Dal Bosco, A., Mugnai, C., Ruggeri, S., Mattioli, S., Castellini, C., Trabalza Marinucci, M. and Dalle Zotte, A. (2015). Oregano, rosemary and vitamin E dietary supplementation in growing rabbits: Effect on growth performance, carcass traits, bone development and meat chemical composition. *Livestock Science,* 175: 83-89.

Cavani, C., Bianchi, M., Lazzaroni, C., Luzi, F., Minelli, G. and Petracci, M. (2000). Influence of type of rearing, slaughter age and sex on fattening rabbit. In: II *Meat quality*. Proceeding of the 7th World Rabbit Congress, Spain, A: 567-572.

Cheeke, P. R., Patton, N. M., Lukefahr, S. D., and McNitt, J. I. (Eds.) (1987). *Rabbit Production.* Interstate Printers & Publishers, Incorporated, Danville, Illinois.

Chrenek, P., Makarevich, A., Kozelová D. and Rafay J. (2012). Meat quality of transgenic rabbit. *Slovak Journal of Animal Science*, 45: 60–62.

Dalle Zotte, A. (2000). Main factors influencing the rabbit carcass and meat quality. Proceeding of the 7th World Rabbit Congress, Valencia, Spain. 1-32.

Dalle Zotte, A. (2002). Perception of Rabbit Meat Quality and Major Factors Influencing the Rabbit Carcass and Meat Quality. *Livestock Production Science*, (75): 11–32.

Duncan, D.B. (1955). Multiple Range and Multiple F-tests. *Biometric,* 11: 1-42.

Everitte, M. (2009). Consumer-targeted sensory quality. In*: Global Issues in Food Science and Technology*. Barbosa-CanovasAlan, M., D. Line back, W. Spiess, Buckle and Colonna(ed.). Washington, USA.Pp 177-128.

Fayeye, T.R. and Ayorinde, K.L. (2008). Effects of weaning litter size and sex on post-weaning body weight, mortality and carcass characteristics of domestic rabbit in the humid tropics. In: Proceeding of 9th World Rabbit Congress – June 10-13, 2008 – Verona – Italy. P. 1535-1538.

Featherstone, S. (2003). Food Hygiene not for sissies. South African Food Review. *Journal for Food and Beverage Manufactures*, 30: 49-53

Food and Agricultural Organisation (2001). Slaughter of livestock. Guidelines for human handling; transport and slaughter of livestock. Heinz, G. and svicuvan, T. (ed.). Food and Agricultural Organization of the United Nations. Rome, Italy. https:/www.fao.org/dorcep/003/6909e.ht

Friday, K., Nkwocha Oyilieze, A. A., Abba, M. J., Oji, S.I., Joe-Nkechebelu, N. and Friday, K. N. (2020). Perception and Impacts to Climate Emergency in Maiduguri Urban, North-East Nigeria: A Case for Community -Based Adaptation Approach *Environmental Earth Sciences* 6(2):24-33 DOI:10.18488/journal.80.2019.62.24.33

Harris, D. J., Cheeke, O. R. and Patton, N.M. (1984). Effects of fryer rabbit performance on supplanting a pelleted diet of alfalfa or grass hay. *Journal of Applied Rabbit Research*, 7(4): 148-150.

Ijaiye, A. T. and Fasanya, O. O. A. (2002). Effects of varying levels of dietary protein on the carcass characteristics of growing rabbits. *Nigerian Journal of Animal Production*, 27(1): 230 235.

James, G. (1993). Packaging, storage and delivery of ingredients. *Journal of Food Technology,* 47(8): 54-63.

Jimme, M. A., Bukar, W. M. and Monguno, A. K. (2016). Contamination levels of domestic water sources in Maiduguri Metropolis, Borno State, Northeast Nigeria. *Ethiopian Journal of Environmental Studies & Management,* 9: 760-768.

Kone, A. P., Cinq-Mars, D., Desjardins, Y., Guay. F., Gosselin, A. and Saucier, L. (2016). Effects of plant extract and essential oil as feed supplements on quality and microbial traits of rabbit meat. *World Rabbit Science*, 24: 107-119.

Lebas, F. (1980). Nutritional Requirements for Rabbits. Retrieved from:https://www.google.com/url?q=https://www.researchgate.net/profile/ Rana-Al Difaie/post/What-the-nutrient-requirement-for-rabbit-during pregnancy/attachment/59d64eb079197b80779a7fc8/AS%253A493952089899008%254014947787 63533/download/nutritional-requirements-of rabbits.pdf&sa=U&ved=2ahUKEwjSyaS395KA AxVzhv0HHc7iDcgQFnoECAsQAg&usg=AOvV

aw3OzBu2uQvoUh7CGZrccFbJ on 20th may 2023.

Metzger, Sz., Kustos, K., Szendro, Zs., Szabo, A., Eiben, Cs. and Nagy, I. (2003). The effect of housing system on carcass traits and meat quality of rabbit. *World Rabbit Science*, 11: 1-11.

Mohamed, K. I. (1989). Studies on some productive traits in rabbits under the environmental conditions of El-Minia Governorate (MSc Thesis). El-Minia, Egypt, E-Minia University.

Murshed, H. M., Shishir, S. R., Rahman, S. M. E. and Deog-Hwan, O. H. (2014). Comparison of carcass and meat characteristics between male and female indigenous rabbits of Bangladesh. *Bangladesh Journal of Animal Science,* 43(2): 154-158.

National Research Council. (1977). *Nutrient Requirements of Rabbits, Second Revised Edition*. Washington, DC: The National Academies Press.https://doi.org/10.17226/35.

Omojola, A. B. and Adesehinwa A. O. K. (2006). Meat characteristics of scalded, singed conventionally dressed rabbit carcasses. *World Journal of Zoology*, 1: 24-29.

Para, P. A., Ganguly, S., Wakchaure, R., Sharma, R., Mahajan, T. and Praveen, P. K. (2015). Rabbit has the potential of being a possible alternative to other meats as a protein source: A brief review. *International Journal of Pharmacy and Biomedical Research,* (2):17-19.

Piles, M., Blasco, A. and Pla, M. (2000). The effect of selection for growth rate on carcass composition and meat characteristic of rabbits. *Meat Science*, 54: 347-355.

Statistical Analysis Software, (2005). Statistical Analysis Software (CD-ROM), Version 8.1, SAS Institute Inc., Cary, N.C., USA.

Škandro, M., Tarig, A., Alić, B., Goletic, T. and Kustura, A. (2008). It Qualitativeand quantitative characteristics of New Zealand white rabbit meat. *Meat.* 10, 149-153.

Szendro, Z., Romvári, R., Nagy, I., Andrassy-Baka, G., Metzger, S., Radnai, I., Biro-Nemeth, E., Szabo, A., Vigh, Z. and Horn, P. (2004). Selection of Pannon White rabbits based on computerised tomography. In Proceeding of the 8th World Rabbit Congress. September 7-10, Puebla, Mexico. Pp.175-180.

Tsado, D. N., Larai, I., Adama, T. Z. and Jiya, E. Z. (2018). Carcass characteristics and sensory evaluation of meat from growing rabbits (*Oryctolagus cuniculus*) fed diets containing varying levels of fermented lebbeck (*Albizia lebbeck*) Seed Meal *Nigerian Journal of Animal Science*, 20(2): 271-279.

Yakcin, S., Onbasilar, E. E. and Onbasilar, I. (2006). Effect of sex on carcass and meat characteristics of New Zealand White rabbits aged 11 weeks. *Asian-Australasian Journal of Animal Sciences,* (19): 1212– 1216.

Zepeda-Bastida, A., Martínez, A. M. and Simental, S.S. (2019). Carcass and meatquality of rabbits fed Tithonia tubeworms weed. *Revista Brasileira de Zootecnia*. 48: e20190074. https://doi.org/10.1590/rbz4820190074.

Table 1: Proximate composition of experimental diets

Parameters (%)	Groundnut cake	Moringa leave	Cowpea husk	Groundnut haulms
Dry Matter	93.1	91.92	92.73	91.06
Crude Protein	13.99	13.55	12.13	12.72
Ether Extract	1.94	2.8	2.08	1.84
Crude Fibre	10.36	10.69	14.86	15.32
NFE	47.78	40.29	42.34	51.57
ME(Kcal/kg)	2370.96	2158.45	2120.36	2450.42

NFE = Nitrogen free extract, ME= Metabolizable energy

Table 2: Carcass characteristic of rabbits fed diets containing different plant protein sources

Parameters	Groundnut cake	Moringa leave	Cowpea husk	Groundnut haulms	SEM	LS
Live Weight (g)	1380.7^{b}	1185.0^{b}	1597.7^{a}	1381.0^{b}	60.61	*
Slaughter Weight(g)	1358.0^{ab}	1143.3^{b}	1426.0_{a}	1346.0^{ab}	48.57	*
Dressed Weight (g)	740.3^{b}	549.0^{c}	759.0^{a}	673.0^{b}	39.84	*
Dressing (%)	52.88^{a}	46.05^{b}	47.50^{b}	48.56^{b}	1.39	*
Body Length (cm)	27.33^{b}	26.33^{b}	29.33^{a}	27.67^{b}	0.28	*

^{abc}Means with the same superscript(s) within rows are not significantly different at 5% level of probability. SEM=Standard Error Mean, LS= Level of Significance, * = Significant

Table 3: Prime cuts of rabbits fed diets containing different plant protein sources

Parameters (g)	Groundnut cake	Moringa leave	Cowpea husk	Groundnut haulms	SEM	LS
Shoulder	14.21^{b}	13.01^{c}	15.86^{a}	12.18^{c}	0.54	*
Rack	6.34^{b}	6.03^{b}	8.03^{a}	6.13^{b}	0.44	*
Loin	10.08^{b}	8.32^{c}	14.15^{a}	10.41^{b}	0.83	*
Thigh	21.18^{b}	18.04^{c}	24.56^{a}	20.21^{b}	0.86	*

^{abc}Means with the same superscript(s) within rows are not significantly different at 5% level of probability. SEM=Standard Error Mean, LS= Level of Significance, * = Significant

Table 4: Edible and in-edible by-products of rabbits fed diets containing different plant protein sources

Parameters	Groundnut cake	Moringa leave	Cowpea husk	Groundnut haulms	SEM	LS
Heart (%)	0.31	0.32	0.30	0.28	0.03	NS
Lungs (%)	0.63^{a}	0.66^{a}	0.48^{b}	0.70^{ab}	0.06	*
Liver (%)	2.34^{b}	3.43^{a}	2.35^{b}	2.76^{a}	0.13	*
Kidney (%)	0.91	0.84	0.82	0.78	0.08	NS
Spleen (%)	0.08^{a}	0.07^{ab}	0.05^{c}	0.06^{bc}	0.02	*
Caecum length (cm)	2.85^{b}	3.31^{a}	3.33^{a}	2.73^{b}	0.34	*
Caecum weight (%)	6.12^{c}	7.34^{a}	7.16^{b}	7.33^{ab}	0.45	*
Large intestine length (cm)	5.79^{b}	6.65^{a}	6.94^{a}	6.21^{ab}	0.41	*
Large intestine weight (%)	8.05^{c}	7.95^{c}	11.71^{a}	9.69^{b}	0.75	*
Small intestine length (cm)	13.25^{c}	16.38^{b}	15.89^{bc}	21.66^{a}	1.41	*
Small intestine weight (%)	4.49	4.26	4.99	5.02	0.55	NS
Stomach (%)	4.46	5.28	5.56	5.48	0.67	NS
Head (%)	9.46^{a}	9.91^{ab}	10.28^{a}	8.77^{b}	0.45	*
Forefeet (%)	0.71^{c}	0.89^{a}	0.91^{a}	0.81^{b}	0.01	*
Hind feet shank (%)	1.96^{ab}	2.20^{a}	2.12^{a}	1.86^{b}	0.13	*
Skin (%)	8.03^{b}	7.92^{b}	9.67^{a}	7.21^{b}	0.45	*
Tail (%)	0.48^{a}	0.41^{ab}	0.53^{a}	0.28^{b}	0.07	*

^{abc}Means with the same superscript(s) within rows are not significantly different at 5% level of probability. SEM=Standard Error Mean, LS= Level of Significance, NS= Not Significant, * = Significant.

Table 5: Chemical composition of rabbit meat

Parameters (%)	Groundnut cake	Moringa leave	Cowpea husk	Groundnut haulms	SEM	LS
Water %	66.90^{a}	65.37^{ab}	63.00^{b}	67.40^{a}	1.74	*
Protein %	26.20^{b}	29.29^{ab}	31.16^{a}	29.14^{ab}	1.93	*
Fat %	4.67^{b}	6.67^{a}	6.67^{a}	5.67^{ab}	0.86	*
Crude Fibre %	6.82^{b}	10.00^{c}	16.50^{b}	24.50^{a}	2.69	*
Ash %	0.83^{ab}	0.83^{ab}	0.67^{b}	1.00^{a}	0.11	*

^{ab}Means with the same superscript(s) within rows are not significantly different at 5% level of probability. SEM=Standard Error Mean, LS= Level of Significance, * = Significant.

Table 6: Sensory evaluation of meat floss

Parameters	Groundnut cake	Moringa leave	Cowpea husk	Groundnut haulms	SEM	LS
Palatability	8.25^{ab}	7.70^{b}	8.05^{ab}	8.40^{a}	0.28	*
Juiciness	7.30	7.35	7.40	7.55	0.35	NS
Tenderness	7.00^{ab}	7.10^{ab}	6.45^{b}	7.60^{a}	0.36	*
Colour	8.35^{a}	7.95^{ab}	7.40^{b}	7.70^{b}	0.31	*
Aroma	7.80^{a}	7.65^{ab}	7.00^{b}	7.35^{ab}	0.37	*
Acceptability	7.85	7.85	7.30	7.90	0.44	NS

^{ab}Means with the same superscript(s) within rows are not significantly different at 5% level of probability. SEM=Standard Error Mean, LS= Level of Significance, NS= Not Significant, * = Significant