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Research Paper

Haematological and Serum Biochemical Variables of Weaner Rabbits Fed Diets Containing Cassava Peel Meal As Substitute For Maize As Energy Source

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ABSTRACT:
Eighty(80) weaner rabbits of mixed sexes and breeds (Chinchilla, California and New Zealand white), aged 5 weeks were used to examine the effect of substituting sun-dried cassava peel meal (CPM) for maize on the blood parameters of rabbits using a Completely Randomized Design (CRD). The rabbits were divided into four groups designated 1, 2, 3, and 4 and allotted into four dietary treatments formulated with ratios 100:0, 75:25, 50:50 and 25:75% for maize: sun-dried CPM, respectively. All diets were formulated with equal amounts of non-test ingredients. Parameters measured were; for haematological indices, Red Blood Cell count (RBC), White Blood Cell count (WBC), Haemoglobin concentration (Hb), Packed Cell Volume (PCV), Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC).Serum indices were; total protein, globulin, glucose, cholesterol, Albumin and urea. Results shows that, (Hb) and (PCV) differed significantly ($p<0.05$). RBC and Hb count were not statisticallydifferent ($p>0.05$). White blood cell count (WBC), Mean Corpuscular Volume (MCV), MCH and MCHC were also not significantly affected ($p>0.05$).Significant difference ($p<0.05$) was observed in total protein, urea and cholesterol while globulin, glucose and albumin had no significant ($p>0.05$) difference. The values of haematology and serum biochemistry were comparable with the normal reference values, an indication of nutritional adequacy and safety of the experimental diets. The rabbits were able to meet their nutrient requirements for tissue accretion, since the test ingredient level used did not contain high phytochemicals which are known to reduce protein and specific amino-acids utilization as well as minerals and other nutrients. It was established in this study that, sun-dried CPM can replace maize in rabbit diets up to 25:75% comfortably as revealed from the blood parameters of the rabbits fed diet containing sun-dried CPM but based on the result of this study, It can be concluded that CPM can be included in growing rabbit diets up to 50% as a source of energy.

Key words: *cassava peel meal; haematology; serum biochemistry; Rabbit*

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I. INTRODUCTION

It has being established that in Nigeria, the state of nutrition of the populace is predominantly marked by inadequate animal protein intake both in quality and quantity [1]. This animal protein intake is regrettably low owing to several factors such as poverty, illiteracy and corruption. World Bank report has noted that the number of poor persons in Nigeria will rise to 95.1 million at the end of 2022 from 89.0 million in 2020. This would mean that 6.1 million more persons would have fallen beneath the poverty line of 137,430 naira ($381.75) per year between 2020 and 2022, a 6.7% increase[2]. The implication of this is malnutrition, poor development of the growing child with consequent reduction in expression of human capacity. There is also the problem of stillbirth, poor foetal development and other complications in pregnant women. This situation can be remedied by the production and consumption of micro livestock like the rabbits meat.

Rabbit meat is high in protein and low in fat particularly when the animals are raised on a high forage and low energy diet [3]. Rabbit meat is a source of healthful food as it is low in cholesterol, 50 g/100 g, fat 4 g/100 g, and energy 124 kcal/100 g but high in protein, 22 g/100 g. The meat compares favourably with chicken and beef of good grade [4]. Rabbits are induced ovulators, and will breed within 24 hours of parturition. Thus, it is theoretically possible to produce over 11 litters per year, with the additional advantage of small body size that

requires small land space and the utilization of non-competitive feeds, such as forages. The Rabbit has a rapid growth rate that make it grow much faster than larger livestock [5], in addition to a high reproduction potential. Rabbits and other small animals could make an important contribution to meat production in developing countries where the needs for maximizing food production are greatest. It has potential for genetic improvement that makes it have much variability in traits such as maternal ability, fecundity, resistance to heat stress among other factors. This activity is very promising given the fact that rabbit breeding provides good quality meat and requires a small capital and investment.

Based on these potentials, there is need, therefore, to increase their production as to increase the animal protein intake. However, the limitation to the increased commercial production of the Rabbit is the high cost of feed. There is increasing competition between man and livestock for available feedstuff for food, feed, and industrial raw materials [6]. This limitation imposed by this stiff competition with human for food have forced animal nutritionists to exploit alternative protein/energy feed ingredients that are locally available, cheaper and can meet the nutrient requirement of animals.

Since there is stiff competition for maize between humans and animals which has made its cost to skyrocket leading to increasing cost of finished feed and subsequently the cost of animal products, there is a serious need to reduce the cost of livestock feed ingredients and thereby increase animal protein intake among the populace using unconventional feed resources, such as cassava peel. The prospect of the market that may be dominated by cassava peel at lower cost instead of maize at higher cost should stimulate increase in rabbit production due to lower cost of the feed. Hence, more rabbit products made available to consumers at a more affordable price. Cassava peel meal has a protein content of 5%, Metabolizable energy of 2424 kcal/ kg and 9.5% crude fibre [7].

Cassava peel meal has being known to be a non-conventional feedstuff for rabbits [4]. It could serve as a cheap source of energy for farm animals but should be fortified with additional protein sources because of its low protein level [8]. Cassava peel meal has been successfully included in rabbit diets with no adverse effects [4]. [9] had 75% CPM inclusion of cassava peel meal which appears to have had a comparative growth performance and carcass characteristic traits on rabbits when they examine the effect of substituting sun-dried cassava peel meal (CPM) for maize as source of energy on growth performance and carcass characteristics of rabbits though had no significant differences ($P>0.05$) in daily weight gain, daily feed intake and feed conversion ratio. [10] reported that 15% sun dried cassava peel meal in diets fed to rabbits produced weight gain equal to rabbits fed the control diet. Fermented cassava peel meal has been used to replace up to 60% of the dietary maize portion [11] and 100% of the dietary maize [12] without adverse effects on the performance of rabbits.

Haematological observations provide valuable information about health of human and animals. According to [13], changes in haematological parameters are often used to determine health status of the body and to know the degree of environmental, nutritional and/or pathological stresses. Factors that affect blood like drugs, pathogenic organism or nutrition will certainly affect the entire body adversely or moderately in terms of health, growth, maintenance and reproduction [14]. A readily available and fast means of assessing clinical and nutritional health status of animals on feeding trials may be the use of blood analysis, because ingestion of dietary components has measurable effects on blood composition. [15], [16] observed that nutrition had significant effect on haematological values like park cell volume (PCV), haemoglobin (Hb) and red blood cell (RBC). [17]reported that when the haematological values fall within the normal range reported for the animal, it is an indication that diets did not have any adverse effect on haematological parameters during the experimental period but when the values fall below the normal range, it is an indication of anaemia. White blood cell (WBC) roughly represents the immune status of the animals; when WBC (leucocytes) falls within the normal range, it indicated that feeding patterns do not affect the immune system; most immunological abnormalities observed in malnutrition are usually reversed with adequate adjustment to the quality of the feed [18]. According to [19], increase in neutrophils: lymphocyte ratio is a good indicator of stress which could be of nutritional origin. Serum parameters are important in the proper maintenance of the osmotic pressure between the circulating pH and the fluid in the tissue spaces so that exchange of materials between the blood and the cells could be facilitated. Moreover, these parameters contribute to the viscosity and maintenance of normal blood pressure and pH [20].

However, scanty information is available on the effect of sundried cassava peel meal on the Haematological and serum biochemical indices of rabbits. This study was, therefore, designed with the objectives of evaluating the haematological and serum biochemical variables of rabbits fed with sun-dried cassava peel meal inclusion

II. MATERIALS AND METHODS

Experimental site

The study was carried out at a privately owned Standard Rabbitry in Obubra, approved for research by the Department of Animal Science, Faculty of Agriculture and Forestry, Cross River University of Technology, Obubra Campus. Obubra has a latitude $6^0 5'8.47"_N$ and longitude 8^0. $19'40.83"^0_E$ of the equator (GPS

Coordinates of Obubra), with a warm weather and ambient temperature of about 21 – 30^0c and an annual rainfall of 500 – 1070 mm (Google Map).

Experimental Animals, Housing and management

A total of Eighty (80) weaned rabbits of mixed breeds and sexes (Chinchilla, California and New Zealand white) between the ages of 4 and 5 weeks old were used for the feeding trial in a completely randomized design. The rabbits were weighed and randomly allocated to four treatments with twenty (2) animals per treatment with five replicates. Four animals represented a replicate. The rabbits were housed in a wire mesh/wood cage of 60 cm x 60 cm x 40 cm raised 50 cm above the concrete floor in an open sided building screened with wire gauze for protection. After thoroughly cleaning and drying the cages, the rabbits were introduced into them for an adaptive period of seven (7) days before the commencement of the experiment. The cages were equipped with metal feeders and plastic/concrete drinkers. The rabbits in each treatment were fed weighed amount of their group diet to appetite daily and fresh water given *ad-libitum* for 3 months (90 days).

At the commencement of the experiment, all the animals were provided with antistress (Vitalyte) agents, 2 g each. They were also dewormed and given cocciodiostat using piperazine citrate and proccox, respectively. Each rabbit was given 0.02 ml of 1vomec Subcutaneous against ecto and endo-parasite, as prophylactic treatment.

The rabbits were individually weighed using Camry top loading weighing scale, grouped in such a way as to ensure uniformity of initial body weights in all the groups and allotted to different treatments in agreement with the design of the study.

Feed ingredients, sources, Processing

Composite cassava peel (CP), was sourced within the campus's environs, washed and sun dried intensively on a concrete slap for a period of 7 days and roughly crushed with a hammer mill for inclusion in the test diets. Cassava peel meal was served as the test ingredient while the major feed ingredients were maize, full-fat soybean, Rice offal and palm kernel cake. All feed ingredients were sourced from markets around the University communities. Micro nutrients were added in equal amount to the diets so as to improve palatability and to meet nutrient requirements. The proximate chemical composition of sun dried cassava peel meal and major ingredients is presented in Table 1, using the [21] methods.

Table 1: Proximate Chemical Composition of Feed Ingredients on dry matter basis

Parameters%	Ingredients				
	CPM	Maize	FFSBM	Rice offal	PKC
Dry matter	92.55	88.50	82.00	83.00	78.25
Crude protein	5.80	8.89	38.88	6.55	18.35
Crude fibre	10.52	2.30	6.10	35.98	12.90
Ether extract	5.70	3.80	18.10	7.80	11.00
Ash	7.50	1.22	4.68	10.55	4.50
NFE	63.03	72.29	32.24	22.12	31.15
ME(Kcal/kg	2,913.87	3,203.03	3,305	1,442.61	2,675.78

CPM: Cassava Peel Meal, FFSBM: Full-fat soybean meal, PKC: Palm Kernel Cake, NFE: Nitrogen Free Extract; ME(kcal/kg): calculated from Pauzenga equation (1985) ME= (37 X %CP)+(81 X %EE)+(35 X %NFE)

Experimental diets and its calculated nutrients

Based on the results of the Proximate chemical composition of the test and major ingredients, four (4) experimental diets were formulated to contain sun dried cassava peel meal (CPM) at 0%, 25%, 50% and 75% in the ratio of 100:0, 75:25, 50:50 and 25:75 for maize: sun dried cassava peel meal, respectively. The dietary treatments were designated as 1, 2, 3 and 4 respectively. Treatment 1 served as the control diet. The diets were formulated to obtain crude protein range of 14.12-15.28% and a Metabolizable energy of range 2,693.87-2,802.31 kcal\kg as shown in Table 2.

Table 2. Composition of the experimental diets and calculated nutrients

	Dietary levels of the cassava peel meal inclusion (%)			
Ingredients %	T1 100 MM 0 CPM	T2 75 MM 25 CPM	T3 50 MM 50 CPM	T4 25 MM 75 CPM
Maize	50.00	37.50	25.00	12.50
Cassava peel meal	00.00	12.50	25.00	37.50
Full-fat soybean	20.00	20.00	20.00	20.00
Rice offal	15.00	15.00	15.00	15.00
Palm kernel cake	11.30	11.30	11.30	13.30
Bone meal	3.00	3.00	3.00	3.00
Vit-min premix^{+}	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Methionine	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10
Total	100.00	100.00	100.00	100.00
Calculated values:				
Crude protein%	15.28	14.89	14.50	14.12
Crude Fibre %	9.23	10.26	11.29	12.32
ME(Kcal/kg	2,802.31	2,766.16	2,730.02	2,693.87

MM= maize meal, CPM=Cassava peel meal, ME= Metabolizable energy, $^{+}$ Each 1 kg of vitamin/mineral premix manufactured by BEAUTS Co. Inc. Man, U.S.A., contains Vitamin A 220,000, Vitamin D 66,000, Vitamin E 44, 014; Vitamin K 88 mg; Vitamin B 12; 0.76 mg; Niacin 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 pp. ME = Metabolizable Energy

Blood Sampling and Determination of Haematological Variables

At the end of the 90thday of the study, when the animals were slaughtered for carcass analysis, blood was collected between 6-8am in the morning when the neck of the grasscutter was severed. Ten (10ml) each was collected from the animal. Five (5ml) of the blood was put in blood sample bottles containing 1mg ethylene-diamine-tetra acetic acid (EDTA) an anti-coagulant for haematology assay. Another 5ml of the blood was put in sterilized blood sample bottles, without anticoagulant, for serum biochemical assay. In order to isolate serum; the whole blood was put in a glass tube and allowed to stand for 2hours at room temperature to clot. The clotted blood was then placed in a centrifuge which spins the blood at a high speed for 10 minutes at the rate of 2000 rpm thereby causing the clot and the cellular parts of the blood to separate from the serum and sink to the bottom of the tube. The serum remained at the top of the tube and was collected for analysis. Serum is preferred for the estimation of the biochemical substances because many of these substances are present in different concentrations in the serum and the RBC and it is the concentration in the serum that changes in disease or abnormal condition, therefore aids in diagnosis [22].

Hematological indices determined were red blood cell count (RBC) or erythrocyte count using the improved Neubaer Haemocytometer method [23], white blood cell count (WBC) or leucocyte count using the method of [24], Haematocrit or packed cell volume (PCV) using Win Trobe'sMicro haematocrit method [25] and haemoglobin (Hb) using Cyan methaemoglobin method [25]; others such as the Mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were determined using the procedure outlined by [23],

$$MCV = \frac{PVCX10}{RBC} \text{ fenolitre (fl)}$$

$$MCH = \frac{HbX\ 10}{RBC} \text{ Picogram (pg)}$$

$$MCHC = \frac{HbX100}{PCV} \text{ gram per decilitre (gm/dl)}$$

A second set of tubesfree of anticoagulant was used to collect blood samples for serum biochemical analysis. The blood was allowed to clot to obtain Serum by allowing the blood sample to stand for 2 hours at room temperature, and centrifuged using the High Speed Wintrobes Micro haematocrit for 10 minutes at 2000 rpm to separate the cells from the serum. Serum is preferred for estimation of biochemical substances because many of these substances are present in difference concentrations in the serum and the RBC and it is the concentration in the serum which changes in disease or abnormal conditions, and therefore aids in diagnosis.

Serum protein, globulin and urea were analysed using Sigma Kids, serum glucose was estimated by the method described by [27]and Cholesterol was determined using an automatic device (HITACHI 902).

Chemical Assay

The proximate chemical composition of sun dried cassava peel meal and major ingredients and the proximate composition of the formulated experimental diets was done using the [21] methods.

Experimental design and data analysis

A completely randomized design was used for the study. All data obtained were subjected to one way Analysis of variance (ANOVA) using [28]. Where significant differences occurred, means were separated using Fisher's least significant difference (LSD) as contained in the statistical package.

III. RESULTS AND DISCUSSION

Proximate composition of the test ingredients and the formulated experimental diets.

The results of proximate composition of cassava peel meal, maize, full-fat-soya bean, rice offal and palm kernel cake recorded in this study showed comparable values in crude protein, crude fibre, ether extract, ash, and Nitrogen free extract with values by [29], [30] and [7]. Cassava peel meal from the results has lower protein and higher fibre content than maize, hence the need to fortify cassava peel meal diets with additional protein sources to meet up their dietary requirements. The crude protein content of diets (15-16 percent) was within the recommended level of 16-18 percent for weaner rabbits under tropical conditions, as recommended by [31], [32]. The crude fibre level ranged from approximately 14-16 percent and similar to the 14 percent reported by [33]. The energy content of diets ranged from 2,438-2,822 kcal/kg. The energy content decreased with increasing levels of cassava peel meal in the diets. The energy content was slightly higher than the recommended level of 2400 kcal/kg [33]. There was, however, no evidence of harmful effects on the rabbits. As slight excesses of energy have been reported to cause no deleterious effects on rabbits, except for extra deposition of fats [34]. The Proximate composition of the formulated experimental diets is presented in table 3.

Table 3: Proximate composition of the formulated experimental diets.

Parameters%	T1 100 MM 0 CPM	T2 75 MM 25 CPM	T3 50 MM 50 CPM	T4 25 MM 75 CPM
Moisture	8.20	10.50	12.30	13.00
Dry matter	91.80	89.50	89.70	87.00
Crude protein	14.78	14.39	14.00	13.62
Crude fibre	9.03	10.06	11.09	12.12
Ether extract	4.15	4.22	4.88	5.10
Ash	2.08	6.50	6.88	7.00
NFE	61.76	54.33	50.85	49.16
ME(Kcal/kg)	3,075.49	2,802.97	2,718.46	2,662.22

CPM: Cassava Peel Meal, MM: Maize meal, NFE: Nitrogen Free Extract; ME(/kcal/kg), calculated from Pauzenga equation (1985) :ME= (37 X %CP)+(81 X %EE)+(35 X %NFE)

Haematological indices

Haematological indices of rabbits fed diets containing cassava peel meal as substitute for maize as energy source is presented in Table 4. The effect of the experimental diet on Red blood cell count (RBC), Haemoglobin concentration (Hb) and Packed Cell Volume (PCV) was significant ($p<0.05$). RBC was highest ($9.67x10^6$/µl) inrabbits fed T_4 diet and lowest ($6.70x10^6$/µl) inrabbits fed T_5 diet whilerabbits fed T_1, T_2 and T_3 diets werenot statistically different ($p>0.05$). Hb count was not statisticallydifferent ($p>0.05$)fromrabbits fed T_1 and T_4 diets and had the highest Hb count of 12.97g/dl and 13.57g/dl respectively whilerabbits fed T_5diet had the least Hb count of 10.00g/dl. PCV was also statistically not different ($p>0.05$) betweenrabbits fed T_1, T_2 and T_4 diets and had the highest values of 39.00%, 35.67% and 40.67% respectively whilerabbits fed T_5 diet had the lowest PCVvalue of 26.67%. White blood cell count (WBC) and Mean Corpuscular Volume (MCV) were not significantly affected ($p>0.05$). Numerically WBC was highest ($4.40x10^3$µl) inrabbits fed T_1 diet and lowest inrabbits fed T_5 diet ($2.43x\ 10^3$/µl). MCV was also highest ($50.00x10^{15}$/fl) inrabbits fed T_1 diet and lowest ($38.27x10^{15}$/fl) inrabbits fed T_3 diet.

TABLE 4: Haematological indices of Rabbits fed diets containing cassava peel meal as substitute for maize as energy source

Parameters	T1 100 MM 0 CPM	T2 75 MM 25 CPM	T3 50 MM 50 CPM	T4 25 MM 75 CPM	NRV	SEM
RBC $x10^6$/µl	7.87^{ab}	7.80^{ab}	8.77^{ab}	9.67^{a}	3.70-7.50	0.76
WBC $x10^3$/µl	4.40	3.93	2.73	3.47	5.20-16.5	11.86
Hb g/dl	12.97^{a}	11.87^{ab}	11.10^{ab}	13.53^{a}	11.6-14.5	0.90
PCV %	39.00^{a}	35.67^{a}	33.33^{ab}	40.67^{a}	26.7-47.2	2.61
MCV $x10^{15}$/fl	50.00	46.00	38.27	42.23	58.0-76.6	4.85
MCH (Pg)	25.65	25.35	25.50	25.90	25.85	0.42
MCHC(g/dl)	28.35	28.20	29.20	28.10	28.45	0.39

[abc] Mean on the same row with different superscripts are significantly different ($p<0.05$), SEM = Standard Error of Mean, *= Significant difference ($p<0.05$), NRV = Normal Reference Value, RBC = Red blood cell count, WBC = White blood cell count, Hb = Haemoglobin concentration, PCV = Packed Cell Volume, MCV = Mean Corpuscular Volume.

4.4.2**: Serum biochemical indices of Rabbits fed diets containing cassava peel meal as substitute for maize as energy source**

Serum biochemical variables of rabbits fed diets containing cassava peel meal as substitute for maize as energy source is presented in Table 5. Significant difference ($p<0.05$) was observed in total protein, urea and cholesterol. Total protein was highest (7.27g/dl) inrabbits fed T_2diet whilerabbits fed T_1 had the least total protein of 5.00g/dl. Globulin was not significantly ($P>0.05$) different, the highest value was on rabbits fed T_1 diet while the least was on rabbit fed the control diet. However, urea was lowest (29.90 mg/dl) inrabbits fed T_1diet and was highest (40.57mg/dl) in rabbits fed T_4 diet and it was significantly ($p<0.05$) different. Rabbits fed T_1 diet had the highest (54.43mg/dl) glucose whilerabbits fed T_4 diet had the least (48.20 mg/dl) glucose level. Cholesterol was highest (89.23mg/dl) inrabbits fed T_4 diet and was lowest inrabbits fed T_1 diet (79.05 mg/dl). There was also no significant difference ($p>0.05$) in globulin, glucose and albumin. Rabbits fed T_2 diet had the highest albumin of 3.73 mg/dl whilerabbits fed T_1 diet had the lowest albumin of 2.67mg/dl.

Table 5. Serum biochemical indices of Rabbits fed diets containing cassava peel meal as substitute for maize as energy source

Parameters	T1 100 MM 0 CPM	T2 75 MM 25 CPM	T3 50 MM 50 CPM	T4 25 MM 75 CPM	NRV	SEM
Total Protein (g/dl)	5.00[b]	7.27[a]	7.73[a]	5.33[b]	5.30-6.00	0.35
Globulin (mg/dl)	3.37	4.20	4.17	3.63	-	1.40
Urea (mg/dl)	29.93[b]	40.20[ab]	40.17[ab]	40.57[ab]	30.0-37.30	3.50
Glucose (mg/dl)	54.43	54.33	48.20	51.40	65.3-74.80	8.43
Cholesterol (mg/dl)	79.07[b]	83.46[ab]	85.18[ab]	86.19[ab]	77.9-134.4	2.66
Albumin (mg/dl)	2.67	2.73	3.57	2.70	2.40-6.10	0.73

[abc] Mean on the same row with different superscripts are significantly different ($p<0.05$), SEM = Standard Error of Mean, NRV = Normal Reference range.

IV. DISCUSSION

Proximate composition of experimental diets

The dry matter content range of 90.82-92.46% are in agreement with 90.00-93.27% reported by [35]. The crude protein levels in the experimental diets were within the range of 16.00-18.38% and similar to16-18.00% [36] and in line with 15-19% [37] which have been found as being the best for rabbit's performance base on feed intake, weight gain and feed conversion (FCR) in the tropical environment. The ether extract range of 6.98-11.88% was higher than 2.40-4.00% reported by [38]. The ash levels in the experimental diets 7.85-8.99% were within the range reported by [39]. The crude fibre levels of the experimental diets range from 9.84-12.05 and similar to 11.0-15% reported by [40] as being adequate for normal growth and to reduce incidences of gastroenteritis. The nitrogen free extract which represent the readily available carbohydrate are also within the range reported for rabbits [39]. The Metabolizable energy in this study is within the range of 2642.48-2954.14kcal/kg recommended by [41].

The RBC values of 6.70 to 9.67 x 10^6µl obtained in this study was higher than the normal reference values of 3.7 to 7.5x106µl, reported by[42]. The higher values may be an indication that the sun-dried CPM had some detrimental effect on the RBC of the rabbits. The WBC in this study (2.43 to 4.40 x10^3µl) were below the normal reference range of 5.2 to 16.5 x 10^3µl [42] for normal rabbits, this may be an indication that the incorporation of sun-dried CPM in the diets suppress haemopoietic tissue, hence inadequate WBC were produce [43]. However the effect of inadequate WBC did not occur as the rabbits were healthy throughout the experimental period and no motility was recorded. Haemoglobin values of (10.00 to 13.53g/dl) were recorded in this study. Hb of rabbits in the control and the test diets were within the range of (11 to 14.5g/dl) reported by [44] for normal rabbits. This may be suggested that, the utilization of sun-dried CPM in rabbit diet did not impair nutrient availability in the diets such that would cause anaemic condition and that protein intake was adequate. The PCV values of (26.67-40.67%) obtained in this study are within the normal range of (26.7-47.2%)

reported by [42] for normal rabbits. It thus means that, the nutritional adequacy of the diet was maintained despite the partial replacement of maize with sun-dried CPM in the diet.

The MCV values obtained in this study varied from 38.27 to 50.00x10^{15}/fl. They were observed to be lower than the normal reference range of (58.0 to 76x10^{15}/fl) reported by [42] for normal rabbits. The MCV values in this study were below normal range. [45] reported that reduction or abnormal values of haematology indices may indicate a low protein intake, liver damage, anaemia or parasitological infestation.

The MCH and MCHC are respectively defined as the contained amount of haemoglobin in a red blood cell and average concentration of haemoglobin in the cells. They are related to haematocrit and red blood cell count so they occupied volume by them in a specified volume of blood. This reflects their change when the volume of blood sample is increased. Other factors such as stress, explains modification of both haematological parameters. Grasscutters, according to some studies, are very sensitive animals to the environment so their haematological studies can vary [43]. Normal values of Hb, PCV, RBC, MCH, MCV and MCHC could be related to nutritional adequacy and safety of the test ingredients [44]. Lindsay [44] 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 with mineral and vitamins supplementation.

The total protein in this study varied from 5.00g/dl to 7.27g/d and it is in agreement with the normal reference value (5.3 to 6.0g/dl) reported by [44] for rabbits. However, rabbits in 0, 10 and 20% diet had abnormal values from the range, this may imply that the rabbits were under thermal stress thus there was deviation in total serum protein. [46] reported that thermal stress causes an increase in adrenal activity resulting in increase or decrease turnover which leads to change in total serum protein. Sun-dried CPM at 10% and 20% inclusion must have helped in the reduction of internal thermal stress which helped in osmotic balance between the circulatory blood and tissues space. Total protein concentration is a measure of the quality of the diet consumed by livestock. Thus from the performance of the rabbits it can be inferred that the various experimental diet contains adequate nutrients for the healthy growth of growing rabbits.

The globulin values obtained ranged from 3.37 to 4.20g/dl. The serum globulin values of the control group were 3.37g/dl and it was in line with the globulin for rabbits fed the sun-dried CPM base diets since they did not differ ($P>0.05$) significantly from different levels of the test ingredients. This may be an indication that the sun-dried CPM in the diet did not adversely affect the nutritional status of the experimental diets.

The range of serum urea nitrogen of 29.93 to 40.57 mg/dl in this study were higher except for the control that was approximately similar with the reference value of [47]. Thevalues obtained in this study were lower than the values range of 45.7 to 68.9mg/dl [44] and 81-250mg/dl [42]. Abnormal level of serum urea is an indication of the quality of protein fed. Urea is a function of protein quality, and high urea indicates low protein quality fed [48]. Since urea was highest in T_4 with the inclusion level of 30%, it may be suggested that sun-dried CPM increase the level of urea in rabbit diet.

Glucose levels of 48.20 to 54.40 mg/dl in this study are lower than 65.3 to 74.8mg/dl reported by [47], and 63.83 to 82.93mg/dl recently reported by [49]. It was observed that, there was no significant different in the glucose levels as higher levels of sun-dried CPM was partially replacing maize in the diet but numerically there was a reduction in glucose concentration across the treatments. This showed a tendency towards hypoglycaemic condition. Hypoglycaemia implies low blood glucose levels which in extreme cases results to death. Low blood glucose levels in rabbit could also occur due to anorexia starvation and disturbance in digestion [47], probably due to higher temperature. However, the abnormal range of serum glucose level obtained for rabbits in this study indicate that, the rabbit were probably suffering from anorexia and disturbance in digestion due to high environmental temperature as at the time of the experiment since it was in the dry season (February to May).

The serum cholesterol obtained varied from 79.07 to 86.19 mg/dl, and were within normal reference values of 77.9 to 134.4mg/dl [44]. The study revealed that the inclusion of sun-dried CPM in rabbit diet increase the serum cholesterol as the level of maize cobs meal increase. The experimental rabbits were not vulnerable to coronary condition which may result to ill health when the serum cholesterol is high, since values obtained were within the normal reference value. The serum albumin values of 2.67 to 3.73 mg/dl obtained in this study are also within the normal range of 2.4 to 6.1g/dl [44], thus, replacing maize with sun-dried CPM in the diet did not adversely affect the nutrient quality of the experimental diet. It was generally observed in this study the inclusion level 50:50% maize: sun-dried CPM had the best performance in terms of the quality of nutrients that were available for the rabbits.

V. CONCLUSION

The proximate content of the test ingredient revealed that sun-dried cassava peel meal did not interfere with nutrients by rabbits since dietary fibre can act by changing the nature of the contents of the gastrointestinal tract and by changing how other nutrients are absorbed.

The values of haematology and serum biochemistry were comparable with the normal reference values, an indication of nutritional adequacy and safety of the experimental diets. The rabbits were able to meet their nutrient requirements for tissue accretion, since the test ingredient did not contain phytochemicals which are known to reduce protein and specific amino-acids utilization as well as minerals and other nutrients.

Finally,the results as shown above indicate that the sun-dried CPM meal can serve as an alternative energy source in rabbitfeed, without any adverse effects on the haematological and biochemical indices of the rabbits.It can therefore be concluded that sun-dried CPM can be included in growing rabbit diets up to 50% as a source of energy.

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