

Nutrient digestibility, visceral organ changes and carcass yield of rabbits fed with diets containing graded levels of rumen filtrate-fermented rice offal

Kpehe*, A.T.¹, Tuleun, C.D.², and Kaankuka, F.G.²

¹Animal Husbandry Department, Akperan Orshi College of Agriculture, Yandev, PMB 181, Yandev-Gboko, Benue State, Nigeria.

²Department of Animal Nutrition, Federal University of Agriculture, Makurdi, PMB 2373, Makurdi, Benue State, Nigeria.

Abstract

A total of twenty-five crossbred rabbit bucks with a mean weight of 628.73g were utilized to investigate their nutrient digestibility, visceral organ changes, and carcass yield when fed with diets containing graded levels of rumen filtrate-fermented rice offal (FRO) for 10 weeks. Five rabbits were grouped into five treatments with each rabbit serving as a replicate in a completely randomized design experiment. The control group was fed with a diet containing no rumen filtrate fermented-rice offal meal while the other four groups were fed with diets in which the FRO replaced the maize at 5%, 10%, 15%, and 20%, respectively. The results of the analyzed nutrient composition and energy content of the experimental diets showed no trend across the treatments except for crude protein and metabolizable energy whose values appeared to increase across treatments as the levels of FRO increased from 0% to 20%. Dry Matter (DM), Crude Fiber (CF), Ether Extract (EE) and Nitrogen Free Extract (NFE) digestibility values were affected by the inclusion level of the fermented rice offal in the diets of the rabbits, except Crude Protein (CP). Crude fiber values appeared to increase across the treatments as the levels of FRO increased from 0% to 20%. Dressed weight showed significantly ($p<0.05$) higher values for rabbits fed with diets containing 20% FRO and prime cuts were significantly ($p<0.05$) influenced by treatments. The result of visceral organ and GIT weights showed treatment effect ($p<0.05$), except fasted live weights, spleen, and visceral fats. Of the visceral organ lengths, only the esophagus and stomach were similar ($p>0.05$) across treatment groups. It was therefore concluded that the digestibility of nutrients was not adversely affected; such that 20% inclusion of rumen filtrate-fermented rice offal showed no modification on visceral organ changes and a better carcass yield observed in rabbits on the diets. It was suggested that up to 20% rumen filtrate-fermented rice offal meal can be integrated into rabbit diets without impairing their digestibility, visceral organ characteristics, and carcass yield.

Keywords; Rice offal, Rumen liquor, Biodegradation, Digestibility, Rabbit meat yield.

***Corresponding Author's contact:** kpehealbert@yahoo.com; +2347069624060.

Introduction

In livestock production, feed constitutes a very important component and the high cost of feed or lack of these feed resources has often imposed a major constraint on the development of animal production in Nigeria (Dairo et al., 2005). In an intensive system of production in

developing countries like Nigeria, feeding accounts for up to 70% of the total production cost in non-ruminant animals (Oni et al., 2015). Feedstuff that supplies energy in the diet makes up to 60% of the finished feeds for these animals (Onifade and Tewe 1993), and

currently, maize is the major source of energy in livestock feeds (Ayoola and Akinbani 2011). The use of alternative energy resources in non-ruminant feeding has long been embraced by many researchers chiefly because of their availability all year round. This has reduced the over dependence on maize and has also reduced the cost of production significantly (Kpehe et al., 2020). To improve the nutritive value of these by-products animal scientists have used several processing techniques that proved to be comparable to maize. Rice offal which is a non-competitive feed material can be fermented with rumen liquor to make rumen filtrate fermented rice offal meal which may be capable of replacing maize, without adverse effect on the performance of rabbit (Kpehe et al., 2020).

Rice offal and bovine rumen content are abundant agro-processing by-products produced in Nigeria all year round. Inappropriate dumping of these waste materials poses environmental threats. This has provoked more investigation into the prospective application of rice offal and rumen content in livestock feeding (Kpehe et al., 2020). Rice offal contains; 5.09% crude protein, 30.39% crude fiber, 3.40% ether extract, 16.67% ash, 46.10% nitrogen free-extract and dry matter 94.42% (Maikano 2007). Some of the consequences of feeding non-ruminants rice offal without any form of treatment have been reported to include low nutrient utilization and poor growth performance.

Rabbits have been known to do well on high fibrous feeds because of their distinctive digestive system, yet there is restricted digestion (Belenguar et al., 2000). Adegbola et al (1985) reported that feeding rabbits with meals containing meagre concentrate supplies in the diets did not enhance optimum utilization

of the fibrous wastes hence the need to enhance nutrient quality and utilization. One of the procedures used in improving the nutrient properties of alternative feed materials is fermentation. Fermentation will reduce the fibre content while increasing the protein value of any material rich in non-digestible carbohydrates, thereby making it a useful livestock feed (Obboh et al., 2012).

This study was conducted to investigate the effects of inclusion of graded levels of rumen filtrate-fermented rice offal on the digestibility, visceral organ changes, and carcass yield of the rabbit.

Materials and Methods

Study area and experimental design

The experimental site, collection and preparation of study materials were carried out according to the procedures outlined by Kpehe, et al (2020) in their previous work where they soaked rice offal with rumen filtrate at 5L/10kg and allowed the mixture to ferment in air tight conditions for forty-eight (48hrs) hours. Table 1 shows the ingredients of test diets.

Twenty-five, mixed breed, grower rabbit bucks were obtained from very notable farms around Gboko metropolis. On arrival, the initial weights of the animals were taken, and vitamins were also administered. Five rabbits were carefully selected to reduce live weight disparities and randomly assigned to five dietary treatments with five replicates per treatment, after allowing the animals seven days to adjust to the environment. The animals were managed intensively and housed in hutches. Daily routine management was carried out which included cleaning, provision of water, and feeding twice daily. The experiment properly lasted for ten (10) weeks.

Table 1: Ingredients Composition of Test Diets

Ingredients (%)	Experimental Diets				
	T ₁	T ₂	T ₃	T ₄	T ₅
	Control	5%FRO	10%FRO	15%FRO	20%FRO
Maize	44.54	39.54	34.54	29.54	24.54
FFSB	13.55	13.55	13.55	13.55	13.55
BDG	22.27	22.27	22.27	22.27	22.27
FRO	-	5.00	10.00	15.00	20.00
Soybean Straw	14.55	14.55	14.55	14.55	14.55
Bone Ash	4.10	4.10	4.10	4.10	4.10
DL-Methionine	0.44	0.44	0.44	0.44	0.44

Table salt	0.25	0.25	0.25	0.25	0.25
Vit/Min Premix®	0.25	0.25	0.25	0.25	0.25
L-Lysine	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100

@Vitamin-mineral premix (BEAUTS CO. Inc. Man, U.S.A) to provide the following vitamins and minerals per kg of diet: Vitamin A 220,000; Vitamin D 66,000; Vitamin E 44,014; Vitamin K 88mg, Vitamin B120.76mg; Niacine1122mg; Calcium 27%; Phosphorus 10%; Iron 0.6%; Zinc 0.35%; Manganese 0.25%; Copper 0.06%; Iodine 0.002%; Cobalt 26ppm; Selenium 4ppm.

T1–T5= Treatments 1,2,3,4 and 5, FRO= Fermented Rice Offal, FSSB= Full Fat Soybean, BDG= Brewers Dried Grain.

Nutrient digestibility

At the end of the 10th week of the study, a digestibility trial was carried out. Three rabbits from each treatment with average live weights nearly measuring up to their treatment mean were chosen for this trial. During the following five days, 90% of their daily feed intake was offered to the rabbits and the corresponding feces voided were collected by placing plastic netting under the cages. The weights of the fresh feces collected for each rabbit was recorded, oven-dried to a constant weight. At the end of the trial, the fecal sample for each rabbit was pooled, milled and sampled for proximate analysis as outlined by A.O.A.C (2005). Determination of apparent nutrient digestibility was calculated using the formula below;

$$\text{Apparent digestibility} = \left[\frac{\text{Nutrient intake} - \text{Nutrient voided}}{\text{Nutrient intake}} \right] \times 100$$

Carcass and viscera organ evaluation

At the end of the feeding period, three rabbits with live weights most closely approximate their treatment means, were randomly selected from each treatment, starved overnight as recommended by Joseph et al (1994), and slaughtered. Starving animals for 12 hours before slaughter has proven to reduce bowel content hence reducing the risk of carcass contamination during dressing with little or no effect on the quality and yield of meat (Joseph et al., 1994). The rabbits were weighed to obtain their live weight and then stunned. Their jugular veins were severed with a sharp knife and allowed to bleed thoroughly under gravity. The dressed weight was a measure of the eviscerated and singed carcasses. The carcasses were reduced into the traditional cuts; neck, forelimbs, rack/ribs, back/loin, and hind limbs, and the weights of the various cuts were recorded. All weights were measured using an electronic weighing balance. The remaining part of the carcass (including skin, head, feet, and tail) after the hair and visceral

parts were taken out was referred to as the dressed carcass. These carcass cuts were expressed as a percentage of the dressed weight as given by the formula;

$$\% \text{Carcass cut} = \left[\frac{\text{Carcass part}}{\text{Dressed weight}} \right] \times 100$$

The visceral organs (the heart, lung, kidney, liver, intestines, stomach, esophagus, caecum, and the spleen) were each removed, trimmed free of fats and adhering connective tissues weighed, and expressed as a percentage of live weight;

$$\% \text{Organ Weight} = \left[\frac{\text{Organ weight}}{\text{Live weight}} \right] \times 100$$

The lengths of the GIT components (Esophagus, Stomach, Small intestine, Large intestine, and Caecum) were also measured using a meter rule. The organ lengths were expressed as a percentage of the total GIT length as given by the formula;

$$\% \text{GIT component} = \left[\frac{\text{GIT component}}{\text{Total GIT length}} \right] \times 100.$$

The fat around the kidney and viscera was carefully peeled off for each carcass and the warm fat was obtained and expressed as a percentage of the slaughter weight as outlined by Anugwa et al (1998).

Statistical Analysis

Collected data were subjected to one-way analysis of variance using the MINITAB 19th version and where significant differences were observed, treatment means were separated using fisher's least significant difference, of the same statistical software.

Result and Discussion

Proximate Composition of Experimental Diets

The results of analyzed nutrient composition and energy content of experimental diets showed no numerical trend across treatments except for crude protein and metabolizable energy whose values appeared to increase across treatment as the levels of FRO increased from 0% to 20%. This could be attributed to

the higher crude protein content of the rumen filtrate fermented rice offal meal. Table 2 shows

proximate composition of the experimental diets.

Table 2: Proximate composition of the experimental diets.

Nutrients (%)	Experimental Diets				
	T ₁	T ₂	T ₃	T ₄	T ₅
	Control	5% FRO	10% FRO	15% FRO	20% FRO
Dry Matter (DM)	93.16	93.16	93.99	93.52	93.96
Crude Protein (CP)	16.19	16.25	16.31	17.04	17.13
Crude Fibre (CF)	15.10	16.28	17.02	15.82	16.95
Ether Extract (EE)	5.12	4.52	5.64	5.03	4.72
Ash	12.17	12.86	13.53	11.07	11.72
*NFE	51.42	50.09	47.5	51.04	49.48
**ME (Kcal / kg)	2794.39	2872.71	2879.49	2905.05	2973.38

FRO = Fermented Rice Offal

*NFE = Nitrogen Free Extract [$*NFE = 100 - (CP + CF + EE + Ash)$] (Aduku, 1993).*

*ME = Metabolizable Energy [$**ME (Kcal/kg) = (37 \times \%CP + 81 \times \%EE + 35.5 \times \%NFE + 35.5 \times (0.22) \times \%CF)$] (Pauzenga, 1985 as modified by Carew, 2016).*

This result revealed crude protein values which were slightly higher than 15% and 16% recommended by Lebas (1980) and NRC (1977) respectively as the minimum for meeting the growth requirements for growing rabbits. The CP in this study was similar to the 16-17% recommended by Halls (2010) but lower than the level of 18% recommended for growing rabbits in a tropical environment (Aduku, 1993). The crude fiber (CF) values were similar to those reported by Aduku (1993) and Provet (2015) as being adequate for the normal digestive physiology in grower rabbits. The Ether Extract (EE) observed in this study was slightly higher than the recommendations of 2% by NRC (1977), 3% by Lebas (1980), and within the ranges of 2-5% as recommended by Halls (2010) and Provet (2015) desirable to provide the essential fatty acids for good performance and maintain glossy sleek hair. Dairo et al (2005) reported a typical rabbit diet to contain energy between 2400-2800Kcal/kg to meet the energy needs of grower rabbits. The results of this study revealed energy values that agreed with these values, thus meeting the recommended energy needs of the rabbits.

The nutrient compositions of the experimental diets in this study were also within the acceptable range for growing rabbits as reported by (Onifade and Tewe1993; Okpanachi 2008; Oni et al., 2015).

Nutrient Digestibility

The result of the apparent digestibility of dry matter and nutrients is presented in Table 3. Digestibility values for all parameters were significantly ($p < 0.05$) affected by the inclusion levels of fermented rice offal in the diets of rabbits, except for similar crude protein ($p > 0.05$) across all treatments. Rabbits on T₅ recorded the highest digestibility for DM, CP, CF, and NFE while rabbits on T₂, T₃ and T₅ recorded the highest digestibility for ether extract significantly. Crude fiber values appeared to increase across treatment as the levels of FRO increased from 0% to 20% while protein values remained similar across all treatments. The high digestibility of crude protein despite the high crude fiber values could be as a result of an increased protein digestion of FRO when incorporated into other feed materials.

Table 3: Nutrient digestibility by rabbits fed diets containing graded levels of fermented rice offal

Nutrients (%)	Experimental Diets					SEM	P-Value
	T ₁	T ₂	T ₃	T ₄	T ₅		
	Control	5%FRO	10%FRO	15%FRO	20%FRO		
Dry Matter (DM)	72.16 ^{ab}	71.62 ^b	71.88 ^b	72.24 ^{ab}	73.13 ^a	0.17	0.02
Crude Protein (CP)	80.41	80.62	80.02	79.78	81.64	0.26	0.17
Crude Fibre (CF)	68.76 ^b	68.68 ^b	69.41 ^{ab}	69.88 ^{ab}	72.37 ^a	0.41	0.00
Ether Extract (EE)	90.80 ^b	96.46 ^a	96.21 ^a	94.92 ^{ab}	96.21 ^a	0.60	0.00
*NFE	69.26 ^{ab}	68.22 ^b	68.86 ^b	69.69 ^{ab}	70.56 ^a	0.27	0.04

FRO = Fermented Rice Offal, SEM = Standard Error of Mean

*NFE = Nitrogen Free Extract [$*NFE = 100 - (CP + CF + EE + Ash)$] (Aduku, 1993).*

a b = Means on the same row with different superscripts are significantly ($p < 0.05$) different

Similar digestibility values for CP across treatments indicated that FRO provided adequate protein in the diet devoid of higher levels of insoluble fiber and anti-nutritional factors that limits protein digestibility in rabbit digestion. The CP values listed in this trial fell within the range of 70.56-81.31% and 72.25-82.88% reported by Anugwa et al (1998) and Onifade and Tewe (1993) respectively. High values indicate efficient utilization of protein for tissue accretion (Adegbola et al., 1985; Anugwa et al., 1998). The digestibility values for dry matter observed in this trial were somewhat lower than 74.14-83.35% reported by Onifade and Tewe (1993) but higher than 36.66-66.02% reported by (Adegbola et al., 1985). Rumen filtrate fermented rice offal improved palatability of the diets as it was observed that Ether extract values were similar for T₂, T₃ and T₅. These values were higher than 80.00-81.90% reported by Onifade and Tewe (1993) and 71.12-78.43% (Anugwa et al, 1998). The high digestibility value for ether extract in this study attests to the rabbit's good ability to utilize dietary fat (Anugwa et al., 1998; Adegbola et al., 1985). While rabbits on T₁ and T₂ showed the least digestibility values for crude fiber, rabbits on T₅ showed the highest values. This could be attributed to the presence of cellulolytic organisms in the caecum that acted on the fiber material effectively. Crude fiber digestibility reported in this study was higher than 33.08-55.69% reported by Onifade

and Tewe (1993) but slightly lower than 71.00-82.29% reported by Adegbola et al (1985). The better utilization of nitrogen-free extracts observed in rabbits across all treatment diets indicates that the readily available carbohydrates were well utilized by the rabbits across the treatments. The highest digestibility values for NFE were observed for rabbits on T₅ while rabbits on T₂ and T₃ had the least values. This could be an indication that fermented rice offal provided the readily available carbohydrates. This corroborates the findings of Onifade and Tewe (1993) who opined that for rabbits to gratify their energy needs, a reasonable amount of energy is pulled from their fibrous feeds.

Carcass Characteristics

The result of carcass analysis is presented in Table 4. Dressing percentage and fasted live weights showed no significant ($p > 0.05$) effect. Dressed weight showed significantly ($p < 0.05$) higher values for rabbits fed diets containing 20% FRO. However, dressing percentage showed higher values at T₅ and the least values at T₃ while fasted live weights showed an upward trend from T₁ to T₅. These variations across treatments could be as a result of the acceptability of the test diets by rabbits on the treatments. Proportions of the prime cuts (Neck, Rack/Ribs, Loin/Back, Forelimbs, and Hind limbs) were significantly ($p < 0.05$) influenced by treatments.

Table 4: Carcass characteristics of rabbits fed diets containing graded levels of fermented rice offal

Parameters (%DW)	Experimental Diets					SEM	P-value
	T ₁	T ₂	T ₃	T ₄	T ₅		
	Control	5%FRO	10%FRO	15%FRO	20%FRO		
Fasted live weight (g)	1659.67	1663.67	1794.00	1831.33	1975.00	49.86	0.24
Dressed weight (g)	1266.79 ^c	1332.75 ^b	1362.29 ^b	1393.73 ^b	1582.49 ^a	29.23	0.00
Dressing percentage (%)	76.33	80.11	75.94	76.11	80.13	4.78	0.77
Head	12.92 ^a	12.03 ^b	11.05 ^c	11.48 ^{bc}	11.49 ^{bc}	0.20	0.00
Neck	5.02 ^c	4.93 ^c	5.92 ^b	6.36 ^{ab}	6.72 ^a	0.20	0.00
Rack/Ribs	14.31 ^b	15.48 ^a	13.16 ^c	15.59 ^a	15.68 ^a	0.28	0.00
Loin/Back	18.97 ^{ab}	19.78 ^a	17.42 ^c	19.13 ^{ab}	18.23 ^b	0.26	0.01
Fore limbs	17.05 ^a	16.73 ^{ab}	15.48 ^c	16.22 ^b	17.05 ^a	0.18	0.03
Hind limbs	37.64 ^b	38.13 ^b	37.84 ^b	38.72 ^{ab}	39.56 ^a	0.24	0.04

FRO = Fermented Rice Offal, SEM = Standard Error of Mean

%DW = Percentage Dressed Weight; Carcass cuts expressed as a percentage of dressed weight.

a b c = Means on the same row with different superscripts are significantly ($p < 0.05$) different

In this study, the result of carcass yield showed that fasted live weight and dressing percentage were not significantly affected by the inclusion of fermented rice offal across the treatments. Overall, the values observed for dressed weights in this study were higher compared to other researchers in the tropics, likely because the experimental diets provided the nutrients well above the maintenance level that supported production (tissue synthesis).

Even so, the values were similar to 1305.00g-1425.00g reported by Anugwa et al (1998) but lower than 1595.83g-2290.00g reported by Biya et al (2008).

There were no significant effects on the dressing percentage which is an indication that feeding rabbits on diets containing upto 20% FRO had no harmful effect on their meat yield. The dressing percentage observed in this study is similar to the report of Oni et al (2015) in rabbits fed graded levels of dried citrus, and Shaahu et al (2008) when they fed rabbits with cassava leaf meal. However, they were higher than (53.70-63.27%) reported by Ayoola and Akinbani (2011) when they replaced maize with sun-dried yam peel meal in rabbit rations. These higher values might be attributed to better nutrient utilization by the rabbits due to the availability of balanced nutrients provided

by the inclusion of rumen filtrate-fermented rice meal in the test diets.

All proportions of the prime cuts in this study were significantly ($p < 0.05$) influenced by treatments. Meat yield for hind limbs significantly showed highest values for rabbits on T₅ while T₁ and T₅ showed the highest values for fore limbs. The rack and the back recorded the least values at T₃ while the head and the neck recorded best values at T₁ and T₅ respectively. The differences observed across treatments may be due to the differences in weights at the time of slaughter. The weights of the head, forelimbs, and hind limbs in this study were higher than (8.67-10.08%, 7.24-9.09%, and 12.14-14.26% respectively) reported by Oni et al (2015). The rack/rib weights were, however, comparable to the values reported by Anugwa et al (1998).

The age/weight at slaughter, sex, experimental diets, and feeding habits could be responsible for the variations observed between findings of this study and previous reports.

Visceral Organ Changes

The result of visceral organ weights and lengths is presented in Table 5. Organ weights (Lungs, Liver, Heart, Kidney, Esophagus, Stomach, Caecum, Small intestine, Large intestine) and

GIT weight showed treatment effect ($p < 0.05$), while fasted live weights, spleen and visceral fats showed no significant ($p > 0.05$) effects. Visceral lengths for the esophagus and stomach were similar ($p > 0.05$) across

treatment groups. While, significant ($p < 0.05$) effects were observed on the average GIT lengths, caecum, small intestine, and large intestine.

Table 5: Visceral organ weights and lengths of rabbits fed diets containing graded levels of fermented rice offal

Parameters (%)	Experimental Diets					SEM	P-value
	T ₁	T ₂	T ₃	T ₄	T ₅		
	Control	5%FRO	10%FR O	15%FR O	20%FR O		
Fasted live weight (g)	1659.67	1663.67	1794.00	1831.33	1975.00	49.86	0.24
Lungs	0.63 ^a	0.46 ^d	0.56 ^b	0.52 ^c	0.62 ^a	0.02	0.00
Liver	2.72 ^a	2.27 ^d	2.12 ^d	2.63 ^b	2.32 ^c	0.06	0.00
Heart	0.24 ^b	0.29 ^a	0.21 ^c	0.20 ^c	0.19 ^c	0.01	0.00
Spleen	0.04	0.05	0.04	0.04	0.05	0.00	0.09
Kidney	0.65 ^a	0.56 ^b	0.38 ^c	0.63 ^a	0.57 ^b	0.03	0.00
Esophagus	0.10 ^{ab}	0.11 ^a	0.09 ^b	0.09 ^b	0.08 ^c	0.00	0.04
Stomach	0.94 ^a	0.76 ^c	0.75 ^c	0.70 ^d	0.79 ^b	0.01	0.00
Caecum	1.05 ^a	0.76 ^d	0.76 ^d	0.88 ^b	0.86 ^c	0.03	0.00
Small Intestine	1.48 ^c	1.15 ^d	1.13 ^d	1.92 ^a	1.55 ^b	0.09	0.00
Large Intestine	1.16 ^b	0.90 ^e	1.23 ^a	0.94 ^d	1.08 ^c	0.01	0.00
GIT weight	4.94 ^a	4.73 ^b	4.88 ^a	4.68 ^c	4.83 ^{ab}	0.03	0.01
Visceral fat	2.60	3.26	2.47	3.20	3.12	0.60	0.09
Avg. GIT Length (cm)	469.00 ^b	437.88 ^d	431.00 ^e	486.67 ^a	452.67 ^c	5.45	0.00
Esophagus	2.38	2.67	2.40	2.29	2.40	0.07	0.50
Stomach	4.75	4.75	4.69	4.22	4.56	0.12	0.62
Caecum	8.64 ^d	8.77 ^c	9.19 ^b	8.82 ^c	9.57 ^a	0.09	0.00
Small Intestine	59.77 ^c	60.59 ^b	61.95 ^a	61.64 ^{ab}	58.15 ^d	0.39	0.00
Large Intestine	22.08 ^{ab}	21.57 ^b	20.19 ^c	21.47 ^b	22.88 ^a	0.30	0.04

FRO = Fermented Rice Offal, SEM = Standard Error of Mean

GIT = Gastro-intestinal tract; Visceral/Organ weights expressed as a percentage of fasted live weight; Visceral/Organ lengths expressed as a percentage of GIT length.

a b c d e = Means on the same row with different superscripts are significantly ($p < 0.05$) different

Previous reports have shown that weights of some internal organs of animals such as the kidney and the liver have been used as an index for toxicity and functionality. Aberrations noticed in the weights of the kidney and the liver in these animals were reported to come from feeds containing toxic elements when the organs struggled to convert these anti-nutrients into useful chemicals (Olabanji et al., 2007; and Igwebuike et al., 2003). Observations of organ weights/lengths and visceral changes of rabbits in this study showed that rumen filtrate fermented rice offal had no significant effect on the spleen and visceral fat weights, and esophageal and stomach lengths. All other visceral parameters measured were significantly affected by treatment but were all comparable to literature values of previous reports. Stomach, caecum and liver weights showed significantly higher values at T₁ while lung and GIT weights showed least values at T₄. The small and the large intestines recorded the highest weights at T₄ and T₃ and the least weights at T₁ and T₂ respectively. T₁ and T₄ recorded the highest values for kidney weights while T₂ recorded the highest values for heart and esophageal weight. The significant differences in the weights of these internal organs could be due to the variations in the physiological activities of the organs caused by the varied levels of inclusion of fermented rice offal in the diet across treatments.

The weights of the liver reported in this study were comparable with the values reported by Igwebuike et al (2003) in a study to investigate the effect of feeding graded levels of soaked *Acacia albida* pods on the performance and organ weight of growing rabbits but lower than the values of 2.91-3.36% reported by Olabanji et al (2007) when comparing the growth performance, organ characteristics and carcass quality of weaned rabbits fed different levels of wild sunflower leaf- blood meal mixture. Igwebuike et al (2003) reported lung weight to be in the range of 0.67-0.84% which was higher than the values reported in this study. Results of the weight of lungs showed similarities with the values (0.56-0.68%) reported by Okpanachi (2008). The weights of the heart were within 0.19-0.26% (Olabanji et al., 2007), but lower than the values (0.32-0.63%) reported by Igwebuike et al (2003). The weights of the spleen reported in this study were similar to the findings of Okpanachi (2008). Whereas, kidney values were lower than 0.65-0.70% (Olabanji et al., 2007). The stomach weights were within the values (0.73-1.09 and 0.96-1.04%) reported by Igwebuike et al (2003) and Olabanji et al (2007). Small intestine weights were similar to the range of

1.40-2.71% reported by Okpanachi (2008). The range of values obtained with the internal organ characteristics may suggest that none of the organs in the experimental rabbits were damaged by the effect of experimental diets or experimental procedures. The general body condition of farm animals can be determined with the aid of these organs.

The caecum lengths recorded highest values for rabbits on T₅ and least values for T₁ significantly. Lengths for small and large intestines showed significantly higher values for rabbits on T₃ and T₅ respectively. The fiber contents of the different diets might have exerted varied pressure on the GIT components that would have led to the obvious modifications thereby resulting in differences among treatments. The average length of the gastrointestinal tract (GIT) in this study was comparable with the report of Igwebuike et al (2003). Esophageal lengths were similar across treatment and also close to the findings by Olabanji et al (2007). The lengths of the small intestine were lower than the values (81.00-100.50%) obtained by Igwebuike et al (2003) but similar to the findings of Olabanji et al (2007). The large intestine lengths were however lower than 30.32-31.34% reported by Olabanji et al (2007) but similar to the values reported by Igwebuike et al (2003). Caecum lengths recorded in this study were unsubstantially lower compared to 9.79-12.17% (Igwebuike et al., 2003), but similar to 8.27-9.99% reported by Olabanji et al (2007). This finding agrees with the opinion that high amounts of fiber in the diet resulted in alterations and thus variations in the GIT components (Igwebuike et al., 2003; Olabanji et al., 2007).

The general health of farm animals can be ascertained by the condition of their organs, and this was shown in the overall good health of the experimental rabbits.

Conclusion and Recommendation

The digestibility of nutrients was not adversely affected; such that 20% inclusion of rumen filtrate-fermented rice offal showed no modification on organ/visceral characteristics and a better carcass yield observed in rabbits on the diets. It was suggested that up to 20% rumen filtrate-fermented rice offal meal can be integrated into rabbit diets without impairing their digestibility, visceral organ characteristics, and carcass yield.

References

A.O.A.C. (2005). Official Method of Analysis, 18th ed., Association of Official Analytical Chemists Washington DC.

- Adegbola, T.A., Tibi, E.U., Adogwa, D.C. (1985). Feed intake and digestibility in rabbits on all forage plus concentrate and all concentrate diet. *J. Anim. Prod. Res.* 5: Pp. 15-16.
- Aduku, A.O. (1993). Tropical Feedstuff-Analysis Table. Department of Animal Science, Faculty of Agriculture. ABU Zaria, Nigeria. Pp. 1-2.
- Anugwa, F.O.I., Adesua, M. And Ikuor, S.A. (1998). Effects of dietary crude fibre levels on performance, nutrient digestibility and carcass characteristics of weaning-growing rabbits. In; proc. of the silv. Anniv. Conf. of NASA/WSAP inaug. conf., Abeokuta, March, 21-26, Pp. 327-328.
- Ayoola, M.A. and Akinbani, A.S. (2011). Effects of replacing maize with sundried yam peel meal on growth performance, carcass characteristics and economic of production of meat type rabbit. *Res.* 3(4) Pp. 70-73.
- Belenguar A, Fondevila M, Balcells J, Torre C (2000). Effect of the source and level of cereal in diet on the rabbit caecal environment and microbial population. In: Proc. 7th World Rabb. Cong., vol. C, Pp. 95-100.
- Biya, A.J., Kannan, A., Murugan, M., and Anil, K.S. (2008). Effect of different feeding systems on the carcass characteristics of Newzealand white rabbit. Department of Livestock Production Management, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, Kerala. Pp. 104.
- Dairo, F.A.S., Aina, O.O. and Asafa, A.R. (2005) Performance evaluation of growing rabbits fed varying levels of rumen content and blood rumen content mixture. *Nig. J. Anim. Prod.* 32(1): Pp. 67-72.
- Halls, A.E. (2010). Nutritional requirements for rabbits. Shur-Gain, Nutreco Canada Inc. Pp. 10.
- Igwebuike, J.U, Anugwa, F.O.I., Ikuor, S.A. and Ehiobu, N.G. (2003). Effect of feeding graded levels of soaked *Acacia albida* pods on the performance and organ weight of growing rabbits. *The Indian J. of Ani Sci.* 73. Pp. 802-806.
- Joseph, K.J., B. Awosanya and A.A. Adebua. (1994). The effects of pre-slaughter withholding of feed and water from rabbits on their carcass yield and meat quality. *Nig. J. of Ani Prod.* 21: Pp. 164-169.
- Kpehe, A.T., Tuleun, C.D., Kaankuka, F.G and Tiough, S.M. (2020). Evaluation of Rice Offal Meal Improved by Rumen Filtrate Fermentation on the Performance and Economics of Producing Table Rabbits. *Asian J. of Adv. in Agric. Res.* 13(2): Pp. 9-19, 2020; Article no.AJAAR.56153 ISSN: 2456-8864. DOI: 10.9734/AJAAR/2020/v13i230099.
- Lebas, F. (1980). Nutrient requirements of Rabbits. *The J. of Appl. Rab. Res.*, Vol.3. No. 2. Pp. 15.
- Maikano, A. (2007). Utilization of rice offal in practical ration of broilers. *The Zoologist*, 5; Pp. 1-7.
- Minitab 19 Statistical Software. [Computer software]. State College, PA: Minitab, Inc. 2011.
- N.R.C. (1977). Nutrient Requirement of Domestic Animal, Nutrient Requirement of Rabbits. Second Edition. National Academy of Science Washington D.C.
- Oboh G, Ademosun AO, Lajide L (2012). Improvement of the nutritive value and antioxidant properties of citrus peels through (*Saccharomyces cerevisiae*) solid substrate fermentation for utilization in livestock feed. *LRRD.* Vol. 2. Pp. 24.
- Okpanachi, U. (2008). Growth and haematological response of growing rabbits to diets containing graded levels of sun dried bovine rumen content. A project report submitted to the department of animal science, university of Nigeria, Nsukka in partial fulfilment of the requirement for the award of M.sc in Nutrition and Biochemistry. September, 2008. Pp. 62.
- Olabanji, R.O., Farinu, G.O., Akinlade, J.A. and Ojebiyi, O.O. (2007), "Growth Performance, Organ Characteristics and Carcass Quality of Weaner Rabbits Fed Different Levels of Wild Sunflower Leaf- Blood Meal Mixture", *Inter. J. of Agric. Res.*, Vol. 2, Pp. 1014-1021.
- Oni, O.O., Idowu, O.M.O., Olanite, J.A. And Bamgbose, A.M. (2015). Nutrient intake, Growth performance and Carcass yield of weaner Rabbits fed graded levels of dried citrus (*Citrus Sinensis*) pulp. *J. of Agric. Sci. & Envi.* 2015, 15 (1): Pp. 60-68.

Onifade, A.A and Tewe, O.O. (1993). Alternative tropical energy feed resources in rabbit diets: growth performance, diet's digestibility and blood composition. *World Rabb. Sci.* 1 (1): Pp. 17-24.

Pauzenga, U. (1985). Feeding parent stock. *Zoot. Inter.*, December, 1985. Pp. 22-24.

Provet Health Care (2015). Rabbit feeding. [www.provet.co.uk/./rabbitfeeding.Htm](http://www.provet.co.uk/./rabbitfeeding.htm)-provet.

Shaahu, D.T., Carew, S.N and Ayoade, J.A. (2008). Growth performance, meat yield and organ weight of rabbits fed cassava leaf meal. *Proced. of the 13th Conf. of ASAN*, Bawa, G.S., Akpa, G.N., Jokthan, G E., Kabir, M., and Abdu, S.B. (eds.) ABU, Zaria 15–19th September, 2008; Pp. 449-451.