Journal of Agriculture, Food, Environment and Animal Sciences
Tarım, Gıda, Çevre ve Hayvancılık Bilimleri Dergisi
http://www.jafeas.com, ISSN: 2757-5659

J. Agric. Food, Environ. Anim. Sci.
4(2): 137-149, 2023

The Growth Performance, Nutrient Digestibility, Organ Characteristics of Weaner Rabbits Fed Sun Dried Bovine Rumen Content as Replacement for Maize

Charles Onochie OSITA[1] , Ezenwosu CELESTINE[2*], Odum Nnaemeka CALISTUS[3], Augustine Ogbonna ANI[4]

[1-4] Department of Animal Science, Faculty of Agriculture, University of Nigeria, Nsukka, NIGERIA

[1]https://orcid.org/0000-0002-0163-6452, [2]https://orcid.org/0000-0002-1559-8709, [3]https://orcid.org /0009-0007-5281-5278
[4]https://orcid.org/0009-0006-0271-4412

*Corresponding author: celestine.ezenwosu@unn.edu.ng

Research Article

Article History:
Received: 16 October 2022
Accepted: 03 November 2023
Published online: 15 December 2023

Keywords:
Growth performance
Weaner rabbits
Rumen digester
Growth performance
New Zealand white

ABSTRACT

The aim of this study was to investigate the growth performance, nutrient digestibility, and organ characteristics of weaner rabbits fed sun dried bovine rumen content-based diet as energy source in weaner rabbits. A total of eighty (8 weeks) crosses of New Zealand White x Chinchila weaner rabbits consisting of 40 males and 40 females weighing 880-920g were randomly allotted to 4 dietary treatments in a completely randomized experimental design with 5 replicates of 4 rabbits each. Treatments were 4 experimental diets (T1, T2 T3 and T4) replacing 0, 30, 60, and 100% maize in the diets respectively. Results showed that rabbits on dried rumen contents had higher growth performance, percentage nutrient digestibility, and improved organ traits compared to the control group. The growth performance of rabbits and percentage nutrient digestibility increased as the level of dried rumen content increased in the diet. In conclusion, dried rumen content can be used to replace 100% maize in diets of rabbits by rabbit producers.

To Cite : Osita CO, Ezenwosu C, Odum NC, Ani AO., 2023. Growth Performance, Nutrient Digestibility, Organ Characteristics of Weaner Rabbits Fed Sun Dried Bovine Rumen Content as Replacement for Maize. Agriculture, Food, Environment and Animal Sciences, 4(2): 137-149.

INTRODUCTION

The provision of a sustainable source of farm animal protein to satisfy the growing protein needs of the increasing global human population and to attain self-reliance in the supply of animal protein, especially in developing countries such as Nigeria calls for the production of different types of farm animal meat, including rabbit. Rabbits are farm animals with strong reproduction rates and capacity to use fodder. Rabbit husbandry is presently of great importance because of its possible support to sustain the increasing need of the human population for protein of animal origin. (Cherfaoui, 2015). They have minimal initial capital costs, a small unit area requirement, and have no cultural or religious restrictions on their intake as meat (NRC, 1991).

According to Dalle Zotte (2014) production of rabbit is very beneficial because of their tall prolificacy, diminutive biological cycle, and as well as their organoleptic and dietary features. According to Elkholy et al. (2019) meat obtained from rabbits have less sodium content. Rabbit is a very fascinating animal species because it is genetically developed for diverse purposes such as pets, livestock animals and for research (Crowell-Davis, 2021; Menchetti et al., 2018). Rabbits represents the 4th livestock sector in commercial importance after cattle, pigs, and chickens (Cullere and Dalle Zotte, 2018). Meat from rabbit is esteemed by consumers for its great nutritive and sensory qualities. This type of meat is high in protein and also have a high quantity of unsaturated fatty acids (Dalle Zotte and Szendrő, 2011).

However, one of the most crucial elements of rabbit's production is their diet. Their production is being hampered by the lack of or insufficient supply of rabbit pellets, which are primarily made of cereal grains (Aduku and Olukosi, 1990). Additionally, rabbit breeders that only use concentrates are now facing severe issue related to the feeding challenges associated with pig and poultry husbandry. Therefore, it is crucial to find other sources of energy in rabbit feeding and must be one of those alternative energy feed stuffs that is readily available, cheap and can lessen competition between animals and humans for the most convectional feed ingredients for consumption (Biobaku, 2002).

However, dried bovine rumen contents is one of such alternative enrgy feed sources that can be used to replace energy feed ingredients such as maize in rabbit nutrition An animal byproduct known as sun dried bovine rumen content is produced when rumen of an animals is split open after slaughter and is typically found at abattoirs. There is 10.69% moisture, 10.82% crude protein, 5% extract, 20% ash, and 20% fiber in cow rumen content or digester (Whyte and Wadak, 2002). Additionally, dried bovine rumen digester was shown by Esonu et al. (2006) to contain 18.20% moisture, 15.30% crude fiber, 18.52% crude protein, 7.60%, 8.79% ether extract, and 38.39% carbohydrates. Rumen contents are inedible to humans and they contains many microorganisms that help in feed decomposition, protein synthesis, and fatty acid synthesis in farm animals. The rumen digester is also made up of undigested feed that ruminant animals consume and fiber concentration in rumen digester is also high. With regard to finding a solution to reduce the competition between human beings and animals for most feed stuffs used in animal nutrition, the present study was designed to investigate the growth performance, nutrient digestibility, and organ characteristics of weaner rabbits fed sun dried bovine rumen content as a replacement for maize.

MATERIALS and METHODS

Ethical Consideration

This study was carried out in accordance with the guidelines esestablished by the University of Nigeria's Nsukka, Enugu, Nigeria, Ethical Committee on the use of animals in biomedical research (No: UNNC301ARO09.20.08.2021).

Study Site and Duration of The Study

The study was conducted at the Rabbits Section of the Department of Animal Science Teaching and Experimental Farms, University of Nigeria, Nsukka Enugu State. The study area lies within longitude 6° 45′E and 7° E and latitude 7° 12.5 ′N and at an altitude of 447m above sea level. The annual rainfall according to the Metrological Center, Crop Science Department, University of Nigeria, ranges from 1567.05 mm-1846.98 mm. The climate of the study environment is naturally tropical, with relative humidity ranging from 65 to 80% and 26.8 °C mean daily temperature (Okonkwo and Akubuo, 2007). The study lasted for 8 weeks.

Feed Ingredients and Preparation

After the cattle were butchered, the rumen content used in the study was gathered at the main abattoir in Nsukka town, Enugu, Nigeria. A butcher's knife was used to split apart the rumen and empty the contents. The fluid-filled rumen content was poured into sacks to drain. On a spotless zinc roof, the drained rumen content was sun dried until the appropriate moisture content was attained. Prior to the beginning of the study, the dried rumen digester was packed and kept in a dried place. To create finely ground dried rumen content meal, the sun-dried bovine rumen content was processed with a hammer mill. Before being used in diet formulation, proximate analysis of the obtained dried rumen content was conducted using (AOAC, 2012).

Experimental Diet

The treatments consisted of four experimental diets (T1, T2, T3, and T4) that were designed to replace 0, 30, 60, and 100% of maize in the diets with dried rumen digester. Table 1-2 display the compostions of the experimental diets and their proximate components.

Experimental rabbits and management procedure

In a thoroughly randomized experimental design with 5 replicates of 4 rabbits each, a total of 80 (8 weeks) crosses of New Zealand White x Chinchilla weaner rabbits,

consisting of 40 males and 40 females, were randomly assigned to 4 dietary treatments (T1, T2, T3 and T4). Out of a batch of 300 weaned rabbits, 40 males and 40 females were randomly selected as weaner rabbits and were used for the study. The rabbits were kept in individual cages measuring 76x 62x 42 cm in size and 90 cm off the ground, surrounded with galvanized wire, and fitted with feeding and water basins. To facilitate easy transit of urine and feaces, the cage floors were built with perforated metal slates. The cages, feeders, and water troughs were carefully cleaned and disinfected before the rabbits arrived. The rabbits were stabilized with commercial top feed growers mash for a week at the experimental site before receiving ivomec as a preventative treatment for both internal and external parasites. The rabbits were fed diets containing 0, 10, 20, and 30% dried rumen contents replacing 0, 30, 60, and 100% maize in the diet respectively. Every day, the rabbits in each treatment received 700 g of feed split into two portions: 350 g in the morning between 7 and 8 am and 350 g in the afternoon between 3 and 4 pm. Water was available at all times.

Table 1. Percentage composition of the experimental diet diets

Ingredients	T1	T2	T3	T4
Maize	30.00	20.00	10.00	0.00
Wheat offal	20.00	21.00	21.39	22.20
Palm kernel cake	26.50	27.00	28.05	27.60
Soybean meal	7.75	6.50	5.52	4.70
Groundnut cake	9.28	9.00	9.00	9.00
Dried rumen contents	0.00	10.00	20.00	30.00
Salt	0.25	0.25	0.25	0.25
Vitamin premix	0.25	0.25	0.25	0.25
Bone meal	1.00	1.00	1.00	1.00
Blood meal	5.00	5.00	5.00	5.00
Total	100	100	100	100

Table 2. Proximate composition of the experimental diet

Parameters	T1	T2	T3	T4
Dry matter	90.10	90.68	91.58	91.20
Moisture	10.90	9.32	8.42	8.80
Crude protein	15.94	15.33	15.98	15.97
Crude fibre	6.00	8.40	10.10	12.00
Ash	6.89	6.87	6.98	6.88
Ether extract	5.32	5.20	5.51	5.50
Nitrogen free extract	55.95	54.88	53.01	50.85

Parameters Measure

Growth Performance

The rabbits were weighed before the experiment began to determine their starting body weight. The average live weights of all the rabbits in each replicate were then calculated on a weekly basis. The average daily body weight gain per rabbit in each replicate was calculated using the live weight gain. From the first day of the trial until the last day, feed intake was recorded. Prior to giving the diet to the rabbits, the feed was weighed to see how much was consumed. Then, to calculate the daily feed intake of rabbits in each replicate, the difference between the feed that was delivered the day before and the leftover feed in the feeding trough the following morning was divided by the number of rabbits in each replicate. Conversion of dry matter in feed was calculated by dividing the feed intake of rabbits with body weight gain of rabbits.

Percentage Nutrient Digestibility

Two rabbits with a similar body weight was chosen from each replicate of each treatment during the last week of the feeding trial The rabbits were taken to a clean, disinfected metabolic cage. Before the four days of data collection, a three-day adaptation time was permitted. To prepare the collected droppings for proximate examination, they were air-dried at room temperature Following the proximate analysis of the faecal samples using (AOAC, 2012), the following formula was used to determine the apparent nutrient digestibility of crude protein, crude fat, crude fiber, and dried matter:

Nutrient digestibility = (nutrient in feed-nutrient in faeces/nutrient in feed) × 100.

Carcass and Organ Evaluation

In accordance with the guidelines established by the University of Nigeria's Ethical Committee on the use of animals for biomedical research, three rabbits were randomly chosen from each replicate at the conclusion of the feeding trial for the measurement of organ weights and sizes. After the rabbits were killed, they were carefully dissected to ascertain the weights and lengths of their visceral organs (liver, heart, kidney, spleen, and intestinal weights).

Statistical Analysis

Data produced were subjected to analysis of variance (ANOVA) in CRD using the statistical package (SPSS 2003) Windows version 8.0. Mean differences were separated using Duncan's New Multiple Range Test (Duncan, 1955) as outlined by Obi (2002). In the present study, the significance was held at 5% for the entire analysis. The statistical model used to test the effects of treatments on the various parameters determined was written below:

$Xij=\mu+t1+\sum ij$

Where, Xij = any observation or measurement taken

μ = population mean

t1 = treatment effect

∑ij =experimental error

i= number of treatments

j=number of replicates

RESULTS

Results of the growth performance of weaner rabbits fed sun dried rumen digester as an energy source are presented in Table 3 and Figure 1-3. Average daily weight gain and average daily feed intake values of rabbits on T4 significantly were the highest (P<0.05) among the treatments, followed by T3, T2, and T1 respectively. Values of feed conversion ratio of T3 and T4 were the same (p>0.05), but significantly lower than the values of 3.98 and 4.44 observed for the rabbits on T2 and T1 respectively.

Table 3. Results of the growth performance of weaner rabbits fed sun dried rumen digester as energy source

Parameters	T1	T2	T3	T4	SEM	P value
Initial body weight(g)	920.00	880.00	910.00	900.00	30.00	0.54
Average daily weight gain(g)	19.48d	22.22c	27.57b	30.34a	0.87	0.02
Average daily feed intake(g)	86.51d	88.91c	93.63b	100.00a	1.08	0.05
Feed conversion ratio	4.44a	3.98b	3.39c	3.29c	0.25	0.01

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

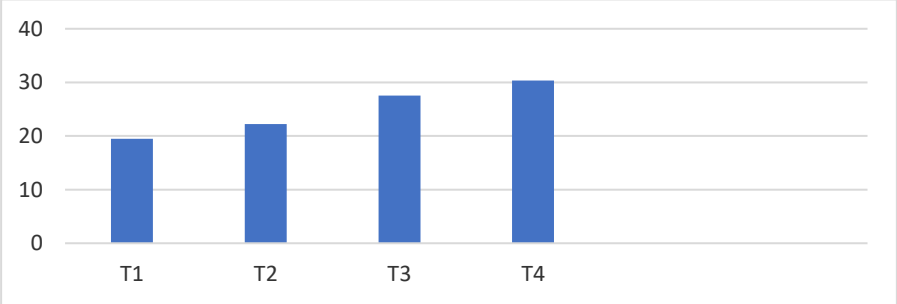

Figure 1. Average daily weight of weaner rabbits fed sun dried rumen digester as energy sour

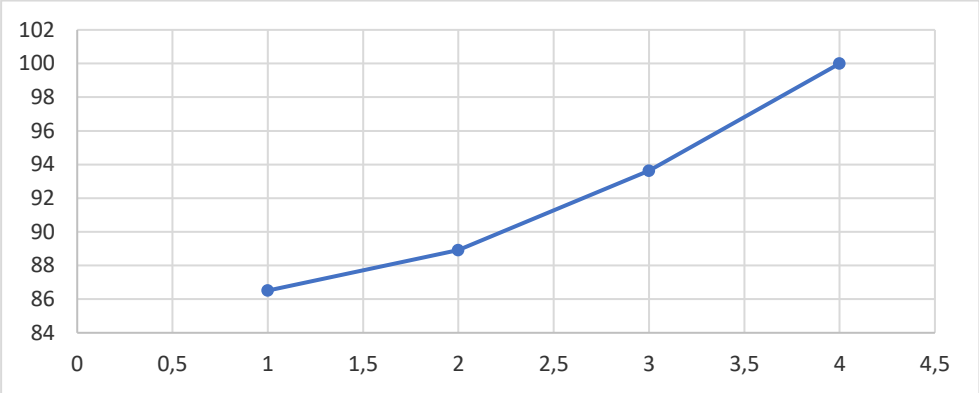

Figure 2. Average daily feed intake of weaner rabbits fed sun dried rumen digester as energy source

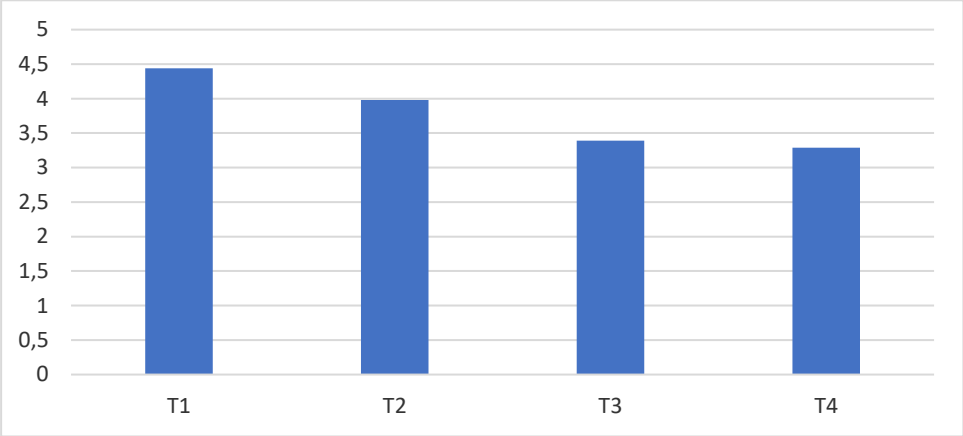

Figure 3. Feed conversion ratio of weaner rabbits fed sun dried rumen digester as energy source

Results of the apparent nutrient digestibility (%) of weaner rabbits fed sun dried rumen digester as energy source are presented in Table 4 and Figure 4. Percentage crude protein digestibility of rabbits on T1 and T2 were the same (P>0.05), but significantly lower than the values of 72.63 and 85.23 observed for the rabbits on T3 and T4. Percentage digestibility of dry matter among the treatment groups followed the same trend as observed for crude protein digestibility. Percentage digestibility of crude fat of rabbits on T4 were the highest among the treatments, followed by T3, T2 and T1 respectively. The percentage digestibility of nitrogen free extract among the treatments followed the same trend as observed for crude fat percentage digestibility among the treatments . The percentage digestibility of crude fibre of rabbits on T2 and T3 were the same (P>0.05), but significantly higher than the value of 59.73 recorded in T1 and lower than also the value of 76.27 observed for the rabbits on T4.

Table 4. Results of the apparent nutrient digestibility (%) of weaner rabbits fed sun dried rumen digester as energy source

Parameters	T1	T2	T3	T4	SEM	P value
Crude Protein (%)	61.69c	64.56c	72.63b	85.23a	2.98	0.03
Crude fat (%)	62.15d	70.06c	79.64b	90.98a	3.60	0.05
Crude fibre (%)	59.73c	66.71b	68.76b	76.27a	2.60	0.02
Dry matter (%)	62.46c	66.76c	77.89b	88.64a	4.20	0.04
Nitrogen free extract (%)	69.06d	75.78c	80.73b	87.25a	2.00	0.01

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

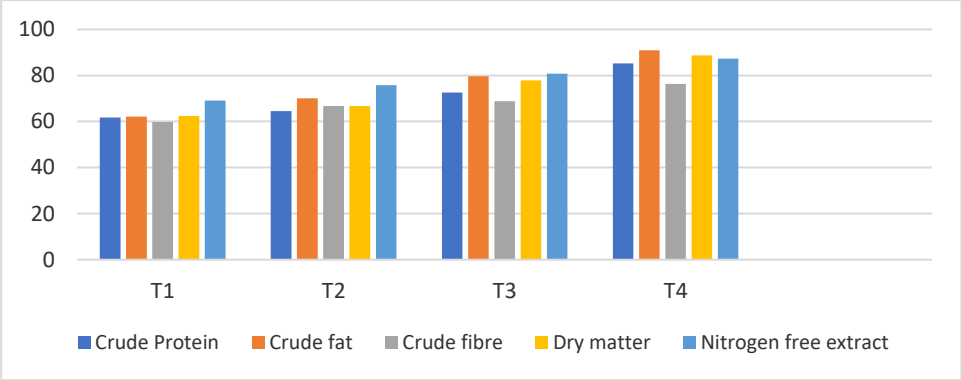

Figure 4. Results of the apparent nutrient digestibility (%) of weaner rabbits fed sun dried rumen digester as energy source

Results of the organ indices of weaner rabbits fed sun dried rumen contents as energy source are presented in Table 5. The values of liver weight of T4 and T3 were the same ($P>0.05$). but lower than the values of 41.25 and 43.65 observed for the rabbits on T2 and T1 respectively. Heart, and kidney weight values and large intestine length values of T4 and T3 were the same ($P>0.05$), but lower than the values recorded in T2 and T1 respectively. The spleen weight value of rabbits on T4 was the highest, followed by T3, T1, and T2 respectively. Small intestine lengths of T4 and T3 were the same ($p>0.05$), but higher than values of 11.00 and 9.50 recorded in T2 and T1.

Table 5. Results of the organ indices of weaner rabbits fed sun dried rumen digester as energy source

Parameters	T1	T2	T3	T4	SEM	P value
Liver (g)	41.25c	43.65b	55.10a	55.20a	0.74	0.03
Heart (g)	6.78b	6.60b	8.13a	8.23a	0.28	0.01
Kidney (g)	10.42b	10.72b	11.98a	12.58a	0.20	0.04
Spleen (g)	0.93ab	0.75b	0.94ab	1.08a	0.03	0.01
Small intestine (cm)	9.50c	11.0b	12.50a	12.50a	0.50	0.02
Large intestine (cm)	67.50b	63.00b	82.50a	87.50a	2.50	0.03

abc:Means on the same row with different superscript are significantly different ($p<0.05$).

DISCUSSION

Growth performance of rabbits on sun dried rumen digester based diets (T2, T3 and T4) were better when compared with those on T1 (control). This may be connected to the differences in the fiber contents among the treatment diets. Nevertheless, if the protein requirement of rabbit is well-balanced in the diet and there is substantial amount of fibre in the diet using feeding material such sun dried rumen digester that contains also some levels of crude protein 10.82% (Whyte and Wadak, 2002), rabbit will increase its voluntary feed consumption to gratify its energy requirements, and also there will be improvement in dry matter feed conversion. Comprehensive or fractional replacement of maize as energy source with sundried rumen content that contains some levels of protein and also rich in digestible fibres (18.52%) (Esonu et al., 2006) in the diet of rabbit functions in two dimensions: First, when energy sources like maize were replaced, the digestible fibers will be better utilized for growth as result of improvement in the digestive health of the rabbits. Secondly, its digestible fibers also have a dietary function in promoting the maturation of the caecal flora in young rabbits, which in turn improves gut health for better feed fermentation. Finally, this will lead to improved development and growth. Rabbit is typically a monogastric agricultural animal, that has been genetically adapted to consume high plant cell walls found in rumen digester. However, the primary ingredient in a balanced feed for rabbits is dietary fiber and it helps to lessen or eliminate digestive issues in growing rabbits and also helps to maintain gut health

Therefore, the improved performance with regards to increased linear daily weight gain, feed intake, and improved dry matter conversion when maize was replaced up to 30-100 % with dried rumen content in this present study could be attributed to the fibrous carbohydrates, vitamins, short chain fatty acids and influence of the readily digestible microbial protein of the rumen content (Okorie, 2005; Ekwuoma, 1992; Whyte and Wadak, 2002). The rumen content contains a lot of microbial cell walls and volatile fatty acids chains which might become available to the microbes involve in fermentation process in rabbits for their growth and proliferation and thus, increasing feed utilization for improved performance. The increased weight gains and feed conversion ratio recorded in the current study agree with the reports of white and Wadak (2002) who after a similar study reported that there were significant differences in weight and feed conversion ratio in favor of rabbits on rumen contents-based diet. Adequate fiber in the diet of rabbits supports performance by way of enhancing the health of intestines for better nutrient digestion, transport, and absorption of nutrients.

Lack of fiber in the diet may have contributed to the poor growth performance of rabbits on control diets with balanced protein supplies when compared to treatment groups with the same protein supply. According to Champe and Maurice (1983), for normal growth, rabbits need crude fiber levels over 9%. Additionally, lack in dietary

fiber in the diet of growing rabbits has been linked to slower growth rates in rabbits (Bamgbose et al., 2002).

The results of the apparent nutrient digestibility (%) of weaner rabbits fed sun dried rumen content as an energy source are present in Table 4. Apparent nutrient digestibility (%) results showed that the treatment groups had better nutrient digestibility than those on the control diet, respectively. Percentage nutrient digestibility increased as the level of dried rumen content increased in diet with the rabbits on T4 and T3 having the highest values in all the nutrient digestibility parameters measured. However, the quantity and quality of dietary fiber have an impact on the digestive health (mortality and morbidity) of the weaner rabbit. The digestive health of growing rabbits is expressly weakened by a diet lacking in fiber. However, when enough digestible fibers are added to the meal, digestive problems are also somewhat reduced. The fermentative activity in rabbits' stomachs is positively impacted by adequate fibre in their diet (Gidenne and Bellier, 2000). Higher percentage values of nutrient digestibility in favor of the treatment groups may also be connected to the 'their high dietary fiber content. This range can be ideal for effective nutrient usage.

Table 5 show the results of the organ indices of weaner rabbits fed sun dried rumen digester as energy source. However, the result of this present study disclosed that dietary treatments, significantly ($P<0.05$) enhanced the visceral organs of rabbits. Sun dried rumen content significantly ($P<0.05$) increased the relative weight of the spleen, heart, kidney, and liver and the length of the large intestine. The weight of an animal is positively correlated with the body organs. Normal increase in the size of digestive organs leads to improvement in rabbit's capacity to ingest and digest feed. This could be the reason why rabbits on dried rumen content diet made the highest organ weights. A well-developed heart will function to provide oxygen needed for digestion and other physiological activities in the body. Small intestine and large intestine's lengths of rabbit's on rumen content-based diet increased with increasing level of the dried rumen content. This is probably due to increased body weight gain and feed intake. The small intestine is where nutrients are absorbed, and the increased weight and length suggest higher nutritional absorption and utilization. The small intestine is the site for absorption and the improved weight and length indicates better absorption and utilization of nutrients. The observed decrease in relative length of the small and large intestine in the control group could probably be caused by a decrease in the thickness of the contents of the small intestine and a reduction in the crypt cell proliferation rate (Oyeagu et al., 2019a). According to some authors, the shorter length of the gut may be related to a decrease in the viscosity of the gut contents, a rise in the concentration of volatile fatty acids in the ceca, a faster digestion rate, and a larger dilution with water (Afsharmanesh et al., 2016; Oyeagu et al., 2019c).

CONCLUSION

It could be concluded from the results obtained in this study that replacement energy sources in weaner rabbits up to 100 percent using bovine rumen content improved nutrient digestibility, performance, and carcass characteristics in the reatment group compared to the control group. Therefore, rabbit farmers can use it to improve rabbit performance.

ACKNOWLEDGEMENT

The authors desire to acknowledge the Department of Animal Science, University of Nigeria Nsukka for providing the amenities for the successful analysis of the egg samples.

Conflict of interest: The authors declare no competing interest.

Funding: The authors state that no funds or other support was received during the preparation of this paper.

Authors Contribution

The authors contributed equally to the article.

REFERENCES

AOAC., 2012. Association of Official Analytical Chemists (AOAC). Official Methods of Analysis of AOAC International, 19th Edition. Association of Official Analytical Chemists International, Gaithersburg, Maryland, USA.

Aduku AO, Olukosi JO., 1990. Rabbit management in the tropics; Production, Processing, Utilization, Marketing, Economics, Practical Training, Research and Future Prospects. Living Book Series, GU Publication, Abuja FCT, 1990, 1-105.

Afsharmanesh M, Lotfi M, Mehdipour Z., 2016. Effects of wet feeding and early feed restriction on blood parameters and growth performance of broiler chickens. Anim Nutr., 2: 168- 172.

Bamgbose AM, Abimbola M, Olayemi WA, Osofowora AO, Oso AO, Ojo OT., 2002. Performance of Weaner rabbits fed supplemented Tridax procumbens diets: In: Proc. 7th Ann. Conf. Anim. Sc. Ass. Of Nig. (ASAN) Sept. 16-19, 2002, University of Agriculture, Abeokuta, Nigeria. Eds. A.O. Fanimo and J.A.Olanite. Pp. 69-70.

Biobaku WO., 2002. The potential of Irolanut tea in rabbit feeding: Proceeding of the 20th Annual National Conference of the Nigerian Society for Animal Production, F.U.T Minna, Niger State.

Cherfaoui YD., 2015. Evaluation of production performance of rationally reared rabbits in Algeria. Doctoral Thesis in biological sciences, option: Animal production. The Mouloud Mammeri University of Tizi Ouzou, Algeria. p. 113.Available at: http://www.secheresse.info/spip.php?article79406.

Crowell-Davis S., 2021. Rabbit Behavior. The veterinary clinics of North America. Exot. Anim. Pract., 24-53–62.

Cullere, M, Dalle Zotte A., 2018. Rabbit meat production and consumption: State of knowledge and future perspectives. Meat Sci., 143: 137–146.

Champe KA, Maurice DV., 1983. Research review on response of early weaned rabbits to source and level of dietary fibre. The J. Appl. Rabbit Res., 6(2): 64-67.

Dalle Zotte A., 2014. Rabbit farming for meat purposes. Animal Frontiers, 4(4): 62-67. doi: https://www.doi.org/10.2527/Af.2014-0035.

Dalle Zotte A, Szendrő Z., 2011. The role of rabbit meat as functional food. Meat Sci., 88: 319–331.

Duncan DB., 1955. New Multiple Range Test. Biometrics 11:1-42.

Elkholy K, El-Deen T, El-Latif A, Mekawy A., 2019. Effect of dietary addition of two selenium source on productive efficiency and selenium content in tissues in growing rabbits. Journal of Sustainable Agricultural Sciences, 45(1): 27–36. doi: 10.21608/jsas.2019.6784.1122.

Esonu BO, Ogbonna UD, Anyanuwn GA, Emenalom OO, Uchegbu MC, Etux EB and Udedibie ABI., 2006 Evaluation of performance, Organs characteristics and Economic Analysis of Broiler finisher fed Dried Rumen Digesta. Inter. J. Poult. Sci., 5(12): 1116 – 1118.

Ekwuoma I., 1992. The chemical composition of ruminal contents of cattle, sheep and goats. B.Sc. Project Report. Department of Animal Production, University of Agriculture, Abeokuta.

Gidennen T, Bellier R., 2000. Use of digestible fibre in replacement to available carbohydrates- Effect on digestion, rate of passage and caecal fermentation pattern during the growth of the rabbit. Livest. Prod. Sci., 63: 141-152.

Okonkwo WI, Akubuo CO., 2007. Trombe wall system for poultry brooding. Int. J. Poultry Sci., 6:125-130.

Menchetti L, Canali C, Castellini C, Boiti C, Brecchia G., 2018. The different effects of linseed and fish oil supplemented diets on insulin sensitivity of rabbit does during pregnancy. Res. Veter. Sci., 118: 126–133.

NRC., 1991. Micro livestock: little known small animal with a promising economic future. National research council, national academic press, Washington, D.C.

Oyeagu CE, Mlambo V, Muchenje V., 2019a. Effect of dietary Aspergillus xynalase on nutrient digestibility and utilization, growth performance and size of internal organs in broiler chickens offered maize-soybean meal based-diets. Pakistan J. Nutr., 18(9): 852-865.

Oyeagu CE, Ugwuanyi CL, Onwujiariri E, Osita CO , Akuru EA, Ani AO, Idamokoro EM and Falowo AB., 2019c. Blood bio-maker, growth traits, carcass characteristics and income over feed cost of broiler birds fed enzyme fortified dried brewer's grain. Pakistan J. Nutr., 18(9): 834-844.

Obi IU., 2002. Statistical methods of detecting differences between treatments means a research methodology issues in laboratory and field experiments. 2nd Ed. Express Pub. Ltd. Enug u. Pp1321.

Okorie KC., 2005. The effects of dried pulverized rumen content on the performance carcass and organ characteristics of finisher broiler. Anim. Prod. Res. Adv., 2: 96-100.

SPSS, 2003. Statistical Package for Social Sciences. Window Version 8.0

Whyte EP, Wadak I., 2002. Evaluation of rumen content on the growth performance of weaner rabbits. Proc. 7th Ann. Conf. Anim. Sci Ass. Of Nig. (ASAN). Sept. 16-19, 2002. University of Agric. Abeokuta, Nigeria, pp. 143 – 146.