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Influence of Fermented Icacinia manni Meal on Growth Performance, Carcass, Internal Organs and Nutrient Digestibility of Weaner Rabbits

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Abstract:
A twelve-week trial was conducted to determine the effect of fermented Icacinia manni meal on the performance, carcass, internal organs and nutrient digestibility coefficient of young growing rabbits. A total of forty (40) growing rabbits were used for the study. Four (4) experimental diets were formulated and labeled (T_1, T_2, T_3 and T_4. T_1 (the control) had no fermented Icacinia manni meal, while T_2, T_3 and T_4 contained fermented Icacinia manni meal at 5%, 10% and 15%, respectively, partly replacing maize in the diets. The rabbits were divided into four (4) treatments of ten rabbits, and each treatment was allotted to one of the experimental diets using a completely randomized design (CRD). Each treatment was further sub-divided into five replicates of two rabbits each and house individually in double-tier hutches. Feed and water were supplied ad libitum. Data collected were subjected to a one-way analysis of variance (ANOVA). There were no significant ($p>0.05$) differences in feed intake, growth performance and feed conversion ratio of the growing rabbit. The values for live weight, dressed weight and dressing percentages of the growing rabbits were statistically similar ($p<0.05$). The internal organs (heart, lungs, liver and kidney) were not significantly affected ($p>0.05$) by the diets. The nutrient digestibility coefficient of the growing rabbits was influenced by the diet. It was concluded that fermented Icacinia manni meal could be included in rabbit diet up to 15% with no deleterious effects on the animals.

Keywords: *Icacinia manni, rabbits, performance, carcass, nutrient digestibility*

1. Introduction

Rabbit meat is one of the important animal protein sources that has contributed immensely to human nutrition. Therefore, enhancing its production becomes a fast means of sustaining animal protein availability for the ever-increasing Nigerian population.

Rabbits are known to possess different attributes and have overwhelming advantages compared to other livestock, including short generation intervals and high prolificacy, low capital investment, easy management requirement and ability to subsist on forages and other agro-industrial by-products (Malik *et al.,* 2020; Sam *et al*., 2020a). Rabbit meat is high in protein and low in fat, cholesterol and sodium, and its consumption could prevent the incidence of cardiovascular disease in humans (Sam *et al*., 2020b).

Feed has been reported to be one of the important aspects of animal production and it account for 60 – 70% of the total cost of production of intensively reared livestock (Lawence *et al., 2008*).

Currently, maize, the principal energy component in livestock feed, has become scarce and expensive due to the severe competition for its usage by humans, animals, and industries. As a result, it has affected the production of formulated rabbit feed. Hence, there is a need to search for readily available, cheaper alternative plant energy sources that could serve as replacements for maize in rabbit feed.

Icacinia manni (earth ball) seems to have potential as a source of energy in rabbit feeds. *I*t is a shrub with a modified tuber, mainly carbohydrates (Essien & Sam, 2018a). The tuber could weigh up to 20kg depending on the type of soil and stage of maturity. It is locally abundant in the humid climate of Akwa Ibom State, Nigeria (Akobundu & Agyakwu, 1998).

The chemical composition of *Icacinia manni* was revealed to contain crude protein (3.8%), crude fibre (2.74%), ash (4.12%), ether extract (67.23%) and phytochemical composition showed that it contains an alkaloid, flavonoid, saponin, tannin, phytate and cyanogenic glycoside which could limit its use in animal feed (Essien, 2012 Essien and Sam 2018b). Ekpo and Udedibe (2012) suggested that *Icacinia manni* contains gunning substances suspected to be galactomanan. Galactomannans are a group of polysaccharides with a rigid hydrophilic backbone (polymannose or mannan) and grafted galactose units. The variability in its galactose content and distribution along the Mannan chain could be responsible for its variation in solubility. (Srichamroen *et al.,* 2008). The author further stated that *Icacinia manni* molecules resisted human digestive secretions in the small intestine, hence functioning as dietary fibre.

In light of these, its inclusion in the animal diet requires processing to reduce the anti-nutrient and improve its nutritive value.

Many food processing techniques have been found to reduce or totally eliminate anti-nutrients in plant food, including boiling, roasting, toasting, soaking fermentation, chemical treatment, germination, etc. (Essien & Udedibie, 2007; Kaankuka *et al.,* 2000).

However, several processing methods have been employed to improve the feed value of Icacinia manni (moist treatment, boiling, toasting, soaking fermentation, etc.). Fermentation has been proven to be an effective means of detoxifying the meal.

Umoren *et al.* (2007) reported an improvement in the growth response of broilers fed 15% fermented Icacinia manni. Effiong and Akpan (2017) reported that fermented Icacinia manni in rumen digesta filtrates enhanced the growth performance of broilers at a 20% level of inclusion. Essien & Sam (2018a) and Essien (2021) reported improved growth performance and egg quality enhancement of broilers and laying hens fed a diet containing 10% and 20% fermented Icacinia manni. Akintunde *et al.* (2021) reported that effective reduction in anti-nutritional substances, level of feed and feed quality could be determined by the effectiveness of the processing method employed.

However, there has been no indepth information on the use of fermented Icacinia manni in rabbit feed. Thus, the objective was to determine the growth performance carcass characteristics and nutrient digestibility coefficient of weaner rabbit fed fermented Icacinia manni based diet.

2. Materials and Methods

2.1. Experimental Site

This study was carried out at the Rabbitry Unit of the Department of Animal Science, Teaching and Research Farm, Akwa Ibom State University – Obio Akpa Campus. Obio Akpa is situated between latitude 5^0 17^1N and 5^0 27^1N and longitude 7^0 21^0E and 7^0 58^0E with an annual rainfall ranging between 3500–5000mm, a monthly temperature range of 24 – 26^0C, and a relative humidity between 60–90% (AKSG, 2024).

2.2. Sources of Icacinia manni and Processing Method

Fresh *Icacinia manni* tubers were harvested within the university environs. The tubers were washed and chopped into pieces with the aid of a matchet. The chopped *Icacinia manni* were soaked in plastic buckets containing ordinary water and allowed to ferment for 72 hours. Thereafter, the fermented *Icacinia manni* was bagged, and the fermented water was squeezed out.

The *Icacimia manni* were sun-dried for seven days, run through a hammer mill using a 2mm sieve to homogenize them, and fermented *Icacinia manni* meal (FIMM) was produced.

2.3. Proximate and Phytochemical Analysis of the Test Material

A sample of the fermented lacinia manni meal was subjected to proximate composition analysis to determine crude protein, crude fibre, moisture, ash and ether extract content using the standard procedure (AOAC, 1995). Phytochemical analysis was also carried out to determine alkaloid, saponin, tannin, oxalate, phytate, hydrogen cyanide and flavonoid content according to the methods described by Harborne (1973) and Sofowora (1993).

2.4. Experimental Diet

Four experimental diets were formulated and labeled as T_1, T_2, T_3 and T_4. In treatment One (T_1), the control did not contain boiled African pear seed meal. T_2, T_3 and T_4 contained boiled African pear seed meal at 5, 10 and 15% levels, respectively, with fermented *Icacinia manni* meal partly replacing maize in the diet. The ingredient and nutrient composition of the experimental diets are presented in table 1.

2.5. Experimental Design and Management of Animals

A total of forty (40) weaner rabbits of between 6–7 weeks were used for the experiment. The rabbits were purchased from two private rabbit farms in Uyo, Akwa Ibom State, Nigeria. The rabbits were progenies obtained from mating between New Zealand White and Chinchilla breeds. Prior to the commencement of the experiment, the rabbit house was thoroughly washed and disinfected using an Izal solution. On arrival, the rabbits were weighed and randomly allotted to four dietary treatments of ten (10) rabbits and further sub-divided into five (5) replicates of two (2) rabbits per replicate in a Completely Randomized Design (CRD). The rabbits were housed individually in two double-tier hutches. Each cell has a dimension of 2 x 2 x 2ft with a wire mesh base partitioned with a wooden board. The hutches were located in a well-ventilated house that was completely walled with wide and open windows covered with wire mesh and mosquito nettings. The rabbits were allowed to acclimatize to the environment for one week and fed fermented icacinia manni meal-free diet before the commencement of the experiment.

During this period, ivermectin injections (a parasiticide) were administered to eliminate both external and internal parasites. Each rabbit cell had a feed and water trough, and feed and drinking water were supplied ad libitum. Strict management practices were adhered to. The experiment lasted for 12 weeks.

2.6. Data Collection

Rabbits were weighed individually at the beginning of the experiment and on a weekly basis thereafter to determine their weight gain using an electronic scale. Feed intake per rabbit per day was calculated as the difference between feed offered and left over after 24 hours of feeding. The feed conversion ratio was calculated as the ratio of feed intake to weight gain.

2.7. Nutrient Digestibility Study

At the end of the 11th week of the feeding trial, a nutrient digestibility trial was carried out using three (3) rabbits per treatment housed in specially constructed metabolism cages. The known quantity of feed was given to the rabbits on a daily basis, and the leftovers were collected the following morning. Three days of adaptation were provided before the commencement of the collection of the faecal droppings. Faecal droppings were collected daily from each cage in aluminium foils and oven-dried at a temperature of 60 – 80^{0}C for 48 hours. At the end of the trial, each representative sample was bulked and taken to the laboratory for proximate composition determination using the AOAC method (2002).

$$Nutrient\ Digestibility = \frac{Nutrient\ in\ Feed - Nutrient\ in\ Faecese}{Nutrient\ in\ Feed} \times 100$$

2.8. Carcass Characteristics

At the end of the experiment, twelve (12) rabbits (i.e. three rabbits per treatment) were randomly selected for carcass evaluation. The rabbits were starved of feed for 12 hours, weighed, and stunned by hand blow at the base of the neck. They were slaughtered by cutting the Jugu Marvin, according to Shaahu *et al.* (2014), and allowed to bleed thoroughly. The rabbits were singed, eviscerated, and weighed using a B12001 electronic weighing balance to evaluate their carcasses.

Carcass weight was determined according to Jensen's (1984) method. The dressing percentage was determined by dividing the dressed weight by the live weight and multiplying by one hundred.

2.9. Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) according to Steel and Torrie (1980) and mean separation by Duncan's Multiple Range Test (Duncan, 1955).

Ingredients	**T_1**	**T_2**	**T_3**	**T_4**
Maize	40.00	40.00	40.00	40.00
FIMM	0.00	0.00	0.00	0.00
Soyabean cake	18.00	18.00	18.00	18.00
Groundnut Cake	10.00	10.00	10.00	10.00
Wheat offal	18.00	18.00	18.00	18.00
Palm kernel cake	9.00	9.00	9.00	9.00
Bone meal	4.00	4.00	4.00	4.00
Premix	0.25	0.25	0.25	0.25
Common Salt	0.25	0.25	0.25	0.25
L-Lysine	0.25	0.25	0.25	0.25
L-Methionine	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated Chemical Composition (%Dm)				
Crude Protein				
Ether extract				
Crude fiber				
Ash				
NFE				
ME (Kcal/g)				

Table 1: Gross Composition of Experimental Diets for Weaner Rabbits Fed Varying Levels of Fermented Icacinia manni Meal
FIMM – Fermented Icacinia manni Meal
NFE – Nitrogen Free Extra
ME – Metabolizable Energy

3. Result and Discussions

3.1. Proximate and Phytochemical Composition of Fermented Icacinia manni

The results of the proximate and phytochemical composition of fermented *Icacinia manni* are presented in table 2. The proximate composition result indicated that fermented *Icacinia manni* contained moisture (21.54%), crude fibre (4.21%), crude protein (4.53%), ash (4.12%), ether extract (2.35%) and nitrogen free extract (62.75%). The high nitrogen free extract value obtained in this study showed that fermented *Icacinia manni* could serve as an energy source in livestock feed. The phytochemical composition result revealed the presence of alkaloid, flavonoid, saponin, oxalate and cyanogenic glycoside at (2.25, 4.13, 2.27, 20.38 and 13.14mg/100g) respectively.

Tannin and phytate were not detected. The absence of tannin will benefit the animals, indicating that the protein content of the feed will be effectively utilized.

Tannin is known to inhibit protein digestion and also decrease the efficiency in converting absorbed nutrients to new body substances (Chung *et al.,* 1998). The absence of phytate in fermented *Icacinia manni* will promote the availability of phosphorous, calcium, iron and zinc. These minerals are known to play significant roles in the body. Their absence or deficiencies could result in structural and physiological abnormalities in the animal Banerjee (2018). Phytate has been reported to impair the absorption of phosphorous, iron, zinc and calcium (Chung *et al.,* 1998).

Parameters	Composition (% Dm)
Moisture	21.54
Crude Protein	4.53
Ether Extract	2.35
Ash	4.42
Crude Fibre	4.21
NFE	62.75
Anti-nutrient mg/100g	
Alkaloid	2.25
Flavonoid	4.13
Saponin	Not detected
Phytate	Not detected
Hydrogen Cyanide	13.14
Oxalate	20.38

Table 2: Proximate and Phytochemical Analysis of Fermented Icacinia manni

3.2. Performance of Rabbit Fed Diet Containing Fermented Icacinia manni Meal

The result of the performance of the rabbit-fed diet containing fermented *Icacinia manni* meal is presented in table 3. There were no significant differences (p>0.05) in the final body weight and total body weight gain of rabbits across treatments.

The non-variation in the value of final weight gained total body weight indicated adequate nutrients in feed and efficient utilization of digestive products.

Additionally, better performance observed across treatment groups could indicate the absence or low level of anti-nutrients in the feed. Fructose (2004) reported that the consumption of feed with anti-nutritional factors, especially tannin, reduces the utilization of the diet for growth. This assertion agrees with the phytochemical composition result that showed the absence of tannin and phytate in fermented *Icacinia manni* meal. Also, the non-significant (p>0.05) values observed in the final body weight and total body weight gain across treatment could be attributed to the low level of fibre in the feed. Rabbits are known to digest fibre more poorly than other forage eaters because of the selective separation and rapid excretion of large particles in the hindgut (Reddy, 2018). Also, Sobayo *et al.* (2007) reported impaired nutrient utilization for growth and maintenance by a rabbit-fed diet high in fibre. However, this result agrees with the report of Essien and Sam (2018), where there was no significant effect (p>0.05) on final weight gain and total body weight gain of broiler chickens fed *Icacinia manni* meal processed in saline.

The dietary treatment did not have any negative influence on the feed intake of the rabbits. There was no significant difference (p>0.05) in the feed intake of the rabbits across treatment. This result could suggest that the feed was palatable and devoid of toxic substances.

There was no significant difference across treatments for the feed conversion ratio. The similar feed conversion ratio obtained for rabbits in this study depicts the suitability of the diet in terms of nutrient availability and adequacy comparable to the control diet. The lowest feed conversion ratio was obtained in the control group.

Parameters	T_1 (0%FIMM)	T_2 (5%FIMM)	T_3 (10%FIMM)	T_4 (15%FIMM)	SEM
Initial Weight (g)	763.50	771.40	769.37	767.91	12.14
Total Weight (g)	1796.30	1788.51	1801.21	1794.30	31.35
Body Weight gain (g)	1033.00	1017.18	1031.84	1026.39	38.51
Total feed intake (g)	6551.41	6511.23	6810.40	6603.28	21.30
Feed conversion ratio	6.34	6.40	6.60	6.43	0.03
Mortality	0.00	0.00	0.00	0.00	0.00

Table 3: Replacement Value of Fermented Icacinia manni Meal for Dietary Maize on Growth Performance Rabbits
FIMM – Fermented Icacinia manni Meal

3.3. Carcass Characteristics of Rabbit Fed Diet Containing Fermented Icacinia manni Meal

There were no significant variations (p>0.05) in the values for live weight, dressed weight and dressing percentage of the rabbits across treatment (Table 4). This result implied that the diets had no adverse effect on the carcass traits of rabbits, and the treatment groups had better edible parts (Garba & Mohammed, 2015). The dressing percentage of the rabbits was higher than the 50 to 56% recommended as the normal range for rabbits (Fielding, 1991). The dressing percentage range obtained in this research suggests that the replacement of maize 15% with fermented *Icacinia manni* meal did not exert any negative impact on tissue accretion and also favoured muscle deposition.

Carcass weight is a very significant parameter when evaluating rabbit productivity because a higher carcass weight produces more flesh and also enhances the economic value of the farmer (Abubakar *et al.,* 2021).

The internal organs (heart, liver, kidney and lung) were not affected by the dietary treatment. Non-variation in the values of these organs depicts non-impairment of physiological and metabolic functions of the organs. An increase in weight or enlargement of some internal organs is linked with the presence of toxic substances in the diet. The increase in internal organ weight above normal physiological ranges is used as an index of feed toxicity (FAO, 1997). The liver and kidney are involved in the elimination of toxins and metabolic waste from animals' bodies (Onyeyili *et al.,* 1998). Similar values obtained in this research indicated the low level and absence of some anti-nutritional substances in fermented *Icacinia manni* meal. The carcass weight values in this study ranged between 1387.97–1412.03, which is within the range (1375.00g–1425.00g) reported by Iyayi *et al.* (2003) but lower than 1595.83g–2290.00g reported by Biya *et al.,* (2008). Nuhu (2010) reported lower values of 801.67g–1019.67.

Parameters	**T_1 (0%FIMM)**	**T_2 (5%FIMM)**	**T_3 (10%FIMM)**	**T_4 (15%FIMM)**	**SEM**
Live weight (g)	1796.30	1788.51	1801.21	1794.30	30.25
Carcass weight (g)	1387.97	1412.03	1403.97	1396.59	121.37
Dressing percentage (%)	77.26	78.95	77.94	77.83	0.04
Organ weights					
Kidney	10.01	9.62	9.74	10.22	0.01
Lungs	12.57	13.04	12.71	13.21	0.03
Liver	45.88	46.37	45.53	45.81	0.01
Heart	9.54	9.61	10.32	9.58	0.01

Table 4: Carcass and Organ Characteristics of Weaner Rabbits Fed Diet Containing Varying Levels of Fermented Icacinia manni Meal
FIMM – Fermented Icacinia manni Meal

3.4. Nutrient Digestibility Coefficient

There was no significant variation (p<0.05) in the nutrient digestibility coefficient of the growing rabbits across treatments. This could suggest a balance of nutrients in the diets. Lebas (1999) reported that the balance ratio promotes digestibility. More so, this result depicts the efficacy of fermentation as an effective method of detoxification of tuberous crops, hence promoting their nutritive value. During fermentation, cells of the fermented products are broken by enzymes and micro-organisms, thus facilitating the hydrolysis and washing off of anti-nutritional substances (Frediansyah, 2017).

Also, similar values obtained in nitrogen-free extract for rabbit-fed *Icacinia manni* could suggest a possible breakage of the rigid hydrophilic backbone in mannose and the grafted galactose unit, which are the structural component of lactate mannans by micro-organisms which results in the release of soluble carbohydrate for digestion.

Parameters	**T_1 (0% FIMM)**	**T_2 (5% FIMM)**	**T_3 (10% FIMM)**	**T_4 (15% FIMM)**	**SEM**
Dry matter	87.44	86.78	87.53	81.46	0.01
Crude Protein	86.48	85.79	86.30	86.34	0.03
Ash	74.87	73.51	74.29	74.61	0.01
Ether Extract	81.11	80.30	79.81	81.03	0.04
Crude Fibre	78.49	78.21	77.57	78.43	0.01
NFE	71.53	72.30	71.68	71.25	0.01

Table 5: Nutrient Digestibility Coefficient of Weaner Rabbits Fed Diet Containing Varying Levels of Fermented Icacinia manni Meal
FIMM – Fermented Icacinia manni Meal

4. Conclusion

The study showed that fermentation greatly reduced the levels of anti-nutritional substances in *Icacinia manni*, and the inclusion of fermented *Icacinia manni* meal in rabbit diet up to 15% did not have any negative influence on the performance, carcass internal organs and nutrient digestibility coefficient of the animals.

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