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Haematological Response, Serum Biochemical Parameters and Sensory Characteristics of Rabbits Fed Diets Containing Graded Levels of Rice Offal Treated with Rumen Filtrate

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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

A ten-week study was carried out to determine the effect of inclusion levels of dietary rumen filtrate-fermented rice offal on the haematology and sensory characteristics of rabbits. Twenty five (25) growing crossbred rabbit bucks weighed between 625.34 g-631.21 g 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. Values

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obtained for measured parameters in all treatment groups for haematological and serum biochemical indices were within the normal range for rabbits. However, the experimental diets had significant effect (P<0.05) on haemoglobin, white blood cell count, monocytes, eosinophiles and blood cholesterol. The diets showed no significant effect (P>0.05) on the sensory properties of rabbit meat. It was concluded that inclusion of rumen filtrate-fermented rice offal at 20% levels in the diets of growing rabbits maintained a good health and better meat quality as shown by results of haematological and organoleptic properties of the rabbits. 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 on the health of the rabbits and the quality of rabbit meat.

Keywords: Fermentation; haematology; meat quality; rabbits; rice offal; rumen filtrate.

1. INTRODUCTION

The ability of rabbits to thrive on diverse plant materials is quite useful especially now that studies on the utilization of non-conventional feeds are on the increase because of the necessity to cut feed cost and to conserve grains for human feeding in developing countries [1]. 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. 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 [2]. 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 [3]. Although rabbits can survive on all forage diets optimum performance can only be insured in a mixed feeding regime involving forage and formulated feed [4].

There is the need therefore to search for by-products and crop wastes with a view to improving their nutrient content which can maintain physiological balance and enhance livestock productivity without interfering with the health and quality of meat. Studies in the utilization of agro industrial by-products and plant materials in animal feed have increased in the past two decades. 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 [5], sun-dried yam peel meal [6], sun-dried bovine rumen content [7], rumen filtrate-fermented cassava meal [8], rice offal meal [9] and rice bran and wheat offal meals [10].

Nigeria has the potential to produce about 200,000 metric tonnes of rice offal from the 500,000 metric tonnes of rice produced annually [11]. 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 [12]. 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 [12]. 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 [9]. 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 [9,12].

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 [13]. Fermentation is an alternative method to enhance the nutrient content of feeds through the biosynthesis of vitamins, essential amino acids and proteins, by improving protein quality and fiber digestibility [14]. 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 [14], fermentation with rumen fluid [15]. 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 [16]. 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 [18,19] 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.

Large quantity of rice offal is produced annually and left to cause environmental pollution. 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 assessing the haematological response, serum biochemical parameters and sensory characteristics of rabbits fed diets containing graded levels of rumen filtrate-fermented rice offal.

2. MATERIALS AND METHODS

2.1 Study Location

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 January and April 2019. Yandev lies on latitude 7°23’ North and longitude 9°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 1350 mm-1400 mm. 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 [20].

2.2 Test Ingredient, Collection, Processing and Experimental Diets

The rice offal used for this trial was obtained from the major rice mill plant in Gboko. The rice offal 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 5 L/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 by Dairo et al. [21]. 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 according to A.O.A.C. [22]. Table 1 shows proximate compositions, energy and nutrients of rumen filtrate-fermented rice offal meal.

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)] [23]*

*ME = Metabolizable Energy [**ME (Kcal/kg) = (37 × %CP + 81 × %EE + 35.5 × %NFE + 35.5 × (0.22) × %CF)] [24] as modified by Carew, 2016*

Other ingredients; 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.

2.3 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 625-631 g 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 which 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.*

2.4 Blood Haematological and Serum Biochemical Parameters

From each treatment, three rabbits, with mean live weight closely approximating the treatment mean, were selected and blood samples were

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 26 ppm; Selenium 4 ppm.

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)] [24] as modified by Carew, 2016 collected at point of slaughter from each animal into two labeled test tubes, one of which had been treated with the anti-coagulant, ethylene diamine tetra acetic acid (EDTA). Blood in EDTA treated tubes were used to determine the packed cell volume (PCV), red blood cell (RBC) counts, white blood cell (WBC) counts, mean corpuscular volume (MCV), haemoglobin concentration (Hbc) and white blood cell differential (lymphocites, neutrophiles, eosinophiles, monocytes and basophiles). Blood collected in untreated tubes was used for the measurement of the various serum biochemical parameters (total protein, albumin, globulin, urea, glucose and cholesterol).

RBC, WBC and Hbc values were determined using the Wintrobe's micro haematocrit, improved Neubauer haemocytometer and cyanomethaemoglobin method respectively [25]. The mean corpuscular hemoglobin (MCH) was calculated according to Bush [26]. Blood samples collected without anticoagulant were subjected to serum procurement which was then used to determine the biochemical components. Serum glucose was determined by the colourimetric method described by Trinder [27], urea was estimated using modified Berthelot method as described by Henry [28] while total cholesterol was determined by colorimetric enzymatic method as outlined by Naito [29]. Similarly, serum total protein was determined by Biurate reactions [30]. Albumin was estimated by a method described by Özkan et al. [31] and globulin concentration was calculated by difference between total protein and serum albumin.

2.5 Sensory Analysis

The sensory analysis was conducted by ten trained and experienced assessors in the sensory evaluation laboratory of the college. The critical point of appraisal of meat quality occurs when the product is consumed, and it is this outcome that determines the decision to repurchase. The meat was therefore prepared in a way that simulates meat preparation by the consumer, were cut into 1 cm cubes and served to each assessor. Five sensory attributes, of taste, appearance, aroma, texture and overall acceptability were evaluated. The interpretation of attributes was discussed among assessors prior to the taste sessions. Each attribute was scored using five-point hedonic scale ranging from 1=disliked extremely to 5=liked extremely [32].

2.6 Statistical Analysis

The data collected was analyzed by one way Analysis of Variance (ANOVA) using MINITAB 18^{th} version and where significant differences occurred, treatment means were separated using Fisher's Least Significant Difference (FLSD), of the same statistical software.

3. RESULTS AND DISCUSSION

3.1 Haematological Constituents

Result of assay of hematological parameters is presented in Table 3. Values obtained for all measured parameters, in all treatments were within the normal range for rabbits. Pack Cell volume, Red Blood Cell count, Mean Corpuscular Volume, Mean Corpuscular Haemoglobin, Mean Corpuscular Haemoglobin Concentration, Neutrophils and Lymphocytes had similar ($P>0.05$) values across all treatment groups. However, rabbits fed on diets containing 5% and 20% FRO had significantly ($P<0.05$) higher values for White Blood Cell count, while rabbits fed on diets containing 10% FRO had significantly ($P<0.05$) higher values for Haemoglobin.

Blood is a good indicator to determine the health of an organism [36]. It also acts as pathological reflector of the whole body; hence hematological parameters are important in diagnosing the functional status of exposed animal to toxicants [36]. The values obtained in this study falls within the normal ranges of value for rabbit as reported by Olabanji et al. [35], RAR [33] and Mitruka and Rawnsley [34]. According to Togun et al. [37], when the haematological values fall within the normal range, it is an indication that the diets did not show any adverse effects on haematological parameters during the experimental period, but when the values fall below the normal range especially PCV, it is an indication of anaemia [34,35,38].

The result for Packed Cell Volume (PCV) for animals in different treatment groups may be attributed to the physiological and nutritional status of the animals [39]. PCV is an index of toxicity and its distribution vary with breeds. Reduction in the concentration of PCV in the blood usually would suggest presence of a toxic factor (e.g. haemagglutinin) which had adverse effect on blood formation [40]. The result of this study therefore shows that there was no presence of a toxic factor and as such bovine rumen filtrate fermented meal had no adverse effect on blood formation.

Haemoglobin (Hb) values were comparable with the normal values (11-15 g/dl) reported by PGCVS [41]. However, values were significantly affected by treatments. Normal range of values of Hb indicated that the vital physiological relationship of gases (oxygen and carbon dioxide) to and from the tissues of the body was maintained and also seemed normal [38].

The values for red blood cell (RBC) reported in this study may be an indication that the rumen filtrate fermented rice offal meal did not have any obvious detrimental effect on RBC of the rabbits. The RBC values were in the range found to be within the normal reference point as reported by Mitruka and Rawnsley [34] and Olabanji et al. [35], and as such accounted for the normal respiratory processes observed throughout the experimental period.

White blood cells values obtained were within normal range ($4\text{-}11 \times 10^9$/L) for rabbits, but significantly affected by treatment. The result in this study therefore indicates that there was no microbial infection or the presence of foreign body or antigen in the circulatory system. Olabanji et al. [35] opined that normal range of values for WBC indicated that the animals were healthy because decrease in number of WBC below the normal range is an indication of allergic conditions, anaphylactic shock and certain parasitism while elevated values indicate the existence of recent infection usually with bacteria. This further indicates that adequate WBC was produced as the rabbits were healthy throughout the experimental period.

The MVC values reported in the study were within the normal reference (78.00 to 95.00fl) range reported by RAR [33]. The MCH values were also found to be within the range considered for normal clinically healthy rabbits [33]. MCHC were also within the normal reference (30.00-34.00 g/dl) values [33]. The normal hematological indices reported from this study imply that the processes of blood formation and functions were not interfered by dietary treatments. Lower haematological values entail anaemic conditions, respiratory disorders as well as poor transport and nutrients utilization [35]. Monocytes (2.80-4.45%), Neutrophils (30.13-33.59%), Lymphocytes (62.02-70.34%) and Eosinophiles (1.45-2.57%) reported in this study were also comparable with the normal reference values reported by RAR [33].

Table 3. Hematological indices of rabbits fed diets containing graded levels of fermented rice offal

Parameters	Experimental diets							
	T_1	T_2	T_3	T_4	T_5	NRV	SEM	P-value
	Control	5 FRO	10 FRO	15 FRO	20 FRO			
PCV (%)	40.67	41.00	42.00	40.00	39.67	30.0-50.0	1.16	0.33
Hb (g/dl)	15.00^{ab}	14.90^{b}	15.37^{a}	14.37^{c}	14.83^{bc}	11.0-15.0	0.40	0.01
RBC ($\times 10^{12}$/l)	5.47	5.60	5.27	4.97	5.40	5.0-8.0*	0.09	0.20
WBC ($\times 10^{9}$/l)	4.20^{b}	6.17^{a}	5.60^{ab}	4.46^{b}	6.77^{a}	4.5-11.0	0.81	0.02
MCV (fl)	74.44	73.39	80.36	80.52	73.57	78.0-95.0	6.23	0.34
MCH (pg)	27.45	26.72	29.35	28.92	27.52	27.0-37.0	1.74	0.45
MCHC (g/l)	33.30	33.92	33.08	33.25	33.40	30.0-34.0	0.13	0.36
WBC differential								
Monocytes (%)	2.80^{b}	4.33^{a}	3.92^{ab}	3.22^{b}	4.45^{a}	1.0-4.5	0.19	0.00
Neutrophils (%)	33.29	33.52	31.78	30.13	32.77	32.2-34.5**	1.16	0.07
Lymphocytes(%)	65.34	64.65	62.02	67.67	70.34	39.0-72.0	0.37	0.43
Eosinophiles(%)	1.45^{d}	2.08^{b}	1.94^{c}	1.84^{c}	2.57^{a}	0.0-5.0	0.10	0.00

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
*NRV = Normal Reference Values [33, *34, **35]*
PCV = Pack Cell volume, Hb = Haemoglobin, RBC = Red Blood Cell count
WBC = White Blood Cell count, MCV = Mean Corpuscular Volume
MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration

3.2 Serum Biochemical Indices

Result of serum biochemical indices is presented in Table 4. No significant treatment (P>0.05) effect was observed in Total protein, Albumin, Globulin, Glucose and Urea. However, rabbits fed on diets containing 0% and 15% FRO had significantly (P<0.05) higher values for Cholesterol and the least was observed in 20% FRO treatment group.

There was no significant effect on the biochemical components of the rabbits reported in this study except for cholesterol. The total protein values in this study were in agreement with the normal reference (5.0–8.0 g/dl) range reported by Mitruka and Rawnsley [34] and (5.3–6.0 g/dl) reported by RAR [33] for rabbits. Total serum concentration is a measure of the quality of the diet consumed by livestock [37]. Thus from the performance of the rabbits it can be inferred that the various experimental diets contained adequate nutrients for the healthy growth of rabbits.

The albumin values reported in this study were in line with the normal range of 2.50-4.00 g/dl [34] and 2.50-4.50 g/dl [33] but lower than 3.47-4.00 g/dl reported by Ahemen et al. [42] when water spinach was fed to buck rabbits. The cholesterol obtained in this study varied from 139.30-168.14 mg/dl higher than the range of values (35.00-60.00 mg/dl) reported by Togun et al. [37]. These values were similar to 100-180 mg/dl reported for healthy rabbits [34].

Globulin values of 2.94-3.07 g/dl reported in this study were higher than the values of 1.10-2.70 g/dl reported by Ahamefule et al. [38], but closely related to 1.90-3.50 g/dl reported by Togun et al. [37]. The globulin values influenced by the test diets were not significantly different from one another and this indicates the similarity in strength or the ability of rabbits subsisting on the different dietary treatments to fight against diseases [38].

Glucose levels reported in this study were higher than 68.83-82.93 mg/dl reported by Olabanji et al. [35] and 63.83-82.93 mg/dl reported by Ochefu [43]. These values were within the range of 78.00-155 mg/dl reported by Mitruka and Rawnsley [34] for healthy rabbits. Normal blood glucose level implies that the experimental diets were palatable and met the requirements for growth, good digestive health and development as reflected in feed intake and body weight gain [37]. Low blood glucose level results from anorexia and digestive disturbances. Hypoglycaemia implies low blood glucose and in severe cases can lead to death [34].

Urea levels of 66.91-80.33 mg/dl reported in this study were within the range reported by Mitruka and Rawnsley [34] and RAR [33] but higher than the findings (30.00-37.00 mg/dl) of Togun et al. [37]. The results also concurred with findings of Ahamefule et al. [38]. Urea level in the blood suggests the quality of protein in the diet. High level of urea in the blood thus indicates a diet of poor protein quality [38]. The proteins in the experimental diets were of good quality and thus supported growth throughout the experimental period. Age, sex, sampling techniques, stress during handling and testing methodology could be responsible for the variations in the hematological and serum biochemical values from earlier reports but not necessarily dietary effect.

3.3 Sensory Evaluation of Rabbits

The result of organoleptic properties of rabbit meat is presented in Table 5. There were no significant differences (P>0.05) in the organoleptic properties of rabbit meat fed graded levels of FRO across the treatment groups. Although, there were little variations which were not statistically different as the values ranged from 7.45-8.45 for taste, 7.12-7.89 for appearance, 7.25-8.03 for aroma, 7.50-7.96 for texture and 7.93-8.46 for overall acceptance.

There was no significant difference in the organoleptic properties of rabbit carcass fed diets containing graded levels of FRO. This indicates that FRO did not affect meat quality of the rabbits adversely. Based on the meat quality parameters of taste, appearance, aroma, texture and overall acceptability, 20% FRO inclusion in rabbit diets is safe. Taste refers to the availability and amount of moisture in the meat and the sweetness thereof [32]. There were no significant differences in the taste of the meat of rabbits from all treatments. Sense of sight is used to evaluate the general appearance such as colour of the product. The result showed that the inclusion of FRO at different levels up to 20% did not affect the appearance of rabbit meat. This implies that rabbit meat from animals fed diets containing up to 20% FRO would equally be patronized as the control. Numerically, panelists preferred the meat products in the order from T_2 (5%FRO), T_4 (15%FRO), T_5 (20%FRO),

T_1 (0%FRO) and T_3 (10%FRO) in terms of taste, appearance, aroma, texture and overall acceptability. Lipid content in meat might explain these preferences because the juiciness of meat that is important for consumer choice is connected to fat content [44].

Table 4. Serum biochemical parameters 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	NRV	SEM	P-value
Total protein (g/dl)	7.01	7.18	7.15	6.76	6.77	5.00-8.00	0.07	0.11
Albumin (g/dl)	4.22	4.01	4.12	4.33	4.49	2.50-4.00	0.22	0.57
Globulin (g/dl)	2.79	3.17	3.03	2.43	2.28	2.90-4.90	0.02	0.07
Cholesterol (mg/dl)	168.14^{a}	152.41^{b}	148.86^{bc}	165.72^{a}	139.30^{b}	100-180	3.17	0.00
Glucose (mg/dl)	85.32	86.76	90.85	85.54	82.88	78-155	1.49	0.20
Urea (mg/dl)	69.70	74.98	80.33	66.91	76.70	81-250	2.64	0.63

a b = Means on the same row with different superscripts are significantly (P<0.05) different,
FRO = Fermented Rice Offal, SEM = Standard Error of Mean
NRV = Normal Reference Values, [34]

Table 5. Sensory data 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	SEM	P-value
Taste	7.50	8.45	7.45	8.30	8.23	1.08	0.75
Appearance	7.15	7.89	7.12	7.70	7.63	0.98	0.37
Aroma	7.35	8.03	7.25	7.85	7.78	1.13	0.76
Texture	7.62	7.96	7.50	7.85	7.65	1.20	0.54
Overall Acceptance	8.24	8.46	7.93	8.38	8.40	0.89	0.73

FRO = fermented rice offal, SEM = standard error of mean

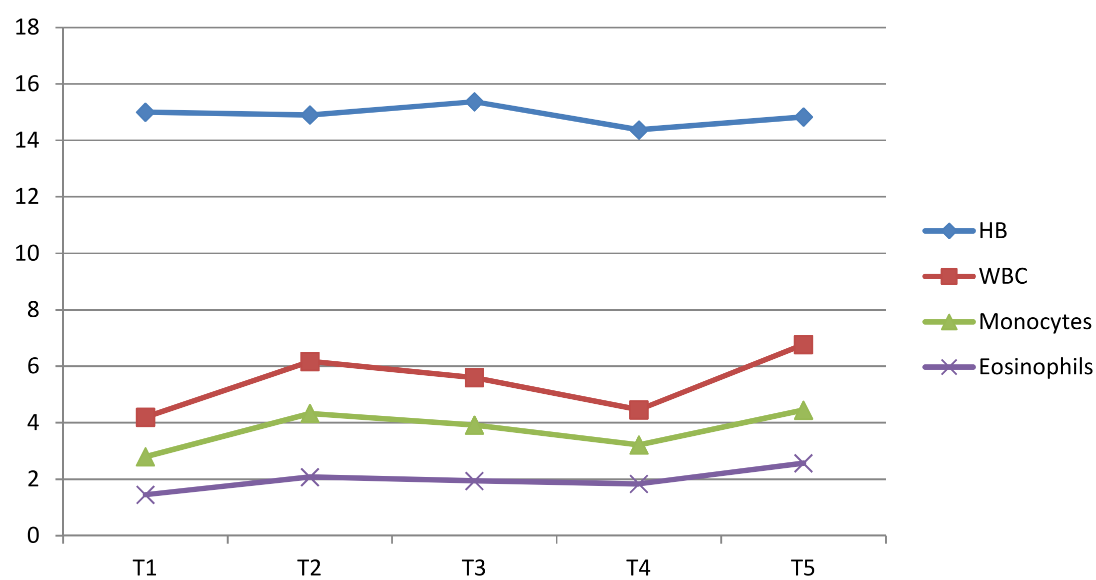

Fig. 1. Graphical presentation of the haematological parameters that showed significant differences to treatment diets

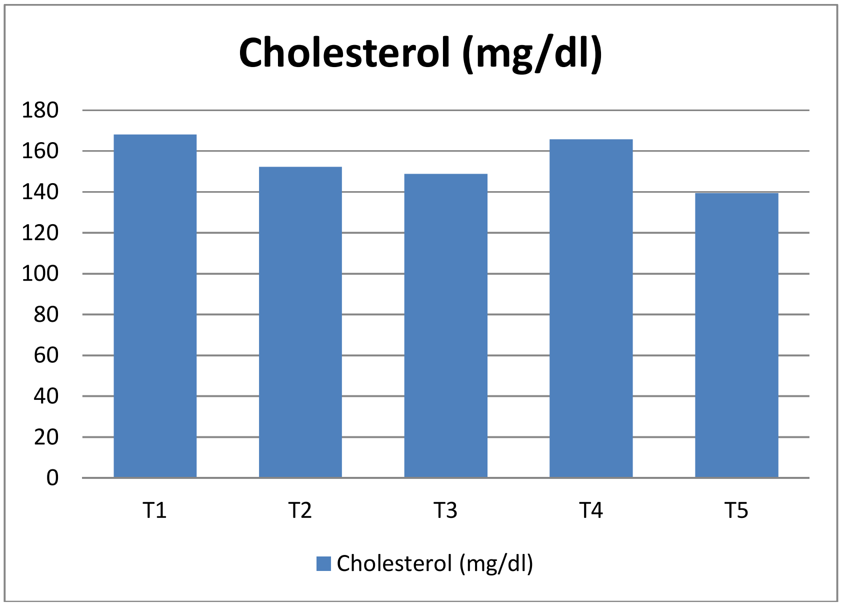

Fig. 2. Graphical presentation of significantly different cholesterol values

4. CONCLUSION

In a trial to expand feed resource base in animal nutrition, this study was conducted to study the nutrient potential of rice offal enhanced by bovine rumen filtrate-fermentation on the haematological, serum biochemical and sensory characteristics of grower rabbit bucks, below are inferences;

- Inclusion of rumen filtrate-fermented rice offal at 20% levels in the diets of growing rabbits maintained a good health as shown in the results of haematological and serum biochemical indices.
- There was no significant difference in the organoleptic properties of rabbits resulting from the inclusion of up to 20% rumen filtrate-fermented rice offal in the diets of growing rabbit bucks.

5. RECOMMENDATION

Based on the results obtained from this study, it could be 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 on health of the rabbits and the quality of rabbit meat.
- Further research should also be carried out to probe the upper limits to which bovine rumen filtrate-fermented rice offal meal could be used in the diets of various classes of rabbits.

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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