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HAEMATOLOGICAL AND SERUM BIOCHEMICAL RESPONSES OF MALE RABBITS FED FERMENTED CASSAVA PEEL MEAL BASED DIETS

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ABSTRACT

This study investigated the haematological and serum biochemical response of male rabbits to fermented cassava peel meal (FCPM) as a partial replacement for maize in their diets. A total of 30 male rabbits (6–7 months old) were randomly allotted to five dietary treatments where FCPM replaced maize at graded level of 0%, 20%, 40%, 60%, and 80% in a completely randomized design feeding experiment that lasted 8 weeks During the trial, data were obtained on haematological parameters and serum biochemical indices. The haematological parameters measured were packed cell volume (PCV), haemoglobin concentration (Hbc), red blood cell count (RBC) and white blood cell counts (WBC) whereas the serum biochemical indices were total protein (TP), albumin (AL), globulin (GL), creatinine (CR), aspartate transaminase (AST), and alanine transaminase (ALT). The results showed significant treatment effects ($p<0.05$) on PCV, Hbc, RBC, MCV while other parameters were not affected ($p>0.05$) namely, MCH, MCHC, neutrophil and lymphocytes. The values for the PCV (39.70%), Hbc (13.35g/dl), RBC (5.88 x 10^6 uL), and MCV (68.50fl) were higher in rabbits fed 40% FCPM as replacement for maize while the lowest values were recorded by those on 80%FCPM with the exception of MCV that had the lowest in rabbits in 20% treatment group (64.45 fl). It showed from the results that the rabbits utilized the FCPM adequately at 40% as the haematological and serum biochemical indices indicated no severe adverse health or physiological stress. It is concluded therefore, that properly fermented cassava peel meal could be used as a viable alternative replacement for maize as an energy source of male rabbit diets since the blood profiles were within the physiological range for healthy rabbits. *It is recommended and advisable that rabbit farmers wishing to optimize healthy rabbits for profitability should consider FCPM inclusion around 40% of the diet.*

Keywords: haematological parameters, serum biochemical indices, fermented cassava peel meal, and male rabbits.

1.0 INTRODUCTION

The growing global demand for livestock products has prompted the search for alternative, cost-effective, and sustainable feed ingredients to improve health and animal nutrition. Cassava (*Manihot esculenta*), a tropical root crop, is widely cultivated in many parts of the world due to its high starch content and suitability for various agro-climatic conditions. However, cassava by-products, especially its peels, are often underutilized despite their potential nutritional value. Cassava peel, which constitutes a significant portion of the crop, has been identified as a rich source of fiber, carbohydrates, and some essential micro-nutrients (Onyango *et al.,* 2020). Fermentation, a process that involves microbial action on organic matter, has been shown to enhance the nutritional value and digestibility of feed ingredients, including cassava peel (Olaofe *et al.,* 2021). The inclusion of fermented cassava peel meal (FCPM) in livestock diets could therefore, be an innovative strategy to improve feed quality while minimizing waste.

Haematological and serum biochemical parameters provide valuable insights into the health, growth, and metabolic status of animals, offering a non-invasive method of assessing the effects of diet on animal well-being. Several studies have indicated that fermented feed ingredients can influence these parameters by modulating metabolic pathways, antioxidant status, and overall immune function (El-Desouky *et al*., 2022). Specifically, fermented cassava peel meal has been suggested to impact blood parameters such as red and white blood cell counts, hemoglobin levels, and serum enzyme activities, potentially leading to improved growth performance and health status in animals (Nde *et al.,* 2023).

However, despite these promising findings, the effects of dietary inclusion of fermented cassava peel meal on haematological and serum biochemical profiles, particularly in male rabbits, remain under-explored. Male rabbits, often used as model animals in nutritional studies, are sensitive to dietary changes and can offer valuable insights into the broader implications of using alternative feed ingredients. Therefore, understanding how the incorporation of FCPM affects the haematological and serum biochemical profiles of male rabbits could provide essential data for optimizing their nutrition and health.

Understanding these responses is essential for determining the suitability of FCPM as a viable alternative to conventional feed ingredients in rabbit nutrition, and by extension, its potential role in promoting sustainable and eco-friendly agricultural practices.

2.0 MATERIALS AND METHODS

2.1 Experimental Site

This study was conducted at the Rabbitry Unit of the Teaching and Research Farm, Department of Animal Production, Prince Abubakar Audu University, Anyigba, located in Dekina Local Government Area, Kogi State. Anyigba is situated on latitude 7°30'N and longitude 7°9'E, with an average altitude of 420 meters above sea level. The area falls within the tropical wet and dry climate zone of the Guinea savanna, characterized by an average annual rainfall of approximately 1600 mm and a daily temperature range between 25°C and 35°C (Aderibigbe *et al*., 2022).

2.2 Collection of the Test Diet and Preparation of Experimental Diets.

Cassava peels of mixed varieties were collected within 24 hours after peeling the tuber from gari-processing plants in Anyigba in Dekina Local Government Area of Kogi State, Nigeria. The peels were washed and allowed to ferment for three days, then sun-dried for 5 days (crispy texture) the dried peels were ground in a *SFSP 110* 65*:90kw, 3-4t/h capacity hammer mill. Other feed ingredients were purchased from the open market in Anyigba. The diets were formulated such that fermented cassava peel meal, replaced 20, 40, 60 and 80 percent of dietary maize, while 0% fermented cassava peel meal was the control (see Table 1)

2.3 Procurement of Experimental Animals and the Experimental Design

Thirty (30) male Dutch, Chinchilla, Hyla, New Zeeland White and Californian White Rabbits aged 6 -7 months were procured from the rabbitry unit of the research and teaching farm VOM. The rabbits were randomly assigned in a completely randomized design into five treatments groups with six rabbits per dietary treatment. ANOVA Table was used to partition the total variability into treatment and error components.

2.4 Experimental Procedure and Animal Management

Thirty (30) male rabbits of mixed breeds, aged between six to seven (6 -7) months old with average weight of 1556.7 grams were randomly assigned in a completely randomized design into five treatments groups with six rabbits per dietary treatment (six replicates and a rabbit per replicate). The diets were formulated such that fermented cassava peel meal, replaced 20, 40, 60 and 80 percent of dietary maize, while 0% fermented cassava peel meal was the control. The rabbits were housed in hutches with individual cages measuring 76 x 62 x 42cm, elevated from the ground to a height of 90 cm and bounded around with wood and wire mesh. The cages were equipped with feeding troughs. The cages' floors were made of perforated metal slates to allow for easy passage of faeces and urine. The experiment lasted for eight weeks. Before the arrival of the rabbits, the cages, feeders and troughs were thoroughly disinfected and washed. The rabbits were fed commercial hybrid feed growers mash to stabilize them for one-week during which they were also prophylactically treated against internal and external parasites using ivermectin (0.2ml/rabbit) subcutaneously; other drugs used were; embazine forte (0.5grams/litre) in their drinking water for five days and tetracycline (0.5grams/litre) in their drinking water for five days to prevent coccidiosis and bacterial infections. The initial weights of the rabbits were taken before they were introduced to the

experimental diets. The rabbits in each treatment were served 250gm feed daily between 7.00 - 8.00am and 100 grams of wet forages (corn leaves and banana leaves at ratio 1:1) were also fed daily at 3pm. Water was supplied *ad libitum*. Daily feed consumption was recorded for each rabbit, weight gain was calculated weekly on an individual basis.

Table 1: Diet Composition of Experimental Diets for Rabbits

	%FCPM				
Ingredients	**Diet 1**	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**
	0%	**20%**	**40%**	**60%**	**80%**
Maize	37.18	29.74	22.31	14.87	7.44
FCPM	0.00	7.44	14.87	22.31	29.74
FFSBM	16.35	16.35	16.35	16.35	16.35
Dry Brewers' Grain	20.00	20.00	20.00	20.00	20.00
Bambara nut Waste	23.12	23.12	23.12	23.12	23.12
Bone meal	2.50	2.50	2.50	2.50	2.50
Lysine	0.20	0.20	0.20	0.20	0.20
Methionine	0.20	0.20	0.20	0.20	0.20
Vit. /Min premix	0.25	0.25	0.25	0.25	0.25
Salt	0.20	0.20	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated values					
Crude Fibre (%)	7.26	7.78	8.38	8.94	9.49
Crude Protein (%)	17.95	17.66	17.37	17.09	16.79
Energy ME (kcal/kg)	2690.86	2616.21	2541.24	2466.17	2391.20

FFSBM= full fat soyabean meal, ME = metabolizable energy, FCPM= fermented cassava peel meal

2.5 Haematological and Serum Parameters

At the end of the experiment, blood samples were collected at 06:30am – 08:00am from two rabbits per treatment. The samples were collected from the central ear artery using the pressure needles into a properly labelled ethylenediaminetetraacetic acid (EDTA) bottles for haematological analysis. While Blood samples for serum biochemistry were collected into clean well -labelled empty blood sample bottles without any anticoagulant. Packed cell volume (PVC) and haemoglobin concentration (Hb) were determined by the method described by Lang and Altman (1991). Red blood cell (RBC) count, Lymphocytes, Neutrophils and white blood cells (WBC) counts were determined using haemocytometer. Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined according to Mitruka and Rawnsley (1977). Serum biochemical parameters determined were; total protein, albumin, globulin, creatinine, alanine amino transaminase (ALT) EC 2.6.1.2.and aspartate transaminase (AST) EC 2.6.1.1. Serum total protein was determined using biuret method, while serum alanine transaminase (ALT) and aspartate transaminase (AST) were determined according to Reitman and Frankel method (1957).

2.6 Data Analysis

Data collected were subjected to one way analysis of variance (ANOVA) as appropriate for Completely Randomized Design using version 9 Statistics software package (SAS, 2012) and differences between means were separated using Fisher's Least Significant Difference (LSD) method at 5% level of significance.

3.0 RESULTS AND DISCUSSION

3.1 Results

3.1.1 Proximate Composition of Fermented Cassava Peel Meal (FCPM) and Experimental Diets

The Proximate Composition of Fermented Cassava Peel Meal (FCPM) and Experimental Diet is presented in Table 2

Table 2: Proximate Composition of Fermented Cassava Peel Meal (FCPM) and Experimental Diet

Parameters	FCPM	0%	20%	40%	60%	80%
Moisture content (%)	5.15	4.10	5.09	5.16	5.17	4.11
Dry matter (%)	94.85	95.90	94.91	94.84	94.83	95.89
Crude protein (%)	3.55	24.92	23.41	20.02	10.11	6.91
Crude fat (%)	0.53	4.60	3.78	2.64	2.01	1.49
Crude fibre (%)	9.89	3.45	3.64	4.53	4.88	5.00
Ash (%)	1.71	2.13	1.99	1.86	1.94	1.89
NFE (%)	79.17	47.93	62.09	65.79	75.89	80.60

Table 3: Haematological Indices of Male Rabbits Fed Diet containing Fermented Cassava Peel Meal

Parameters	%FCPM							
	0%	20%	40%	60%	80%	Normal Range	SEM	LOS
PCV (%)	37.10^{bc}	37.90^{b}	39.70^{a}	36.40^{c}	34.55^{d}	32.00-44.00	0.55	*
RBC ($x10^6$/uL)	5.48^{bc}	5.47^{bc}	5.88^{a}	5.64^{ab}	5.25^{c}	6.80-10.80	0.13	*
WBC ($x10^3$/uL)	3.42	3.36	4.12	3.50	3.14	5.80-12.80	1.04	NS
Hbc (g/w)	12.45^{ab}	12.15^{ab}	13.35^{a}	12.05^{b}	11.80^{b}	10.30-15.30	0.47	*
MCV (fl)	67.65^{ab}	64.45^{c}	68.50^{a}	67.70^{ab}	65.65^{bc}	55.00-75.00	0.92	*
MCH (pg)	22.65	21.65	22.70	21.60	22.20	17.00-24.00	0.78	NS
MCHC (g/dl)	33.50	32.45	33.50	33.40	34.20	30.00-37.00	1.15	NS
Neutrophil (%)	39.90	50.00	28.75	33.60	30.05	30.00-60.00	10.96	NS
Lymphocyte (%)	53.95	39.40	63.40	59.50	57.10	30.00-60.00	9.34	NS

a,b,c= Means with different superscripts along the same row show significant difference at $p<0.05$., PCV = Packed Cell Volume, RBC = Red Blood Cell, WBC = White Blood Cell Hbc = Haemoglobin concentration, MCV = Mean Corpuscular Volume, MCH = Mean Corpuscular Haemoglobin, MCHC = Mean Corpuscular Haemoglobin Concentration, , SEM = Standard Error of Mean, FCPM=fermented casava peel meal

3.1.2 Haematological Indices of Male Rabbits Fed Diet containing Fermented Cassava Peel Meal

Results of Haematological indices of male rabbits fed diet containing fermented cassava peel meal is shown in table 3. The results showed significant treatment effects ($p<0.05$) on packed cell volume (PCV), haemoglobin concentration (Hbc), red blood cell (RBC) count and the mean corpuscular volume (MCV) while other parameters were not affected ($p>0.05$) namely, white blood cell (WBC) count, mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin, (MCHC), neutrophil and lymphocytes. The values for the PCV (39.70%), Hbc (13.35g/dl), RBC (5.88 x 10^6 uL), and MCV (68.50fl) were higher in rabbits fed 40% FCPM as replacement for maize while the lowest values were recorded by those on 80%FCPM with the exception of MCV that had the lowest in rabbits in 20% treatment group (64.45 fl).

3.1.3: Serum Biochemical Indices of Male Rabbits Fed fermented cassava peel meal

Results of Serum biochemical indices of male rabbits fed fermented cassava peel meal is shown in Table 4. All the parameters measured except albumin were not significantly ($p>0.05$) influenced by the dietary treatment. Rabbits fed 80% FCPM recorded significantly ($p<0.05$) lowest albumin (24.33g/dL) while the highest mean value of 40.24 g/dL were similar for rabbits in treatment groups fed with 40% and 60% FCPM respectively. Values observed for total protein were lowest with the rabbits fed 80% FCPM (55.31g/L) and highest with the rabbits fed 20% (58.10g/L). Globulin lowest mean value of 17.76g/L were similar for rabbits in treatment groups fed 40% and 60% while the highest was recorded for rabbits fed 80% FCPM (28.21g/L). Creatinine observed values had the lowest with the rabbits fed 0% FCPM (136.50mg/dL) while those fed 40% FCPM recorded the highest values (186.00mg/dL), ALT recorded the lowest with the rabbits fed 80% FCPM (12.54U/L) while the rabbits in treatment group fed 20% FCPM had the highest (15.23U/L). AST had lowest values with rabbits fed 20% FCPM (19.33U/L) while 26.57U/L was the highest recorded from the rabbits fed 80% FCPM.

Table 4: Serum Biochemical Indices of Male Rabbits Fed fermented cassava peel meal

Parameters	%FCPM							
	0%	20%	40%	60%	80%	Normal Range	SEM	LOS
Total protein (g/dL)	57.53	58.10	58.00	58.00	55.31	54.00-75.00	5.89	NS
Albumin (g/dL)	37.81[a]	37.65[a]	40.24[a]	40.24[a]	24.33[b]	34.00-54.00	1.56	*
Globulin (g/dL)	19.73	20.08	17.76	17.76	28.21	25.00-50.00	5.66	NS
Creatinine (mg/dL)	136.50	169.00	186.00	146.50	148.50	100.0-180.0	58.97	NS
ALT (U/L)	14.62	15.23	14.62	14.62	12.54	20.00-60.00	4.78	NS
AST(U/L)	20.74	19.33	22.61	22.61	26.57	15.00-40.00	7. 55	NS

a,b,c.=on the same row with different superscripts are significantly different (P<0.05) significance, SEM= Standard Error of Means, AST = Aspartate amino transaminase, ALT = Alanine amino transaminase, FCPM= fermented cassava peel meal.

3.2 Discussion

3.2.1 Haematological Indices of Male Rabbits Fed Diet containing Fermented Cassava Peel Meal

The findings from this study revealed that the inclusion of fermented cassava peel meal at graded levels as partial replacement for maize in male rabbits' diets significantly ($p<0.05$) impacted the haematological parameters measured, namely, Packed cell volume (PCV), haemoglobin concentration (Hb), Red blood cell (RBC), and mean corpuscular volume (MCV). PCV was highest at 40% FCPM followed by 20% and control. The range of 34.55% to 39.70% obtained in this study agreed with the normal range of 36.20 to 39.10% reported by Eruvbetine *et al*. (2017). This is an indication that despite inclusion of fermented

cassava peel meal even at 80% the rabbits still received adequate mineral and vitamins required for blood synthesis. The values were also within the range of 47.27 to 57.27% reported by Ahemen *et al*. (2015), 32.00 to 44.00% reported by Mensah *et al.* (2018), 31.00 to 35.50% by Akinbola *et al.*, (2019) for rabbits. It thus means that, the nutritional adequacy of the diet was maintained despite the partial replacement of maize with FCPM in the diet. Rabbits with 40% FCPM recorded the highest haemoglobin (Hb). The values of 11.80 to 13.35g/dl recorded in this study were within the normal range of 10.30 to 15.30 g/dL reported by Mensah *et al*. (2018) for growing male rabbits and similar to 11.00 to 13.50g/dl observed for female adult rabbits by Oglesbee (2017), and also within the range of 10.4 to 17.4g/dl reported by David *et al* (2019) for adult male rabbits. RBC was highest at 40%. The values of 5.25 to 5.88 x 10^6µl obtained in this study was lower than the normal range of 6.80 to 10.80 x 10^6µl reported by Omojola *et al.* (2018) for growing male rabbits fed CPM diet and 6.13 to 9.67 x 10^6µl was reported for female rabbits by Mensah *et al*. (2018). The variations may be dependent on factors such as breed, sex, environmental and nutrition status or processing method. Even though slightly lower, it may be suggested that the utilization of FCPM in rabbit diet did not impair nutrient availability in the diets such that would cause anaemic condition and that protein intake was adequate. The MCV values obtained in this study varied from 64.45 to 68.50fl. These values fall within the values of Mensah *et al*. (2018) who reported 55.00 to 75.00fl male rabbits, and 55.40 to 73.20fl for female rabbits. The values were observed to be in contrast to 38.27 to 50.00fl reported by Akpet and Gboshe (2023) who fed weaner rabbits with diets containing CPM. These differences may be as a result of the sex and age of the rabbits. However, Akpet and Gboshe (2023) reported that, reduction or abnormal values of Hb, PCV, RBC, MCH, MCV and MCHC may indicate a low protein intake or liver damage, anaemia, or parasitological infection. This however did not apply to the rabbits in this study, as the diets were balanced and well-fortified to supply adequate nutrients. The MCH, MCHC, WBC, Neutrophil and lymphocyte values across the different treatments were not affected by the dietary changes. These findings suggest that FCPM, as a high-fibre alternative to maize, can be incorporated into rabbit diets without detrimental effects on haematological indices, supporting its potential as a cost-effective and nutritionally viable feed ingredient. WBC was also highest at 40%. All other values were similar indicating that the rabbits were adequately immune to infection. The values of 3.14 to 4.12x10^3/uL obtained from this study is lower than the normal range of 5.80 to 12.80x 10^3/uL reported by Omojola *et al.* (2018) for male rabbits of 6 to 7 months old fed CPM diet. Despite the lower values of WBC, the rabbits in this study obtained the adequate dietary needs of rabbits without inducing nutritional stress or anaemia. Thus, indicating that rabbits were healthy. The values of MCH, MCHC, Neutrophil and lymphocyte obtained from this study were all within the normal values of 17 to 24 pg, 30 to 37 g/dL, 30 to 60% and 30 to 60% respectively for rabbits as reported by Mensah *et al*. (2018). These results collectively underscore the potential of FCPM as a sustainable feed ingredient, providing both economic and nutritional benefits in rabbit production systems.

3.2.2 Serum Biochemical Indices of Male Rabbits Fed Diet containing fermented cassava peel meal

The total protein in this study was not significantly ($p>0.05$) affected by treatment. The highest was 20% FCPM group. The observed values of 55.31g/L to 58.10g/L from this study are within the normal total protein ranges of 54.00 to 75.00 g/L for male rabbits (Mensah *et al*., 2018; Melillo, 2021). The observed values were also in line with the report of Oyebadejo *et al*. (2020) who reported that dietary inclusion of up to 25% CPM did not significantly affect serum total protein of rabbits indicating that the protein quality and quantity in FCPM diets were sufficient for maintaining protein metabolism in rabbits. The observed values were also within the values of 56.00 to 81.00 g/L and 59.00 to 85.00 g/L

(Afolabi *et al.*,2019: Alaba *et al*. 2020) for female rabbits. There was significant ($p<0.05$) difference observed for the albumin. The rabbits fed diets containing 40% and 60% FCPM showed the highest values. Apart from the values of rabbits fed 80% FCPM, all other values fell within the normal range of 34.00 to 54.00 g/L reported by Omojola *et al.* (2018) for male rabbits. These values were at variance with Oyebadejo *et al*. (2020) who reported that dietary inclusion of CPM for rabbits did not significantly affect serum albumin, and Okpe *et al*., (2022) who fed varied inclusion levels of bitter leaf meal to broilers. The differences may be attributed to some physiological factors such as age, breed and nutrition. The globulin in this study was not significantly ($p>0.05$) affected by treatments. Apart from the rabbits fed 80% FCPM, all others fell below the normal globulin range of 25.00 to 50.00g/L (Mensah *et al*., 2018), 25.00 to 50.00 g/L (O'Brien *et al*., 2018) for male rabbits and 22.00 to 45.00g/L for female rabbits (Afolabi *et al*., 2019). The reduced globulin in this study may be related to factors such as growth stage, parity, breed, genetics and environmental factors. The creatinine was highest with the rabbits fed 40% FCPM. The values obtained fell within the normal values of 100.00 to 180.00µmol/L for male rabbits (Mensah *et a*l., 2018) indicating that protein metabolism was adequate and kidney function was also adequate without kidney damage. The study revealed that the inclusion of graded levels of FCPM in rabbits' diet at 40% showed the highest level of the serum creatinine. This is in line with the study of Oyebadejo *et al*., (2020) which showed that dietary inclusion of up to 20% CPM did not significantly affect serum creatinine, urea, or electrolyte levels in male rabbits, indicating that such levels are safe for kidney function in male rabbits. However, high levels of CPM, especially when unprocessed, have been associated with an increase in serum urea and creatinine, reflecting renal stress and impaired protein metabolism (Okeke *et al.*, 2020). Alanine aminotransaminase, EC 2.6.1.2 (ALT) in this study was not significantly ($p>0.05$) affected by treatments. These values obtained are lower than the normal values of 20.00 to 60.00u/L (Meredith, 2015), 20.00 to 50.00u/L and 25.00 to 60.00u/L for female and male rabbits (Mensah *et al.,* 2018), 25.00 to 60.00u/L for female rabbits (Afolabi *et al*., 2019), 15.00 to 40.00u/L (Afolabi *et a*l., 2019). This is an indication that there may be a malabsorption of protein, some mineral deficiencies such as vitamin E or selenium, or may be as a result of hormonal imbalances, though, they were not clinically significant as the rabbits did not show any sign of infection. However, the values were within the significant levels documented (9.50 - 16.6uL) Okpe and Abdulfatai (2022) who fed pawpaw leaf meal to broiler chicken. Aspartate aminotransferase, EC 2.6.1.1 (AST) mean values were not significantly ($p>0.05$) affected by treatments which agreed with the findings of Okpe and Abdulfatai (2022). The observed range is within the normal range of 15.00 to 40.00u/L (Meredith, 2015). This suggests that the liver and muscles were not damaged or diseased indicative of good overall health in the rabbits. Serum biochemistry parameters, such as total protein, albumin, globulin, glucose, cholesterol, and liver and kidney function markers (e.g., ALT, AST, creatinine), can provide insights into how cassava peel meal affects metabolism, organ function, and nutrient utilization in rabbits (Onyeka *et al*., 2022).

4.0 CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

The inclusion of fermented cassava peel meal (FCPM) in the diets of male rabbits significantly influenced their hematological and serum biochemical parameters. The study demonstrated that FCPM, when properly processed through fermentation, can serve as a viable alternative energy source in rabbit nutrition without compromising health. Among the varying inclusion levels tested, the 40% FCPM diet consistently supported optimal hematological values—such as packed cell volume (PCV), red blood cell count (RBC), and hemoglobin concentration—as well as favorable serum biochemical indices, including total

protein, albumin, and liver enzymes within physiological ranges. These findings indicate that fermentation effectively detoxifies cassava peels, enhances their nutritive value, and supports normal physiological functioning in male rabbits.

4.2 Recommendations

I Adoption of 40% FCPM in rabbit diets is recommended as a cost-effective alternative non-conventional energy source, particularly in regions where cassava peels are abundant.

II Assessment of oxidative stress markers and histopathological analysis of organs could be included in future research to validate internal organ health at higher inclusion levels.

CONFLICT OF INTEREST

I, Oyibo Amina declare that there is no any conflict of interest.

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