ANTINUTIONAL FACTORS AND RESPONSE OF GROWING RABBITS FED YAM-CASSAVA PEEL COMPOSITE MEAL AS REPLACEMENT FOR MAIZE ON INTERNAL ORGANS HISTOLOGY

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ABSTRACT

A study was carried out to investigate the effect of dietary replacement of maize with yam-cassava peel composite meal on growth performance, carcass traits and blood profile of rabbits in 84-days (12 weeks) feeding trial. Thirty six weaner rabbits of mixed sex, strain and average initial weight of 500.89g were randomly allotted to six dietary treatments according to live weight in a Complete Randomized Design (CRD). The six dietary treatments were formulated such that, Diet 1 (T1) contained maize and the proportion of maize in diet 1 (T1) was replaced with soaked and sundried yam-cassava peel composite meal (YCPCM) in a ratio of 6:1 at 20, 40, 60, 80 and 100% in diet 2(T2), 3(T3), 4(T4), 5(T5) and 6(T6) respectively. Weighed amounts of feed were served every morning while fresh, cool and clean drinking water was provided ad-libitum throughout the experimental feeding period. Routine management practices were strictly carried out. Results of the phytochemicals and anti-nutritional factors (ANFs) analysis of YCPCM revealed the presence of oxalates (5.58 mgkg-1), phytate (1.39 %), alkaloid (0.42 %), flavenoid (1.70 %), saponin (1.60 %) phenolics (0.16 %) and cyanides (7.56mgkg-1).Histological results of this study revealed none, mild/moderate and significant lesions/necrosis in some of the selected internal organs evaluated. This suggests that, inclusion of 100%YCPCM in diets of growing rabbits has no adverse deleterious effect on serum biochemical indices and histological parameters of growing rabbits.

KEYWORDS

Yam-Cassava peel meal, antinutritional factors, histology, growing rabbits

1. DESCRIPTION OF PROBLEM

Researchers have shown that, low level of animal protein intake by Nigerians has generated concern as it affects both the physical and mental development of youths and labour force in Nigeria. One way of solving this problem is by focusing on production of animals with high rate of growth and production and one of such animals is rabbit (Akinmutimi and Onen, 2008; Uchewa *et al.,* 2014). Rabbit meat is known to contain high quality and quantity of protein (20.8%), less fat (10.2%) than other meat species. It is also low in energy, sodium, cholesterol levels and is bereft of cultural bias (Akinmutimi and Anakebe 2008; Iyeghe-Erakpotobor, 2009; Amy, 2010; Gbenge *et al.*, 2021). It has high proportion of polyunsaturated linoleic and linolenic fatty acids (Njidda and Isidahomen, 2011, Gbenge and Ikurior, 2019).

In spite of these advantages, the major hindrance to the production of these animals to satisfy the required protein needs of most Nigerians has been attributed to high cost of production of which feed cost is highly significant (Ekpo *et al.,* 2015; Garba and Mohammed, 2015; Mohammed *et* *al*., 2015; Gbenge *et al.*, 2021). This has been attributed to escalating prices of conventional feed ingredients especially the energy sources such as maize, sorghum etc. (Akinmutimi, 2006; Akinmutimi and Anakebe, 2008; Garba and Mohammed, 2015).

Yam and cassava peels which represent unutilized energy sources are readily available at free or cheap costs in many parts of the country (Haln and Keyser, 1985; FAO, 2001; Oluremi and Nwosu, 2002; Akinmutimi *et al*., 2006; IITA, 2014; Gbenge *et al.*, 2021). However, the use of cassava and yam peels in animal feed is hampered by certain limitations, the prussic acid (HCN) and high fiber in cassava peels and anti-nutritional factors in cassava and yam peels limit its utilization by human and livestock (Oluremi and Nwosu, 2002; Aro *et al*., 2010; Oloruntola *et al*., 2016; Yusuf *et al.*, 2017; Gbenge *et al.*, 2021). Thus, appropriate treatment of non-conventional feedstuff such as yam and cassava peels is required to improve their utilization and thus better the health, productivity and profitability of farm animals (Tuleun *et al.,* 2011; Gbenge *et al.*, 2021). This study was therefore aimed at evaluating the potential use of water soaked yam and cassava peel composite meal in rabbit diets and its effect on serum biochemistry and internal organs histology of growing rabbits

2. Materials and Methods

2.1. Experimental Site and Location

The experiment will be conducted at the Rabbit Unit of the Livestock Teaching and Research Farm, College of Animal Science, Joseph Sarwuan Tarka University Makurdi, Benue State, Nigeria. Makurdi is located between latitude 17^{o}14'N and longitude 8^{o} 21'E in the Guinea Savanna Zone of West Africa. It has a tropical climate with distinctive wet and dry season (TAC, 2011). The area has an annual rainfall of 6-8 months (March – October) with rainfall ranging from 508 to 1016 mm with a minimum temperature range of 24.20 ± 1.4^{0}C and maximum temperature range of 36.33 ± 3.70^{0}C. The relative humidity ranges between 39.50 ± 2.20% and 64.00 ± 4.80% and between 00mm to 100mm above sea level (TAC, 2011).

2.2. Test Ingredients (Yam and Cassava Peel) Collection and Preparation

The test ingredients, fresh yam (*Dioscorea spp*) and cassava (*Manihot spp*) peels were collected from fast food and garri processing joints within Makurdi Metropolis and it environ. The freshly collected yam and cassava peels were thoroughly wash to removed sand and other unwanted materials and soaked for twelve hours (12 hrs) in cool and clean water according to Olurotimi *et al*. (2012), Ajuonuma and Uchendu (2013), Oloruntola *et al*. (2016) and Gbenge *et al.* (2021).

The soaked yam and cassava peels were immediately removed after twelve hours of soaking, drained with a basket and subsequently sun-dried on concrete platforms for 5-7 days depending on the prevailing weather condition to attain less than 10% moisture, prevent deterioration, reduced enzymatic and microbial reactions, nutrient leaching and other forms of spoilage. These was also aimed at enhancing it crispness and to reduced the effect of anti-nutritional factors such as hydrocyanide, trypsin inhibitor, tannin, saponin, oxalate and phytate presence in yam and cassava peels (Uchewa *et al.,* 2014; Oloruntola *et al*., 2016).The soaked and sun-dried yam and cassava peel were turned two-to-three (2-3) times per day to ensure uniformity of dryness and the dried peels were pack and store in polythene bags. The peels were then be milled to obtain yam peel meal and cassava peel meal which was later mixed with other feed ingredients to produce the experimental diets.

2.3. Experimental Design and Management of Animals

A total of thirty six weaner rabbits of mixed sex and strain (Dutch, Chinchilla, Flemish giant, California brown and Newzea land) and aged (4-7 weeks) were obtained from local farms within Makurdi town and used for the study. The initial live weights of the rabbits ranged from 336 - 701g. They were randomly allotted to six dietary treatments according to live weights with six rabbits per treatment in a complete randomized design (CRD). Each treatment was replicated six times with one rabbit per replicate. The animals were individually housed in cages (60x60x45cm). Each cage was supplied with a drinker and plastic feeder, both of which were firmly fixed to prevent being tipped over during feeding and water intake. Prior to commencement of the experiment, the cages were well cleaned and disinfected with saponated creso (Izal) and allowed to dry for seven (7) days before the rabbits were introduced therein. The rabbits were condition for seven days (7) to facilitate adaptation and to acclimatize the new environment before commencement of the experiment. During this period, they were fed commercial ration (grower's mash) and water *ad-libitum.*The rabbits were treated against external and internal parasites by subcutaneous injection of ivomectin at 0.2ml per rabbit prior to commencement of the experiment. A broad spectrum antibiotic (water soluble powder) and protective, absorbent anti-diarrhoea (dry suspension) were used in drinking water against bacterial infection.

2.4. Experimental Feed Ingredients, Diets and Feeding

Ingredients and nutrient composition of each dietary treatment is shown in Table 1. Six dietary treatments were designated as T_1, T_2, T_3, T_4, T_5 and T_6. The six dietary treatments were formulated such that, diet 1 (T_1) served as control with maize as the major energy source. The proportion of maize in diet 1 (T_1) was replaced with soaked and sun-dried yam and cassava peel meal mix in a ratio of 6:1 in diet 2 (T_2), 3 (T_3), 4 (T_4), 5 (T_5) and 6 (T_6) at 20, 40, 60, 80 and 100% respectively. Weighed feeds (100g) were served to the experimental animals every morning with fresh, cool and clean drinking water *ad-libitum*.

Table 1: Percentage Ingredients and Calculatede Nutrient Composition of Each Dietary Treatment

Paramenters	Experimental diets					
	T_1 (Control)	T_2 20%YCPCM	T_3 40%YCPCM	T_4 60%YCPCM	T_5 80%YCPCM	T_6 100%YCPCM
White maize	40.63	32.50	24.38	16.25	8.13	-
Yam peel meal	-	6.97	13.93	20.90	27.86	34.83
Cassava peel meal	-	1.16	2.32	3.48	4.64	5.80
Fullfat soya bean meal	14.37	14.37	14.37	14.37	14.37	14.37
Groundnut cake	12.00	12.00	12.00	12.00	12.00	12.00
Rice husk	25.00	25.00	25.00	25.00	25.00	25.00
Brewers dry grains	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Premix*	0.25	0.25	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25	0.25	0.25
Coccidiostat[a]	+	+	+	+	+	+
Total	100	100	100	100	100	100
Calculated analysis						
Crude protein (%)	16.49	16.46	16.44	16.42	16.39	16.37
Crude fibre (%)	12.53	12.99	13.45	13.91	14.37	14.83
Lysine (%)	0.70	0.69	0.67	0.65	0.63	0.61
Methionine (%)	0.24	0.22	0.21	0.20	0.18	0.17
Calcium (%)	1.13	1.13	1.14	1.14	1.14	1.14
Available P. (%)	0.64	0.63	0.63	0.62	0.62	0.61
ME (kcal/kg)	2615.62	2581.54	2547.51	2523.63	2479.39	2445.32

**To provide the following per kg of diet; vitamin A – 15,000.00IU, Vitamin D3 - 3, 000,000IU, Vitamin E-30,000IU, Vitamin K – 3,000mgVitamin B1 3000,mg Vitamin B2-6000mg, Vitamin B- 5,000mg, Vitamin B12-40mg, Biotin 200mg, Niacin-40,000mg, Pantothenic acid 15,000mg,Folic acid 2,000mg, choline 300,000mg,Iron 60,000mg, manganese 80,000mg, copper 25,000mg,Zinc 80,000mg cobalt 150mg, iodine 500mg,selenium 310mg, Antioxidant 20,000mg.*

[a(+)]Administered in water at 0.5g/l per rabbit (weekly) to prevent intestinal coccidiosis

YCPM=Yam-cassava Peel Meal and P.=Phosphorus

2.5. Data Collection and Analysis

2.5.1. Phytochemicals and Antinutritional Factors (ANFs) Screening of the Test Ingredient

Samples of soaked and sun-dried yam and cassava peels were screened for quantitative presence of phytochemicals and anti-nutritional factors (ANFs) such as oxalate, tannin, saponin, phytate, alkaloid, flavanoid and hydrocyanide using standard methods (AOAC, 1990; Obadoni and Ochuko, 2000; Onwuka, 2005; Lawal *et al.*, 2014) at the Animal Feed Research and Quality Control Laboratory, Ogun State.

2.5.2. Histopathological Evaluation of Some Selected Internal Organs

At the end of the experimental period, two (2) rabbits per treatment replicate from the four (4) rabbits selected for carcass evaluation were randomly selected and eviscerated for histopathological evaluation. The selected visceral organs such as lungs, spleen, liver, heart and kidney were carefully dissected out. The histological slide preparations were done using a standard procedure. Samples of the selected visceral organs were carefully cut and immediately fixed in 10% formalin solution for a week. The samples were washed in 25, 50, 75 and 100% alcohol for two (2) hours each to remove water (dehydration). It was transferred into xylene solution to get rid of the alcohol (clearing) and then infiltrated with paraffin wax and embedding media in an enclosure called mould (Amao, 2009). The embedded tissues were left until hardened blocks were formed. Sectioning was done using a microtome to cut only the original tissue at a preset thickness of 5µ thickness using standard procedures (Luna, 1968; Humason, 1972). Each section was stained with haematoxylin and eosin (H&E) and examined with a light microscope as described by Zahid *et al.* (2002). The slides were mounted on a microscope for histological examination. The slides were read for histological indicators in order to observe possible degenerative changes on the lungs, spleen, liver, heart and kidney structure using a microscope connected to a computer system. The slides were captured and printed for interpretation.

2.6. Statistical Analysis

All data collected were subjected to one way analysis of variance (ANOVA) using SAS (2008). Where ANOVA indicate significance difference between treatment effects, mean were separated using Duncan new multiple range test (Steel and Torrie, 1990). All statements of significance were based on 5% level of probability ($p<0.05$).

3. RESULTS

3.1. Phytochemicals and Anti-nutritional Factors (ANFs) Composition of Test Ingredient (Yam-Cassava Peel Composite Meal)

Table 2 present results of the photochemicals and anti-nutritional factors of the test ingredient. Result of the study revealed the quantification of phytochemicals and antinutritional factors presence of yam cassava peel meal sample in concentration of 0.42 % (alkaloid), 1.70 % (flavanoid), 1.60 % (Saponin), 0.16 % (Phenolics), 5.58 mg/g (oxalate), 1.39% (phytate) and (7.56mg/kg (cyanide) Tannins were absent in yam cassava peel meal sample analyzed.

3.2. Histopathology Some Selected Internal Organs of Growing Rabbits Fed Experimental Diets

The results of histopathological examination of some selected internal organs (lung, spleen, liver, heart and kidney) of growing rabbits fed varied levels of dietary YCPCM revealed different levels of lesions/necrosis done on internal organs of growing rabbits by each dietary treatment. The degree or level of lesions/necrosis observed from internal organs of growing rabbits were rated none, mild/moderate and significant lesion or necrosis in respect to the total number of animals used for the analysis per dietary treatment as presented in Table 3.

Table 2: Phytochemicals and Anti-nutritional Factors (ANFs) of Test Ingredient (YCPCM)

Parameters	Yam-Cassava Peel Composite Meal (YCPM)
Flavanoid (%)	1.70
Alkaloid (%)	0.42
Saponin (%)	1.60
Tannin (%)	0.00
Oxalate (mg/g)	5.58
Phytate (%)	1.39
Cyanide (mg/kg)	7.56
Phenolics (%)	0.16

Source: Laboratory Analysis, 2022

Table 3: Histopathology of Some Selected Internal Organs of Growing Rabbits Fed Experimental Diets Containing Graded Levels of YCPCM

	Experimental Diets					
Parameters	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**
No. of rabbits	2	2	2	2	2	2
Lungs (Lg)	NH/NSL	H/NSL	H/NSL	H/NSL	H/NSL	H/NSL
Spleen (Sp)	MSL/NH	MSL/NH	MSL/NH	MSL/NH	MSL/NH	MSL/NH
Heart (Ht)	MSL/NH	MSL/H	NSL/H	MSL/NH	MSL/H	MSL/NH
Liver (Lv)	SL/NH	MSL/NH	MSL/NH	MSL/NH	SL/NH	SL/NH
Kidney (Kd)	SL/H	SL/NH	SL/NH	NSL/NH	MSL/H	MSL/H

H= Hemorrhage, NH= No hemorrhage, SL= Significant lesion or necrosis, NSL= No/None significant lesion or necrosis and MLS= Mild/Moderate significant lesion or necrosis, T_1= Control diet containing 0%YCPCM, T_2= Diet containing 20%YCPCM, T_3= Diet containing 40%YCPCM, T_4= Diet containing 60%YCPCM, T_5= Diet containing 80%YCPCM, T_6= Diet containing 100%YCPCM, YCPCM = Soaked and Sundried Yam-Cassava Peel Composite Meal

4. DISCUSSION

4.1. Phytochemicals and Anti-nutritional Factors (ANFs) of the Test Ingredient (YCPCM)

Results of this study revealed the presence of various medically important phytochemicals in yam-cassava peel composite meal (YCPCM) and anti-nutritive factors (ANFs) such as flavonoids, alkaloid, saponins, oxalates, phytate, phenolics and hydrocyanide (HCN). Cordell *et al.* (2001) opined that, alkaloids and flavonoids are responsible for the antifungal activities in higher plants. Flavonoids have also been reported to function as pigments and can inhibit enzymes in mammals (Kumar 1991; Hollman 1997). The presence of flavonoids in yam-cassava peel meal suggest the ability of this by-product to play an important role in preventing disorders associated with oxidative stress (Eleazu *et al*. 2013; Lawal *et al*., 2014). Although, the alkaloid content of yam peel meal (0.42 %) in this present study is lower, comparably with alkaloids content of some medicinal plants however, its presence in the sample make it recommendable for patients as alkaloids possess a significant pharmacological property (Lawal *et al*., 2014).

The saponin level of 1.60 % in this present study fall within the 3% safe range reported by Anhwange *et al.* (2009) but lower than 2.78±0.01% of yam peel meals but higher than the 0.76±0.00% of cassava peels meal as opined by Ukanwoko and Nwachukwu (2017). The saponin content of the peel meal was observed to be appreciably below 3% which was reported by Kumar (1991) to be responsible for cattle losses when grazed on alfonibrilla and thus, may not be hazardous to livestock thereby making it safe for consumption. The presence of this phytochemical in yam cassava peel meal is an indication that, this by-product can be given to expectant animals (gestating animals) and those that deliver without the expulsion of their placenta (Lawal *et al.,* 2014). The absence of tannins in yam cassava peel meal agreed with the early studies of Tijjani *et al.* (2009) and Lawal *et al.,* (2014) which also found that, not all antinitritional factors are present in all plants.

The Oxalate level of yam peel meal (5.58 mg/g) found in this study is above the 3% safe range report by Anhwange *et al.* (2009) as compared to 1.26 and 1.04% earlier report of Akinmutimi and Anakebe, (2008) for yam peel meal and Sweet potato peel meal and 0.024% by Oluremi *et al*. (2007) for orange peel meal and 0.028± 0.01g/100g reported by Lawal *et al.* (2014) for yam peel meal. In this study, the observed phytic acid value of 1.39% is comparably higher than 0.94 and 0.740% early reports of Akinmutimi and Anakebe (2008) for yam peel and sweet potato peel and 0.36± 0.00g/100g for yam peel reported by Lawal *et al.* (2014) but within the 3% safe range reported by Anhwange *et al.* (2009). It is apparently opined by Oluremi *et al*. (2007) that, phytate content within the safe range of recommendation is safe for consumption by livestock.

The cyanide level of 7.56 mg/kg in the present study seems to be relatively lower than the 5% Levels of cyanide reported by Olomu (1995) to be harmless and non-toxic to humans and animals however, it is below the cyanide level (0.02 g/kg or 20 mg/kg) of the cassava peels opined by Oloruntola *et al*. (2019). However, the cyanide level of this present study was found to be higher than the earlier report of 1.06+0.01g/100g for yam peel by Lawal *et al*. (2014) but lower than the report of 24.80mg/kg and 11.33mg/kg for unsoaked and five hours soaked and sundried cassava peel meal (Oluremi and Nwosu, 2002), 45-150mg/kg report of Tewe *et al*. (1976) and 46.44mg/kg, 55.21mg/kg, 21.62mg/kg and 16.88 mg/kg obtained by Unigwe *et al.* (2017) in boiled, sundried, ensiled and fermented cassava peel meal. Olurotimi *et al.* (2012) also reported higher values of 71.10, 16.54, 29.92 and 9.81mg/kg of HCN in cassava peel meal than the present study using different processing methods (unprocessed, sundried, ensiled and retted). The 0.16% phenol of this study is comparable with the reported values of 0.15% but lower than 0.33% reports of Yusuf *et al.* (2017) for yam peels and sweet potato peels. However, this content is significantly lower than the reported values of Salawu *et al.* (2015) in different skin colours of sweet potato peels. The phenolic content of YCPCM may have been contributed directly link to anti-oxidative action as opined by Salawu *et al.* (2015).

It is established that, only high content of these anti-nutrients prevent the absorption of mineral like iron, magnesium, potassium and calcium which are essential for metabolism in the body (Lawal *et al*., 2014). Reduction of anti-nutrients in foods may be necessary especially when their levels are higher than those generally regarded as safe for human consumption. This can be accomplished through different hydrothermal treatments of feedstuffs which also enhances the nutritional qualities, increase palatability and digestibility of foods (Adeniji and Ehinmidu, 2007; Olurotimi *et al.*, 2012; Unigwe *et al*. (2017). Also, the presence of important phytochemicals in yam cassava peel meal (YCPCM) is an indication that, this by-product if properly screened could yield a drug of pharmaceutical significance.

4.2. Histological evaluation of Growing Rabbits fed Experimental diets

4.2.1. The Lung

The histopathological evaluation of lungs in growing rabbits fed experimental diets indicated that, there was adequate antioxidant defense in deactivating the effect of anti-nutritional factors (ANFs) of the experimental diets as evident in no bronchopulmonary dysplasia with no lung injury across all the dietary treatment groups as opined by Manzano *et al.* (2014). However, haemorrhage of the alveoli in this study may be attributed to the strangling ability of experimental animals during slaughtering as opined by Harcourt-Brown (2002) and Burnett *et al*. (2006).

4.2.2. The Spleen

Histological examination of the spleen of the experimental growing rabbits in this present study is adjudged by the inconsistent non-significant ($p>0.05$) decrease in serum enzyme of the experimental animals which posed no threat to lymphopoiesis and humoral immune responses of growing rabbits fed experimental diets as opined by Cesta (2006) and Rahmoun *et al*. (2019). This may probably be an indication that, the toxin produced by anti-nutritional factors of the experimental diets might be insignificant with a non significant (p>0.05) effect on the experimental animals. However, the present of mild/moderate lesions/necrosis observed in this present study on the spleen of experimental growing rabbits could be attributed to the presence of certain percentage of anti-nutritional factors of the experimental diets. This is in corroboration with the opined reports of Tolleson *et al*. (1996); Ewuola *et al*. (2003) and Ewuola (2009) who stated that, when a diet contain certain percentage of toxic substance such as anti-nutritional factors (anti-nutrients) or toxin (contaminant), the effect always result to histological damage to the body organ of the spleen.

4.2.3. The Heart

The heart is the pumping action of the body and results of this study on heart histological evaluation of growing rabbits fed experimental diets revealed mild/moderate significant lesions/necrosis across all the treatment groups with compensatory hypertrophy, poor striation and nuclear compromised in T1 and interruptive ischemia in T6. Result of this study also revealed the presence of myocardial hemorrhage at T2, T3 and T5 with no hemorrhage in T1, T4 and T6 which might be occasioned as a result of the strangling ability of experimental animals during slaughtering as opined by Harcourt-Brown (2002) and Burnett *et al*. (2006). Handling has been shown to cause physical exertion or tissue damage during blood collection/slaughtering (Harcourt-Brown, 2002). Result of this study on heart histology indicated that, there was no significant (P>0.05) difference between control diet and YCPCM based diets which also indicated that, the presence of anti-nutritional factors (ANFs) in the test ingredient (YCPCM) had no significant (P>0.05) influence on heart tissue damage since all the experimental treatment groups revealed presence of mild/moderate heart tissue lesions. Result of this study could be attributed to the effect of the experimental test ingredient (YCPCM) and it effectiveness in processing method since higher replacement levels of the experimental treatment groups showed certain levels of non/less heart abnormalities/dysfunction. This finding is somewhat similar to Domingo (1987) who reported no significant (P>0.05) absolute or relative histopathological differences in studied organs (brain, heart, lungs, kidney, liver and spleen) between the treated animals and controls in short-term exposure to aluminum.

4.2.4. The liver

Findings in this present study on liver histology of growing rabbits fed experimental diets indicated the presence of nuclear and hepatocyte necrosis in control diet (T1), hepatocytelysis evident by nuclear dumping in T2, sinusoidal fatty degeneration in T3, cellular degeneration in T4, hemosiderin and ferritin breakdown, liver cirrhosis and global hepatic lobular degeneration in T5, hepatocyte and hemosiderin deposit in T6. Result of these study on the presence of liver lesions could not be clearly attributed to the effect of the experimental test ingredient (YCPCM) and it ineffectiveness in processing method since all the experimental treatment groups (control diet and YCPCM based diets) showed certain levels of moderate/mild liver lesions/necrosis in one way or the other though, continuous or repeated exposure and subsequent accumulation of cyanide (toxin) in the body fluids, tissues and organs of the animals for a long period of time (chronic exposure) has been opined to predisposed animals to oxidative stress (Lei *et al*., 2017) and subsequently, caused negative effects on biological activities (Halliwell and Gutteridge, 1989; Oloruntola *et al.* 2018; Oloruntola *et al*., 2019). This might also be related to the metabolic rate of the liver is a detoxifying organ in attempt to reduce certain elements of anti-nutritional factors (Bone, 1979; Sese, 2014) thereby indicating the presence of lesions through detofication process.

Taylor *et al*. (2018) also noted that, an imbalance in hepatic lipid metabolism, deposition, or de novo synthesis promotes lipid buildup in hepatocytes as an initial stage of non-alcoholic fatty liver (NAFL). Result of this study on liver lesions may be attributed to an imbalance in hepatic lipid metabolism, deposition and syntheses as well as iron break breakdown deposition as opined by Taylor *et al*. (2018). Result of this study may also be attributed to the opined observed report of Close (1993) that, there is a reduction in energy intake with increased fibre intake in diets of monogastric animals which reduced both growth and energy utilization which may be associated with inbalance in hepatic lipid metabolism and iron breakdown in the liver. Result of this study might also be attributed to genetic and environmental factors as opined to contribute to lipid accumulation in the liver (Ioannou, 2016; Wree, 2013)

Although, histological diagnosis of the liver revealed that, there was no significant (P>0.05) clinical haemorrhage observed in all the treatment groups. Ismail and Elwan (2017) posited that, low and decreased levels of albumin are also found in chronic liver disease (cirrhosis), oedema and also nephritic syndrome where, it is lost in urine since intravascular oncotic pressure is higher than the pressure in extravascular space however, results of this study disagreed with the low and decreased levels of albumin concentrition with increased replacement levels. Result of this study corroborated with work of Sorbi *et al*. (1999) who revealed mean AST to ALT ratios of 0.7, 0.9 and 1.4 for rabbits with no fibrosis, mild fibrosis or cirrhosis respectively. This finding is concomitant with Domingo (1987) who reported that, there are no significant (P>0.05) absolute or relative histopathological differences in the studied organs (brain, heart, lungs, kidney, liver and spleen) between the treated animals and controls in short-term exposure to aluminum.

Also, Kupffer cells which appeared between the hepatocytes as spindle-shaped cells were more pronounced in the experimental test diets (YCPCM based diets) compared to control diet. These cells act as an effective particulate filtration system in the liver tissue to prevent bacteria and other foreign materials from penetrating the central vein to the systemic circulation. This is due mainly to the phagocytic activity of Kupffer cells as opined by Ismail and Elwan (2017) which might explain the better immunity of treated rabbits (YCPCM based diets) compared to growing rabbits on control diet in terms of higher plasma globulin level due to the effectiveness of the test ingredient (YCPCM). This study on histopathological finding of the liver showed a better preserved structural integrity of the liver tissues in tested diets (YCPCM based diets) than the control diet.

4.2.5. The Kidney

Kidney histological examination of growing rabbits revealed the presence of significant lesion/necrosis at T1, T2 and T3 with mild/moderate significant lesions/necrosis at T5 and T6 and non significant lesion/necrosis at T4. Result of this study on kidney lesions/necrosis could not be attributed to the effect of the experimental test ingredient (YCPCM) and it ineffectiveness in processing method since higher replacement levels of the experimental treatment groups showed certain levels of non/less kidney dysfunction/abnormalities. This finding is similar (at lower replacement levels of the test diets) but disagreed (at higher replacement levels of the test diets) with Domingo (1987) who reported that, there are no significant absolute or relative histopathological difference in the studied organs (brain, heart, lungs, kidney, liver and spleen) between the treated animals and controls in short-term exposure to aluminum.

Findings on histological examination of the kidney of the experimental rabbits adjudged the inconsistent non significant decrease in serum enzymes of the experimental animals. Animals on control diet, T2 and T3 showed more of kidney alterations (necrosis/lesions) which were diffused across the experimental diets with non alterations at T4 and less alterations at T5 and T6 respectively. This may probably be an indication that, the toxins produced by anti-nutritional factors (anti-nutrient) of the experimental diets with increased replacement levels were insignificant with a non significant effect on the experimental animals due to effective processed of the test ingredient (YCPCM) which maybe an indication of protein superiority (high quality) in YCPCM based diets as opined by Esonu *et al.* (2001) and Etim and Oguike (2011).

Result of this study might also be supported with none elevated blood creatinine adjudged as diagnostic of impaired renal function (Henry, 2001) and urea which is known to detect any abnormality of the kidney (Kamath *et al*., 2001). This is also ostensibly due to the biological activities of alkaloid and saponin presence in the test ingredient (YCPCM) which may have contributed to the enhancement of the experimental animal's health status, thus reconfirming the study of Mahato *et al.* (1988); Eleazu *et al*. (2013) and Lawal *et al*. (2014) who reported that, alkaloid and saponin in plant acted as therapeutic, antimicrobial, ant-inflammation and inhibiting factors thereby, performing anti-cytotoxic activities. Result of this study also corroborated with Shinkut *et al.* (2016) who reported a preserved structural integrity of the rabbit kidney (buck) with a decreased in serum enzyme of the experimental diets with an increased dietary replacement levels and Soetan *et al*. (2017) who reported an inconsistent decreased in rat enzymes with a preserved kidney integrity.

5. Conclusions and Recommendations

5.1. Conclusions

From the results obtained, it can be concluded that;

- The YCPCM is a good alternate feedstuff in replacing maize as energy source in diets of growing rabbits
- YCPCM used in this study had no deleterious effects on serum biochemical indices of the growing rabbits
- The use of YCPCM in this study did not have any major significant effect or degenerative changes on histological organs of growing rabbits evaluated

5.2. Recommendations

- Based on the conclusion drawn from the study, 100%YCPCM inclusion is recommended to rabbit farmers and nutritionists for normal health and physiological status of rabbits
- Further research is required to determine other appropriate processing methods of YCPCM that will enhance its potential as feed resource in growing rabbit's production

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