



## Effect of Enzyme Supplemented Cassava Peel–Maize Cob Mixture on The Oxidative Response of Weaned Pigs

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### ABSTRACT

This study assessed the effect of enzyme supplemented cassava peel – maize cob mixture (CPMCM) on the oxidative response of weaned pigs. Forty, 8 weeks weaned male piglets (Duroc) of with an initial body weight of  $9.21 \pm 0.21$  Kg were assigned randomly to four treatments (n = 10 piglets/ treatment). Each treatment consists of 5 replicate with 2 piglets each in a completely randomized design. Enzyme supplemented dried cassava peel and maize cob meal (CPMCM) at ratio 1:1 was incorporated into the experimental diet to replace maize as follows: treatment 1 (T1) control diet (0 % CPMCM with enzymes), T2 (10 % CPMCM with enzymes), T3 (20 % CPMCM with enzymes), T4 (30 % CPMCM with enzymes). The trial lasted for 60 days, feed and water was given ad libitum. Result obtained showed that CPMCM has both nutritional and medicinal properties as proximate composition reveals: dry matter (89.10 %), crude protein (8.98 %), crude fibre (12.04 %), ash (8.07 %) and energy (2900.8 Kcal/kg) while phytochemical composition: saponins (208.2 mg/100g), flavonoids (123.4 mg/100g), tannins (51.82 mg/100g), alkaloids (109.8 mg/100g) and phenols (87.12 mg/100g). Increasing the levels of CPMCM improved total antioxidant capacity, catalase, glutathione peroxidase ( $p < 0.05$ ) and reduced the concentration of malondialdehyde ( $p < 0.05$ ). Superoxide dismutase concentrations was not significantly affected ( $p > 0.05$ ). It was concluded that increasing the levels of CPMCM across the treatment can neutralize the activities of free radicals which are the cause of disease in the body of pigs as well as prevent lipid peroxidation. A higher replacement level is recommended

## **INTRODUCTION**

In addition to being used as a human staple and a source of raw materials for industry, conventional energy sources like maize have been used as a major ingredient in pig diets and have created fierce competition between humans and animals (Bamgbose et al., 2004). According to Ogungbesan et al. (2014), feed currently makes up 70–80% of the entire cost of raising pigs in poor nations like Nigeria. Pigs consume to meet their energy needs; pigs use energy for development, maintenance, production, and body heat. Any attempt to replace the 45–55 percent of maize in swine feed with other ingredients will result in a large reduction in production costs (Bamgbose et al., 2004). Replacing the rare maize in pig diets with agro-industrial by-products that are not used by people, widely available year-round in vast volumes, and affordable or free to obtain, merits investigation given the high cost of feedstuff and the subsequent high cost of production.

Pig feed can be made from the cobs produced by maize (*Zea mays*), one of the most widely planted cereals (Kanengoni et al., 2004; Ndubuisi et al., 2008). There is an abundance of maize cobs that might be used as feed, as estimates from Bozovic et al. (2004) show that 180–200 kg of cobs are produced for every tonne of grains. About 2.4, 1.5, 0.9, and 0.7 million tonnes of maize cobs were produced in 2009 and 2010 by Sub-Saharan Africa, which includes South Africa, Nigeria, Tanzania, and Malawi (FAO, 2012). Nowadays, when the grain is extracted, the maize cob is either used intact or pulverized into smaller pieces. Maize cobs can be burned for cooking or heating purposes, ploughed back into fields for cultivation, or thrown away (Bozovic et al., 2004).

Cassava (*Manihot esculenta*) peels are among the several agro-industrial by-products that exhibit promise for use as an alternative feed ingredient. It is a necessary waste or agricultural by-product that remains after food is made from cassava. According to Oyebimpe et al. (2006), cassava peels weigh 100–130 kg per tonne of tuber weight. Nonetheless, it may be 250–290 kg per tonne of tuber weight if the little roots and the woody part of the tuber appeared to have been thrown in the garbage (Okike et al., 2015).

Although maize cobs and cassava peels, two agricultural byproducts, have the potential to be used as substitute feed ingredients, their suitability for feeding animals with monogastric stomachs is limited due to their low protein content and high levels of anti-nutritional elements such as cyanide, oxalate, and saponin (Anakebe, 2006). On the other hand, maize cobs are poor sources of protein, minerals, and vitamins and have little nutritional value (Akinfemi et al., 2009). The majority of these anti-nutrients have the potential to negatively impact an animal's health, particularly when consumed at larger amounts. The sustainability of livestock and the reduction of environmental pollution will both be enhanced by the use of these agro-industrial wastes. This experiment is aimed at accessing the effect of enzyme supplemented cassava peel – maize cob mixture on the oxidative response of weaner pigs.

## LITERATURE REVIEW

### *Location of the Experiment*

This study was carried out in the Department of Animal Science, Faculty of Agriculture, University of Abuja Teaching and Research Farm, Main Campus, along Airport Road, Gwagwalada, Abuja, Nigeria. The Gwagwalada Area Council's headquarters are located in Gwagwalada, which is located between latitudes 8°57'N and 8°55'N and longitudes 7°05' and 7°06'E. Gwagwalada is one of the six (6) area councils that make up the Federal Capital Territory (FCT). Gwagwalada, the largest town in the study area and one of the urban centers with the greatest rate of growth in the FCT, is home to around 157,770 people. In addition, it is one of the main satellite towns and the third largest urban center (Balogun, 2001; NPC, 2006).

### *Collection, Processing of Test Materials and Analysis*

From a number of Gwagwalada Cassava/maize processing facilities, fresh maize cobs and peels were collected. To reduce their anti-nutritional factor levels and stop microbial reactions that could lead to rotting and nutrient leaching, the samples were exposed to sunlight for 14 days. The dried cassava peels and maize cobs were transported to the laboratory for additional analysis after being separately processed into meals in a hammer mill. The test ingredient's phytochemical analysis was conducted using the methodology recently released by Alagbe (2024).

### *Pigs and Their Management*

Forty eight week old male Duroc piglets weighing  $9.21 \pm 0.21$  kg at birth were divided into four groups at random ( $n = 10$  piglets/treatment). Five replicates of each treatment, each containing two piglets, are used in a fully randomized design. Piglets were kept in 3.5 m<sup>2</sup> semi-open concrete floor pens with drinkers and feeders to provide them with free access to fresh water. The 60-day experimental period included 14 days for therapy adaption. Animals were given a basic diet and dewormed to prevent endo and ectoparasites during the adaption phase. According to NRC (2002), four experimental diets were developed to satisfy swine's nutritional needs.

In order to replace maize in the experimental diet, enzyme-supplemented dried cassava peel and maize cob meal (CPMCM) were added in a 1:1 ratio: Table 1 shows the results of treatment 1 (T1) control diet (0 % CPMCM with enzymes), T2 (10 % CPMCM with enzymes), T3 (20 % CPMCM with enzymes), and T4 (30 % CPMCM with enzymes). By deducting the feed declined from the feed supplied, the amount of feed consumed per piglet was determined. Feed offered and denied was weighed at the end of the experiment and documented every day. The difference between the starting and final body weights was used to compute body weight gain. By dividing the entire amount of feed consumed by the body weight gain, the feed conversion ratio was calculated. Proximate analysis of experimental diet as well as test ingredient were analyzed using the methods outlined by Association of Analytical Chemist (2016).

**Examining Oxidative Stress**

Six randomly chosen piglets per treatment had their livers removed at the conclusion of the experiment and placed in a sterile sample vial with potassium hydroxide solution. After being brought to the lab, samples were examined using the NEXRO kit (Model 81-09A, India). The oxidative detection of glutathione peroxidase, catalase, reduced glutathione, superoxide dismutase, and malondialdehyde was measured using the output unit or display.

**METHODOLOGY**

**Statistical Analysis**

Data were analyzed using one-way ANOVA (SAS Institute, 2004). Treatment differences were assessed using Duncan’s multiple range test (Duncan, 1955).

The following model was used:  $Y_{ij} = \mu + T_i + e_{ij}$

Where:  $Y_{ij}$  = an observation,  $\mu$  = overall mean,  $T_i$  = effect of  $i$ th treatments and  $e_{ij}$  = experimental random error.

Table 1. Ingredient and Chemical Composition of the Experimental Diets (%DM)

Ingredients	T1 (0 %)	T2 (10 %)	T3 (20 %)	T4 (30 %)
Maize	55.00	49.50	44.00	38.50
Wheat offal	6.97	6.97	6.97	6.97
Soya beans	24.00	24.00	24.00	24.00
Groundnut cake	7.00	7.00	7.00	7.00
CPMCM	0.00	5.50	11.00	16.50
Bone meal	3.00	3.00	3.00	3.00
Limestone	1.50	1.50	1.50	1.50
Methionine	0.20	0.20	0.20	0.20
Lysine	0.25	0.25	0.25	0.25
*Premix	0.25	0.25	0.25	0.25
Enzymes	0.03	0.03	0.03	0.03
Salt	1.80	1.80	1.80	1.80
Total	100.0	100.0	100.	100.0
Determined analysis				
Crude protein (%)	18.30	18.00	17.90	17.80
Crude fibre (%)	4.00	4.38	4.50	4.71
Ether extract (%)	3.00	2.92	2.90	2.87
Calcium (%)	0.45	0.45	0.45	0.45
Phosphorus (%)	0.30	0.30	0.30	0.30
Energy (Kcal/kg)	2601.8	2558.7	2556.0	2550.1

vitamin A, 13,000 I.U., vitamin E, 5 mg, vitamin D3, 3000 I.U., vitamin K, 3 mg, vitamin B2, 5.5 mg, niacin, 25 mg, vitamin B12, 16 mg, choline chloride, 120 mg, Mn, 5.2 mg, Zn, 25 mg, Cu, 2.6 mg, folic acid, 2 mg, Fe, 5 mg, pantothenic acid, 10 mg, biotin, 30.5 mg, and antioxidant, 56 mg are provided as premix per kg diet.

Table 2. Proximate and Phytochemical Analysis of Cassava Peel- Maize Cob Mixture

Parameters	Concentration (%)
Moisture	11.90
Dry matter	89.10
Crude protein	8.98
Crude fibre	12.04
Ash	8.07
Energy (Kcal/kg)	2900.8
Components	Concentration (mg/100g)
Saponins	208.2
Flavonoids	123.4
Tannins	51.82
Alkaloids	109.8
Phenols	87.12

Table 3. Oxidative Response of Weaned Piglets Fed CPMCM

Parameters	T1	T2	T3	T4	SEM
TAC (U/mL)	10.02 <sup>c</sup>	13.87 <sup>b</sup>	17.10 <sup>a</sup>	17.18 <sup>a</sup>	0.75
Catalase (U/mL)	50.71 <sup>c</sup>	55.08 <sup>b</sup>	60.97 <sup>a</sup>	60.19 <sup>a</sup>	2.88
SOD (U/mL)	41.36	40.90	40.10	40.02	2.41
GSH (U/mL)	161.3 <sup>a</sup>	140.7 <sup>b</sup>	139.1 <sup>b</sup>	131.5 <sup>b</sup>	8.46
MDA (nmol/mL)	10.72 <sup>a</sup>	7.22 <sup>b</sup>	7.19 <sup>b</sup>	6.05 <sup>b</sup>	0.62

a,b,c Means on the same row with different superscripts are significantly different ( $P < 0.05$ ). TAC: total antioxidant capacity; SOD: superoxide dismutase; GSH: glutathione peroxidase; MDA: malondialdehyde; SEM: standard error of the mean; T1: 0 % CPMCM; T2: 10 % CPMCM; T3: 20% CPMCM; T4: 30% CPMCM.

## RESULTS AND DISCUSSION

Table 2's proximate composition of CPMCM showed that it contains energy (2900.8 Kcal/kg), ash (8.07%), crude protein (8.98%), crude fiber (12.04%), and dry matter (89.10%). The moisture content of CPMCM (11.90%) that was measured in this investigation was comparable to the 10.40% that Daniel et al. (2024) reported. This implies that mold and other microorganisms were unable to thrive on CPMCM. The crude protein found in this study was higher than the 7.71 percent found by Daniel et al. (2024), but it was nearly identical to the 8.90–10.0 percent found for maize (NRC, 1994). Geographical location, variety, and processing method may all contribute to the variation in this conclusion (Omokore and Alagbe, 2019; Agubosi et al., 2022). Energy level of CPMCM shows indicates that it can serve as a good energy source for animals (Singh et al., 2022; Musa et al., 2020). High dietary fibre can promote efficient digestion in animals (Adewale et al., 2021; John, 2024b).

The concentration of CPMCM saponins, as determined by phytochemical analysis, was the greatest at 208.2 mg/100g. Flavonoids (123.4 mg/100g), alkaloids (109.8 mg/100g), phenols (87.12 mg/100g), and tannins (51.82 mg/100g) were next in line. The results indicate that CPMCM has therapeutic qualities in addition to its nutritious components. For example, it has been proposed that saponins have immuno-modulatory and gastro-protective qualities (John, 2024a; Ojediran et al., 2024a). According to Hernandez and Alagbe (2025a,b), flavonoids and phenolic compounds possess antibacterial and antioxidant properties. In the intestinal flora of animals, they can suppress the activities of pathogenic organisms and neutralize the activities of free radicals (John, 2024c; Ojediran et al., 2024b). Antibacterial and antitumor characteristics are possessed by alkaloids and tannins (Daniel et al., 2023; Oluwafemi et al., 2021).

Table 3 shows the oxidative response of weaned pigs fed a mixture of maize cobs and cassava peels as a partial substitute for maize. Catalase, glutathione peroxidase (GSH), superoxide dismutase (SOD), total antioxidant capacity (TAC), and malondialdehyde (MDA) had respective values between 10.02 and 17.18 (U/mL), 55.08 and 60.97 (U/mL), 40.02 and 41.36 (U/mL), 131.5 and 161.3 (U/mL), and 6.05 and 10.02 nmol/mL. Compared to the other treatments, TAC and catalase were increased ( $P < 0.05$ ) in T3 and T4. On the other hand, T1 had higher ( $P < 0.05$ ) GSH and MDA levels than the other treatments. The treatments had no effect on superoxide dismutase (SOD) values ( $P > 0.05$ ).

Oxidative stress is a common problem in swine production that negatively impacts both financial success and animal welfare (Ponnampalam et al., 2022; Bacou et al., 2021). Among the indicators of oxidative stress that changed were glutathione peroxidase (GPx), catalase, superoxide dismutase (SOD), and total antioxidant capacity (TAC). The high levels of malondialdehyde (MDA) in piglets suggest that their antioxidant defense system is out of balance (Gbore et al., 2021; Hadwan and Khabt, 2018). The enzymes catalase and superoxide dismutase, which scavenge reactive oxygen species (ROS), break down hydrogen peroxide and superoxide radicals in piglets (Wan et al., 2018). By lowering equivalent NADPH, GPx catalyzes the elimination of lipid peroxides, transforming glutathione disulfide into two glutathione molecules (Priman et al., 2021).

According to Rotruck et al. (1973), MDA content is also commonly considered a typical indicator of lipid peroxidation. The body's redox state is represented by TAC, which stands for the ferric ion-reducing antioxidant power method (Marklund and Marklund, 1974; Can and Thao, 2020). In the current study, substituting CPMCM for maize increased serum and liver levels of GPx and TAC to counteract the effects of free radicals that can harm animals. These results showed that by preventing oxidative stress in weaned pigs, substituting CPMCM for corn enhanced antioxidant capability. The results of this investigation are consistent with Daniel's (2024) report, which found that grower pigs were fed cob-cassava peels instead of maize.

## **CONCLUSIONS AND RECOMMENDATIONS**

In conclusion, CPMCM contains a cocktail of both nutritional and medicinal compounds capable of having positive influence on animals. Increasing the level of CPMCM up to 30 % was able to neutralize the activities of free radicals which has been identified as one of the causes of disease in animals. This will further improve the immune system of pigs and had no detrimental effect on the health status of animals.

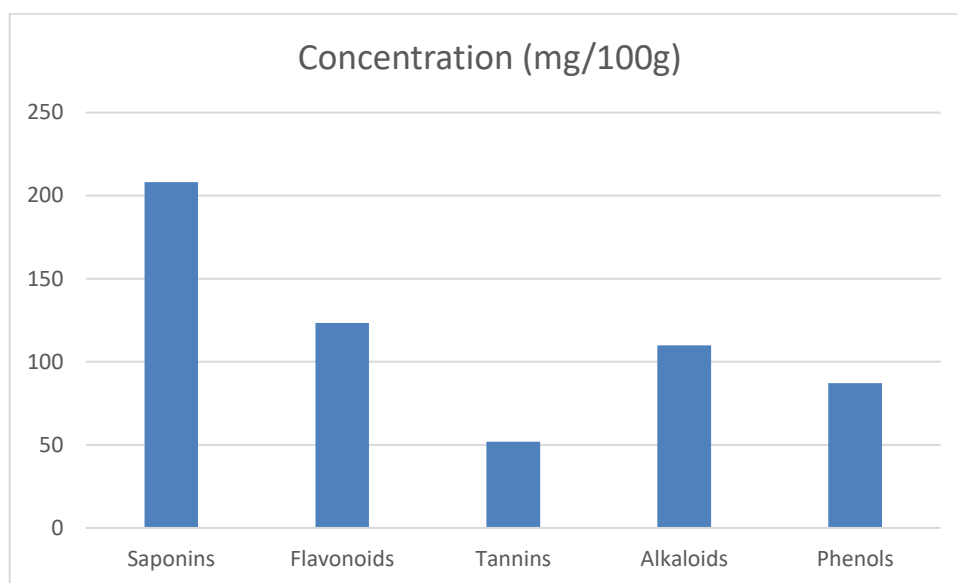


Figure 1. Phytochemical Representation of CPMCM

### FURTHER STUDY

This research still has limitations, so further research is needed related to the topic of Effect of Enzyme Supplemented Cassava Peel–Maize Cob Mixture on The Oxidative Response of Weaned Pigs in order to perfect this research and increase insight for readers.

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