Nutrient digestibility of diets supplemented with fermented cassava (*Manihot esculenta* Crantz.) tuber meal fed to broilers

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Abstract
The nutrient digestibility of diets in which maize was supplemented with graded levels of fermented cassava tuber meal (FCTM) was evaluated in a digestibility trial. 360 broilers in six treatments and three replicates were raised in deep litter for eight weeks and samples were collected over a 5-day period on week 8. The diets were CTRL, a maize based diet with no additives, AGP was CTRL but the birds were given oxytetracycline 25% in their drinking water. FCTM25, FCTM50, FCTM75 and FCTM100 were CTRL with the maize component replaced at 25, 50, 75 and 100% respectively. Both feed and faecal samples were subjected to proximate analysis to determine percentage nutrient digestibility. Nutrient digestibility increased (P<0.05) for all parameters from CTRL to FCTM100 except NFE. AGP and FCTM25 had the best (P<0.05) digestibility for NFE. Diet groups with 25% replacement of maize with FCTM, and those treated with oxytetracycline 25% had better (P<0.05) nutrient digestibility than other treatments. For all parameters, nutrient digestibility increased proportionally to dietary inclusion levels of FCTM. This shows that fermentation makes the feed more digestible and *ipso facto* increases nutrient availability. The diet with 75% of the maize replaced with FCTM had the best dry matter and so is recommended since it offers the least inclusion of maize and more fermented cassava. This enables the birds to take maximum advantage of the benefits of fermentation for improved performance.

Keywords: broilers, nutrient digestibility, fermented cassava tuber meal, nutrient availability, microbial protein

Introduction
With feed cost constituting as much as 70% of the total cost of production, it becomes crucial to improve nutrient bioavailability in feeds. This will have the concomitant effect of improving feed conversion ratio and growth performance. One of the approaches adopted to address the problem of low intake of animal protein in Nigeria is seeking cheaper alternatives to conventional feed ingredients, mainly energy and protein grains. Maize is commonly utilized as an energy source in poultry diet, resulting in a direct competition with man (as food and as industrial raw materials), thus the need for cheaper alternative feedstuffs, which will not compromise quality. Cassava appears to posses the potentials for serving as an alternative to maize.

Cassava is a major staple in most Africa, Caribbean and Pacific ACP countries, and is reported to yield more energy per unit area of land than any other crop (FAO, 2013) besides sugarcane and beetroot. Using cassava to replace maize has been advocated by many researchers, there are many reports of its protein and amino acid deficiency, which pose as a major limitation to its use. Aqueous fermentation of cassava tends to improve its nutritive value by exploiting microbial protein to increase its protein content

(Iji *et al.*, 2011) thus improving the feeding value of cassava and enhancing its potential to supplement or substitute for maize as an energy source in non ruminant diets.

The challenges posed by conventional synthetic antibiotics as growth promoters or medicinal use in prophylaxis or therapy also necessitates urgent action in seeking natural alternatives. The use of probiotic (Brooks, 2008) feed additives are some of the recent developments in animal nutrition, and can be used in a variety of means. In developed countries like UK and Europe, fermented feeds is the major approach used to introduce a large population of lactic acid producing bacteria (LAB) into the gut of pigs and poultry to create the probiotic effects in the gut environment (Brooks, 2008). Fermentation of cassava is mediated by a consortium of organism with a resultant dominating population of lactic acid bacteria in the final product. The process of fermentation initiates microbial breakdown of the cassava such that it is easier to digest (Uguru and Onainor, 2013) especially when fed wet as fermented liquid feed as is the case in this study. These LAB have been shown to have probiotic effect (Brooks, 2008) and eliminate enteropathogenic organisms (Cox and Pavic, 2010), dominate the gut microflora and improve nutrient utilization (Awad *et al.*, 2009). Thus the objective of this study is to determine the potential of aqueous fermentation to improve nutrient digestibility of diets supplemented with graded levels of fermented cassava tuber meal.

Materials and methods

Experimental site and animals

The eight weeks study was conducted at the Teaching and Research Farm of the Department of Animal Science, Ebonyi State University, Abakaliki, Nigeria. Abakaliki is situated within 07^0 30^1E and 08^0 30^1E latitude and 5^0 40^1N and 6^0 45^1N longitude (Nwakpu, 2008) in the rainforest zone of eastern Nigeria. 360 day-old chicks of the Oba Marshall strain were procured from Obasanjo Farms Ltd, Otta, Nigeria, and randomly allocated to six dietary treatments with three replicates, with 20 birds per replicate, in a completely randomized design. The duration of the experiment spanned February through March during which sporadic heavy rainfall, uncharacteristic of late dry season, were observed.

Experimental diets

The experimental diets were prepared by fermenting freshly harvested cassava roots (*Manihot esculenta* Crantz.) TMS 37767 in fresh water until retting was complete in three to four days. Fresh water is emphasized here because it has been observed that sometimes when steeped in water from borehole, rain water or pipe-borne water it does not ret. This is probably as a result of the acidity of the water, which compromises the indigenous microflora that initiates spontaneous fermentation of steeped cassava tubers. Then the wet weights of the retted cassava roots were taken as replacement for equivalent weights of maize in the diets. Conventional maize-based basal diet without any additives or modification served as control (CTRL); AGP contained antibiotic growth promoters (oxytetracycline 25%) to present the status quo in the country and both were used to benchmark the performance of the birds in the treatments fed graded levels of fermented cassava root. Water was added at the ratio of 1.2 L of water to 1 kg of feeds to yield diets of circa 60% DM, consistent with the moisture content (40% mc) of the fermented cassava used in this experiment, as determined by proximate analysis (AOAC, 2012) (Table 3). The maize component of CTRL during the finisher phase was replaced at 25%, 50%, 75%, and 100% and respectively designated as FCRM25, FCRM50, FCRM75 and FCRM100 respectively (Tables 1).

Table 1: Composition of finishers diets containing graded levels of fermented cassava tuber (g/kg) as replacement for maize and their calculated chemical compositions

Ingredient (kg/ton)	CTRL	AGP	FCTM25	FCTM 50	FCTM 75	FCTM 100
Maize	550	550	412.50	275	137.50	0
FCTM	0	0	137.50	275	412.50	550
Wheat offal	70	70	70	70	70	70
SBM[*]	100	100	100	100	100	100
GNC[†]	150	150	150	15	150	150

PKC‡	60	60	60	60	60	60
Fish meal	30	30	30	30	30	30
Bone meal	30	30	30	30	30	30
Salt	2.5	2.5	2.5	2.5	2.5	2.5
Vitamin premix	2.5	2.5	2.5	2.5	2.5	2.5
Lysine	2.5	2.5	2.5	2.5	2.5	2.5
Methionine	2.5	2.5	2.5	2.5	2.5	2.5
TOTAL	**1000**	**1000**	**1000**	**1000**	**1000**	**1000**
Calculated chemical composition						
%CP	20.8	20.8	21.3	21.7	22.2	22.6
%CF	4.2	4.2	4.3	4.3	4.31	4.37
ME (MJ/kg DM)	12.5	12.5	12.43	12.4	12.4	12.33

*Soybean meal; †groundnut cake; ‡palm kernel cake; CP = crude protein; CF = crude fibre

Data were collected over a 5-day period on the Week 8 of the study. Black nylon bags were spread on the floor of the poultry house to prevent adulteration of the faeces. The fresh faeces were collected on a daily basis, and any adhering litter materials or feathers from each replication and stored in the refrigerator. On Day 5, faecal samples from the 5 day collection period were mixed together after thawing before representative samples were drawn for analyses. Feed samples from the six treatments were also collected and sent to the laboratory for proximate analyses according to official methods of analysis (AOAC, 2012).

$$\text{Nutrient Digestibility} = \frac{\text{(Nutrient in feed)- (Nutrient in Feaces)}}{\text{(Nutrient in feed)}} \text{ x } 100$$

Results and Discussion

The nutrient digestibility of diets in which maize was replaced by graded levels of fermented cassava tuber meal is presented in Table 2.

Table 2: Apparent nutrient digestibility (%) of diet containing graded levels of fermented cassava tuber meal as replacement for maize fed to finishing broiler

Parameters	**CTRL**	**AGP**	**FCTM25**	**FCTM50**	**FCTM75**	**FCTM100**	**±SEM**
Dry matter	62.51^{c}	62.65^{b}	64.48^{a}	64.82^{a}	65.84^{a}	65.08^{a}	0.24
Crude protein	65.52^{e}	66.29^{d}	67.51^{c}	68.08^{c}	68.98^{b}	70.16^{a}	0.28
Crude fibre	64.94^{c}	65.69^{c}	68.98^{b}	70.02^{b}	70.98^{b}	72.26^{a}	0.57
Crude fat	87.60^{e}	88.38^{d}	89.31^{c}	90.18^{b}	90.58^{b}	91.43^{a}	0.27
Ash	59.95^{e}	60.33^{e}	61.12^{d}	61.89^{c}	63.03^{b}	63.90^{a}	0.21
NFE	55.76^{e}	59.66^{a}	59.87^{a}	59.33^{b}	58.05^{c}	57.12^{d}	0.49

a, b, c, = means in the same row bearing different superscript differ significantly (P<0.05)

There was increasing nutrient digestibility for all parameters except NFE from CTRL to FCTM100. The diet group treated with antibiotics and that with 25% replacement of maize with FCTM had the best (P<0.05) nutrient digestibility for NFE. It appears that the inclusion of feed additives, such as AGP, and LAB contained in fermented cassava tuber meal, improved its nutrient digestibility. The dietary group fed 25% replacement of maize with FCTM had the best (P<0.05) nutrient digestibility for NFE, which was inversely proportional to increasing dietary inclusion of fermented cassava tuber meal. The reason for this is unclear since cassava has high carbohydrate content (FAO, 2013) and is expected to provide a large proportion of the available energy the birds require. Perhaps, the carbohydrates contained in cassava were not readily digestible by broilers apparently due to its high crude fibre content relative to maize (Montagnac *et al.*, 2009). Sundried cassava have been reported to have high insoluble fermented fibre (Hetland *et al.*, 2005), but fermentation of cassava tuber enhances fermentation of fermentable fibre in the colon, which expectedly should have increased nutrient digestibility.

The observed value of Dry matter and crude protein digestibility for FCTM was higher because of the lower insoluble fermentable fibre compared to sun-dried cassava. Hetland *et al.*, 2005 showed a strong negative correlation between insoluble crude fibre content and nutrient digestibility. Fermentation of cassava helps the fermentable crude fibre to ferment in the colon to increase nutrient bioavailability. Afsharmanesh *et al.* (2010) also reported that feeding broiler with wet feed increases dry matter digestibility, while fermentation increases crude protein digestibility (Wu *et al.,* 2010). Microbial protein is probably more digestible than plant protein contained in maize, a reason for crude protein digestibility increasing proportionally with increasing inclusion levels of FCTM. Fermentation was also reported by Sahlin (1999) to increase the concentration of mineral and protein when measured on dried matter basis.

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