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Evaluation of Rice Offal Meal Improved by Rumen Filtrate Fermentation on the Performance and Economics of Producing Table Rabbits

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

In an effort to expand the knowledge base on the use of non conventional feedstuff in rabbit nutrition, the nutritional potential and the cost effectiveness of using rice offal fermented with rumen filtrate for 48 hours was investigated using twenty five (25) growing crossbred rabbit bucks weighed between 625.34 g-631.21 g for 10 weeks. The rabbits were divided into five (5) treatment groups of five (5) rabbits each with each rabbit serving as a replicate in a completely randomized design experiment. The control group was fed with a diet containing maize as the main energy source while the remaining four groups were fed with diets in which the maize was replaced with 5%, 10%, 15% and 20% Rumen filtrate fermented-rice offal meals respectively. Final weight was similar (P>0.05) in rabbits fed maize-based control diet and those fed diet containing 5% to 20% Rumen Filtrate Fermented Rice Offal Meals (FRO). The experimental diets had significant (P<0.05) effect on the daily feed intake, and daily body weight gain with rabbits on 20% having superior weights of 93.88 g and 20.54 g respectively, and a better feed conversion ratio of 4.57 g. The cost of feed per kg of weight gain was lowered progressively from N446/kg for the control diet to

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N307/kg for the 20% FRO diet, where the lowest feed cost was observed, with a concomitant improvement in overall production profitability. It was concluded that fermenting rice offal with rumen filtrate had high potential as a possible replacement for maize in rabbit diet at inclusion levels of up to 20%. The use of this agricultural by-product can reduce the cost of rabbit production, increase the availability of cheaper animal protein for the populace, generate higher profit margins for the livestock farmer and reduce environmental pollution. It was therefore recommended that feed manufacturers and rabbit farmers can incorporate up to 20% of bovine rumen filtrate-fermented rice offal meal in the diets of rabbits without compromising performance.

Keywords: Fermentation; rabbits; rice offal; rumen filtrate; performance and economics of production.

1. INTRODUCTION

Inadequate animal protein in the diet of people in developing countries like Nigeria has called for the integration of some non-conventional meat sources into the farming system as source of animal protein. Productivity of these livestock species will depend to a large extent on their ability to utilize feeds that are not consumed or competed for by humans [1].

Rabbit, as a micro-livestock, is an economic animal that could bridge the wide gap in dietary protein in Nigeria. This is because rabbit is socially acceptable on the combined basis of space requirement and absence of religious taboo as well as peculiar digestive physiology which permits the use of forages and agro-industrial by-products thus making it a less competitive species with man for cereal and legume grain [1]. In addition, rabbits are efficient converters of feed to meat and can utilize up to 30% fibre as against 10% fibre by most poultry species [2]. Although rabbits can survive on all forage diets only, optimum performance can only be achieved if they are fed rations containing forage and concentrates [3].

There is the need therefore to search for by-products and crop wastes with a view to improving their nutrient contents which can maintain physiological balance and enhance livestock productivity. Studies in the utilization of agro industrial by-products and plant materials in animal feed have increased in the past two decades [4]. Many animal nutritionists have utilized some non-conventional feed sources as alternative to maize and other conventional feed ingredients such as unpeeled cassava root meal [4], sun-dried yam peel meal [5], sun-dried bovine rumen content [6], rumen filtrate-fermented cassava meal [7], rice offal meal [8] and rice bran and wheat offal meals [9].

Nigeria has the potential to produce about 200,000 metric tonnes of rice offal from the 500,000 metric tonnes of rice produced annually [10]. The offal, therefore, makes up about 40% of the parboiled rice and contains husk, bran polishing and small quantities of broken grains. In spite of its abundance, it has been neglected as animal feeds because it contains high level of fibre and low protein and energy [11]. This high fibre concentration results in poor nutrient utilization and consequent poor growth performance due to the presence of non-starch-polysaccharides (NSP) and phytate when fed to animals without any form of treatment [11]. The use of rice offal to replace cereal grains in poultry diets have been studied and has been successfully fed to broiler chickens at lower levels of inclusion in order to reduce feed costs and increase the profit margin [8]. However, higher levels of inclusion may therefore necessitate the development of strategies to increase the value of this by-product in order to reduce its fibre content and increase its protein content [8,11].

Challenges encountered in utilization of most unconventional feedstuffs include but not limited to high crude fibre [12] and low protein content [13] which are able to impair nutrient utilization particularly by monogastric animals. A number of processing techniques such as toasting mucuna seeds [14], soaking in water and cooking of velvet beans [15], soaking of velvet beans in potassium bicarbonate [16] and the use of fermentation [17] have been reported to improve the nutritive value of most identified alternative non-conventional feed resources.

Fermentation technology has been used for many years in the modification of biological materials into useful products, and as a method of reducing anti-nutrient and fibre contents in feed [18]. Fermentation is an alternative method to enhance the nutrient content of feeds through the biosynthesis of vitamins, essential amino acid**s** and proteins, by improving protein quality and fiber digestibility [19]. Many kinds of fermentation methods are used for nutrient enrichment, such as a mixed culture of *Saccharomyces cerevisae* and *Lactobacillus Spp* solid media fermentation technique [19], fermentation with rumen fluid [20]. Also the use of enzymes to improve the digestibility of low quality feedstuffs which are often characterized by high fiber content have long been recognized [21]. However, fermentation with rumen fluid is considered because of the advantage of rumen microbes. There are many kinds of microbes in rumen fluid such as fungi, bacteria and protozoa. Mixed microbes can be utilized by low quality substrates and non protein nitrogen for synthesized microbial protein by improving protein quality [17]. Urea treatment has been reported to improve the nutritional qualities of rice offal, but little or nothing has been done on the possibility of using rumen filtrate fermentation to improve the nutrient value of rice offal in rabbit diet [22,23].

Large quantity of rice offal is produced annually and left to cause environmental pollution [22]. This calls for more research on its potential usefulness in livestock feeding. In addition, rumen content is an abundant abattoir waste in most abattoirs in Nigeria and improper disposal of these materials constitute environmental hazard. Utilization of the rumen content and rice offal will not only serve to increase feed resource base but will also reduce disposal and environmental pollution challenges in the country.

This research work therefore was aimed at evaluating the nutritive value of rice offal treated with rumen filtrate in rabbit feeding.

2. MATERIALS AND METHODS

The study was conducted at the Rabbit Unit of the Department of Animal Husbandry, School of Animal Technology, Akperan Orshi College of Agriculture, Yandev, Benue State between November 2018 and February 2019.Yandev lies on latitude 7^{o}23’ North and longitude 9^{o}10’ East and within the Southern Guinea savannah Agro ecological zone of Nigeria in West Africa. The area is characterized by about 6-7 months of rainfall, with an average precipitation range of 1350mm-1400mm. The ambient temperature is highest around March and ranges from 34°c-36°c. The lowest mean monthly range of 26°c - 28°c occurs around January. The relative humidity is highest (69%) between August and September, and lowest (39%) in January and February [24].

2.1 Test Ingredient, Collection, Processing and Experimental Diets

The rice offal used for this trial was obtained from the major rice mill plant in Gboko. Two popular rice varieties cultivated in the region are African Rice (*Oryza glaberrima*) and Asian rice (*Oryza sativa*). The rice offal plant was carefully bagged and stored prior to commencement of the research. Freshly disemboweled rumen contents of cattle carcasses were collected from local commercial abattoir along Gboko - Aliade road in Gboko into clean plastic containers. Aliquots of the freshly obtained rumen content were manually squeezed to obtain the liquid, which was filtered through a cloth sieve into clean plastic containers. Then, the stored rice offal was soaked with the rumen filtrate at 5L/10 kg, and then mixed thoroughly. The mixture was put into a 20 L black polythene plastic bag and allowed to ferment for 48 hours in air tight condition as described [25]. The fermented mixture was then sun-dried to a moisture level of 10% and stored in bags to be used in formulating diets for grower rabbits throughout the study period. A sample of the fermented rice offal meal was subjected to proximate analysis accordingly [26]. Table 1 shows proximate compositions, energy and nutrients of rumen filtrate-fermented rice offal meal.

Other ingredients such as maize and Full Fat Soybeans (FFSB) were purchased from the open market within Gboko metropolis. Bone charcoal, brewers dried grain (BDG), common salt, DL-methionine, L-lysine, vitamin/mineral premix and drugs required for medications were purchased from veterinary and livestock feed shops within Gboko town.

Five experimental diets coded T_1, T_2, T_3, T_4, and T_5 were formulated such that diet T_1 had no fermented rice offal and served as the control. Diets T_2, T_3, T_4 and T_5 contained rumen filtrate-Fermented Rice Offal (FRO) at 5%, 10%, 15% and 20%, inclusions respectively. The experimental diets were pelletized to avoid waste. The ingredients and calculated nutrients composition of the diets is presented in Table 2.

2.2 Experimental Animals, Design and Management

A total of twenty five, mixed breed (California, New Zealand, American Chinchilla and Dutch), grower rabbit bucks aged between eight to ten weeks ranging in live weights between 625-631g were obtained from rabbit farms within Makurdi and used for the feeding trial which lasted for 70 days. The rabbits were housed in individual cages made of wood/wire netting measuring 60 cm x 60 cm x 90 cm x 90 cm raised 60 cm above the floor. The rabbits were allowed seven days to get acclimatized. Five rabbits were randomly allocated to each treatment, minimizing live weight differential. Each rabbit served as a replicate. The Completely Randomized Design (CRD) model was adopted. Standard rabbit husbandry practices comprising feeding standards, hygiene, medications and external / internal parasite control measures were strictly observed throughout the experimental period. Feed and water were provided *ad-libitum.* Result of analyzed nutrient compositions of the experimental diets is shown in Table 3.

2.3 Parameters Measured

2.3.1 Weight gain

The rabbits were weighed at the beginning of the trial and weekly thereafter. The weight at the beginning of the week was termed Initial Weight (IW), and that at the end of the week was called Present Weight (PW), while the weight at the end of the final week was termed Final Weight (FW). Total Weight Gain (TWG) was calculated by difference. (i.e., TWG=PW-IW). Average daily weight gain (ADWG) over the entire study period was calculated as: ADWG= [(FW-IW)/70], where 70 days was the duration of the study.

2.3.2 Feed intake

A known quantity of feed was set aside for each rabbit at the beginning of the week and the rabbit was offered feed from it during the week. The left over feed at the end of the week was weighed, and feed intake (FI) calculated by difference. Daily feed intake was computed by dividing feed intake by number of days (70 day).

2.3.3 Feed efficiency

The feed to gain ratio (FCR) was computed by dividing Feed Intake (FI) by the Weight Gain (WG) of the animals; as given in the formula, FCR = FI / WG.

Where FCR=Feed Conversion Ratio; FI=Feed Intake; WG=Weight Gain.

2.4 Economics of Production

The costs per kilogram of each experimental diet were calculated based on the prevailing prices of feed ingredients in Gboko. To calculate the cost per kilogram of feed, the price/kg of each ingredient were multiplied by the quantity in Kg of that ingredient in 1 kg of feeds and these values for all ingredients were summed. The cost of feeding each rabbit was calculated as the product of the cost of 1 kg of feed and amount of feed consumed by the rabbit. The cost of 1 kg of each diet was multiplied by feed conversion ratio (i.e. Cost/kg WG=Cost / kg feed x FI / WG) to get feed cost per kg weight gain. The total production cost (TPC) was estimated by using the equation [1]. Revenue obtained from the sales of the rabbits (1 kg of rabbit was sold at ₦1200). Profit from production was estimated as difference between revenue and total cost of production.

2.5 Statistical Analysis

The data collected was analyzed by one way Analysis of Variance (ANOVA) using MINITAB [29] and where significant differences occurred, treatment means were separated using Fisher's Least Significant Difference (FLSD), of the same statistical software.

Table 1. Proximate compositions and nutrients of test ingredient (fermented rice offal) on dry matter basis

Nutrients (%)	Fermented rice offal
Dry Matter (DM)	92.64
Crude Protein (CP)	8.97
Crude Fibre (CF)	36.08
Ether Extract (EE)	5.27
Ash	16.15
Calcium	0.08
Phosphorous	0.65
*NFE	33.53
**ME, (Kcal / kg)	2230.86

*NFE = Nitrogen Free Extract [*NFE = 100 – (CP + CF + EE + Ash)] [27]*
*ME = Metabolizable Energy [**ME (Kcal/kg) = (37 × %CP + 81 × %EE + 35.5 × %NFE + 35.5 × (0.22) × %CF)] [28] as modified by Carew, 2016*

Table 2. Ingredients and calculated nutrients composition of test diets

	Experimental diets				
Ingredients	**T1**	**T2**	**T3**	**T4**	**T5**
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
	Calculated nutrients analysis				
CP (%)	15.99	15.99	15.99	15.98	15.98
ME(Kcal/kg)	3155.64	3089.51	3005.07	2938.49	2868.79
CF (%)	10.89	12.56	14.23	15.89	17.57
EE (%)	6.07	6.14	6.19	6.26	6.32
Calcium (%)	1.35	1.38	1.34	1.36	1.37
Phosphorus (%)	0.94	0.92	0.91	0.93	0.91
Lysine (%)	0.95	0.93	0.97	0.94	0.92
Methionine (%)	0.82	0.81	0.84	0.87	0.85
Cost of Feed (₦/kg)	86.61	81.76	76.91	72.06	67.21

®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 88 mg, Vitamin B12 0.76 mg; Niacine 1122 mg; 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

ME (kcal/kg) = Energy [ME (Kcal/kg) = (37 × %CP + 81 × %EE + 35.5 × %NFE + 35.5 × (0.22) × %CF)] [28] as modified by Carew, 2016

Table 3. Analyzed nutrient composition and energy content of experimental diets

Nutrients (%)	**Experimental diets**				
	T1	**T2**	**T3**	**T4**	**T5**
	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	2973.38	2905.05

FRO = Fermented Rice Offal

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

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

3. RESULTS AND DISCUSSION

3.1 Growth Performance

The performance is presented in Table 4. Final live weights increased significantly (P<0.05) as the level of FRO increased. Daily weight gain, daily feed intake and feed conversion efficiency were all significantly affected (P<0.05) by treatment levels. Daily weight gain, daily feed intake and feed conversion efficiency were better with increase in inclusion levels of dietary FRO.

Growth performance indices in this study revealed significant effect of treatment on daily feed intake, daily weight gain and feed conversion ratio. These parameters improved with the increase of FRO levels in the experimental diets. Specifically, rabbits fed 20% FRO showed superiority among the final weight, daily feed intake, daily weight gain and a better feed conversion ratio. Increase in intake with increase in FRO inclusion levels was in agreement with previous report [30] who recorded higher intake with increasing levels of fermented cassava peel meal fed to rabbits. Fibre is known to be nutrient diluents [31] but the rabbits consumed enough feed to meet their needs for energy and other nutrients for growth and development. A 14-18% of dietary fibre does not only support growth but promotes normal digestive health of the animals [32]. The generally high total feed intake recorded in this study could be attributed to the pelletized diets. Higher feed intake, growth rate, dressing yield, nutrient digestibility and better feed conversion efficiency were recorded when the effect of pellet and mash diets were investigated on growth performance on growing rabbits [32].

Consistent increase in feed intake with increase in FRO across the diets implied acceptability of the FRO diets. This could be the result of the palatability of the 20% FRO meal. The average daily feed intake by rabbits in this study was comparatively lower than 104.88 g per rabbit per day for rabbit fed complete pellet diet [33], but higher than 59.87-65.29 g [34] and 35.12-47.36 g [35]. Palatability is one of the factors that could determine the extent to which an animal consumes a particular feed [32,36]. It has being reported that swine fed fermented cassava meal based diets had high feed intake due to improved palatability of the feed [18]. Therefore, it was likely that the high feed intake by the rabbits as more FRO was consumed in the diets might be due to better palatability of the feeds caused by high FRO levels in the diet which increased fibre levels of the experimental diets.

The final weight for this study was higher than the values earlier reported [35] who fed weaned rabbits with varying dietary levels of cassava root meal and also different from the values reported when growing rabbits were fed with cassava leaf meal [37]. No significant effects were observed among treatments on both the initial and final weights of the rabbits. Better weight gain of animals normally results from increased feed intake [35]. This situation was observed in the present study. Weight gain increased with increased feed intake; the average daily weight gain which was significantly higher for rabbits fed diet containing 20% FRO than those fed the control diet and lower inclusion levels of FRO.

In this study, daily weight gain varied between treatment groups and was higher than 7.84–12.56 g/day/rabbit as previously reported [35], 7.40-10.79 g [6], and 9.00-12.14 g [34]. However, the values were similar to the weight range of 17.65-18.80 g [38] and 19.96-23.26 g [39].

Feed conversion ratio of 2.87-3.54 earlier reported [38] was better than that reported in this study. However, the values for FCR reported in this study were comparable with previous reports [34,38], but better than those reported earlier [6]. The rabbits fed diet containing 20% FRO had better FCR. This was also manifested in the final weights. Disparities observed between results of the present study and those of previous researchers could be due to differences in experimental procedures adopted, dietary effect, size and age of the rabbits used and environmental (weather) conditions during the study period. The performance of rabbits fed diets containing rumen filtrate fermented rice offal may be due to adequate dietary crude fibre level. The increase in feed intake by the rabbits as fermented rice offal inclusion to the diet increased may be due to the high fibre content of the diet which tended to dilute other nutrients [31]. No mortality was recorded during the experimental period.

3.2 Economics of Production

Result of the economics of production is presented in Table 5. Cost of feed (₦/kg), Feed Cost per weight gain (₦/kg gain), feeding cost per rabbit (₦/Rabbit) and Total Production Cost in Nigerian Naira (₦) decreased marginally as inclusion of FRO increased from 0%-20% across treatment levels, while the revenue (₦/Rabbit) and profit (₦) increased across treatment as inclusion of FRO increased from 0%-20%.

The significantly lower cost of diets and cost/kg weight gain observed in this study can be ascribed to the low cost of obtaining rice offal and rumen content and subsequent process of acquiring the rumen filtrate-fermented rice offal. Agricultural by-products that are not directly consumed by man are more readily available and cheaper than the conventional feed ingredients [5]. The better feed conversion ratios observed for rabbits fed diets containing graded levels of fermented rice offal significantly lowered the cost per kg weight gain as observed in this study. The cost/kg of diet and cost/kg weight gain was

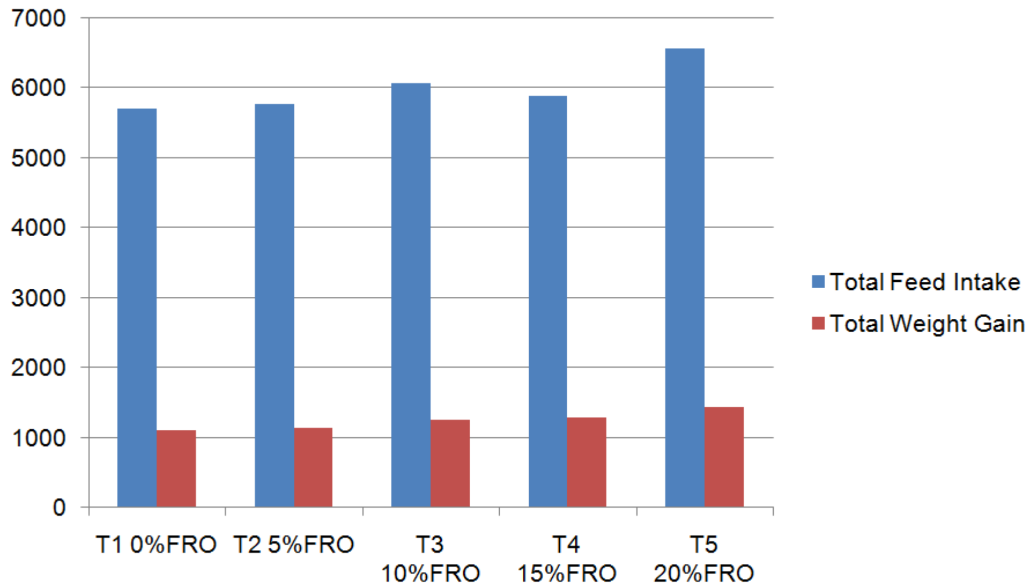

Fig. 1. Graph showing Total Feed intake and Total weight gain in grams (g)

Table 4. Growth performance of rabbits fed diets containing graded levels of fermented rice offal

Parameters (g)	Experimental diets						
	T_1 Control	T_2 5 FRO	T_3 10 FRO	T_4 15 FRO	T_5 20 FRO	SEM	P-value
Initial weight (g)	631.21	625.34	628.42	630.32	627.81	-	NA
Final weight (g)	1740.41^{c}	1759.54^{c}	1886.20^{b}	1913.32^{b}	2065.80^{a}	2.54	0.04
Daily feed intake (g)	81.63^{d}	82.59^{c}	86.73^{ab}	84.14^{b}	93.88^{a}	0.93	0.00
Daily weight gain (g)	15.85^{d}	16.20^{d}	17.98^{c}	18.33^{b}	20.54^{a}	0.41	0.00
Feed conversion ratio	5.15^{a}	5.10^{a}	4.82^{b}	4.59^{bc}	4.57^{c}	0.10	0.00
Motality	0	0	0	0	0	-	-

a b c d = Means on the same row with different superscripts are significantly (P<0.05) different, FRO = Fermented Rice Offal, SEM = Standard Error of Mean, NA=Not Analyzed

higher for the control diet and progressively reduced in the other of 5% to 20% FRO inclusion.

The findings of this study aligned with the previous results [40], who observed significant decrease in cost/kg diet, cost of feeding and cost/kg weight gain as rabbits were fed Lablab seed as major protein source in diet. The cost/kg of the diets, agreed with the previous findings [5] who observed that the cost per kilogram feed was reduced generally with increasing dietary yam peel meal. It was also observed that the total feed cost per kilogram was significantly lower than the control diet as the inclusion levels of dried pitto meal in rabbit diets increased [34]. This was attributed to the high quantity of maize that was contained in the control diet which made it relatively expensive compared to the dried pitto meal. Findings in the present were also corroborated [6,41].

The high cost of maize which constituted the major energy source in the production of the reference diet coupled with the low revenue from the sale of rabbits in the same group resulting from comparably lower final weights could be responsible for the lower profit recorded in rabbits on the control diet. Higher profits were made on rabbits fed diets containing graded levels of rumen filtrate fermented rice offal probably because of the low cost of this non conventional ingredient and the final weights observed with rabbits on these diets. This

Table 5. Economics of production of rabbits fed diets containing graded levels of fermented rice offal

Parameters	Experimental diets				
	T_1 Control	T_2 5 FRO	T_3 10 FRO	T_4 15 FRO	T_5 20 FRO
Average feed intake (kg)	5.71	5.78	6.07	5.89	6.57
Final weight (g)	1740.41	1759.54	1886.20	1913.32	2065.80
Feed Conversion Ratio	5.15	5.10	4.82	4.60	4.57
Cost of Feed (₦/kg)	86.61	81.76	76.91	72.06	67.21
Feed Cost (₦/kg gain)	446.04	416.98	370.71	331.48	307.15
Feeding Cost (₦/Rabbit)	494.54	472.57	466.84	424.43	441.57
*TPC (₦)	899.16	859.22	848.80	771.69	802.85
**Revenue (₦/Rabbit)	2088.49	2111.45	2263.44	2295.98	2478.96
Profit (₦)	1189.33	1252.23	1414.64	1524.29	1676.11

FRO = Fermented Rice Offal
**TPC = Total production cost, Estimated according to Aduku and Olukosi, 1990 that, feeding cost is approximately 55% of TPC **Revenue = 1 kg of Rabbit was sold at ₦1200*

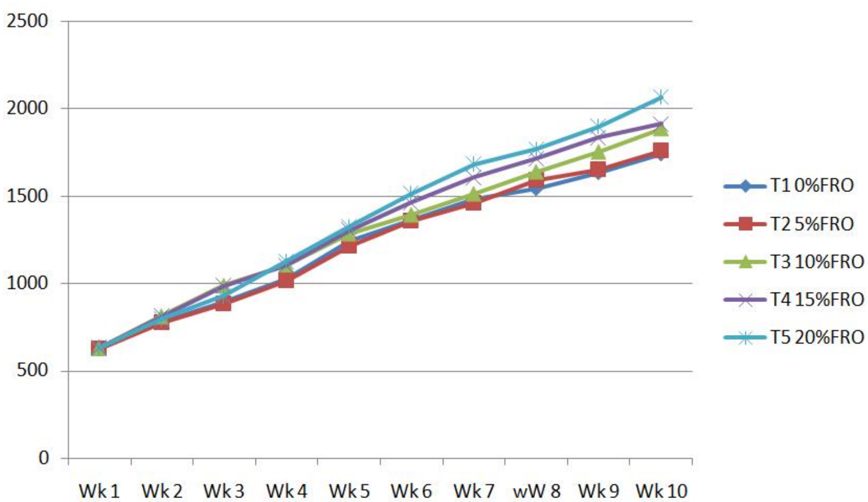

Fig. 2. Weekly performance of Rabbits fed experimental diets

therefore indicates that rabbits can be raised at cheaper cost with the safe incorporation of rumen filtrate fermented rice offal in their diets at up to 20% to replace maize.

4. CONCLUSION

It can be concluded as follows:

- It can be inferred that rumen filtrate-fermented rice offal is a valuable feedstuff in rabbit nutrition. Its combination with other feed materials will therefore provide a nutritionally adequate diet for the growing rabbit.
- Rabbits can be reared at cheaper cost, better return per kilogram weight gain, and higher profit margin with the inclusion of rumen filtrate-fermented rice offal at up to 20% levels in the diet.

Based on the results obtained from this study, it could be recommended that:

5. RECOMMENDATION

- Bovine rumen filtrate-fermented rice offal meal can be used as feedstuff in grower rabbit bucks.
- Feed manufacturers and rabbit farmers can incorporate up to 20% of bovine rumen filtrate-fermented rice offal meal in the diets of rabbits without compromising performance.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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