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Nutritional efficacy of fermented cocoyam mixed with *Tridax procumbens* leaf meal on growth weight, haemoglobin content, serum biochemistry and the carcass evaluation of pigs

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ABSTRACT

The research was conducted to investigate the nutritional efficacy of fermented mixtures of cocoyam mixed with *Tridax procumbens* leaf meal on the growth weight, haemoglobin content, serum biochemistry and the carcass evaluation of pigs. The experiment was conducted at the Swine unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State. Cocoyam mixed with *Tridax procumbens* leaf meal were mixed in the ration of 3:1 and allowed to ferment in an air tight environment for six days and after that was sundried. The product was referred to as FCTPLM premix. A total of 40 grower pigs of large white were used for the study. At the end of the trial, two pigs were slaughtered to compare the internal organs such as heart, abdominal fat, spleen etc; to assess the carcass value. The results from the study shows significant ($p<0.05$) differences on the performance characteristics of weaner pigs, while animals on 16% diet gave the best compared to other diets in final weight gain, feed conversion ratio and protein efficiency ratio (25.67kg, 2.06 and 2.52) respectively. There were significant differences ($P>0.05$) on the carcass evaluation of the pigs. There were no significant different ($P>0.05$) found among haemoglobin content, pack cell volume and red blood cells. It was concluded that FCTPM premix could completely replace maize without adversely affecting the overall growth performance of the pigs. Implications and recommendations were made from the findings of the study.

Key words: cocoyam, Growth rate, Meat quality, *Tridax procumbens*, pigs.

1. INTRODUCTION

The feeds of livestock particularly monogastric animals like pigs has caused many challenges to farmers in Nigeria due to high cost rate and availability. Grains which form bulk of concentrate feed are in short supply and expensive. Moreover, the price of animal protein concentrate has risen in tantamount. Economically, it has been found by various scholars that mixing diet of concentrate and forage is of great value [1-5]. Moreso, researchers have reported the significant effects of this concentrates on weight changes, haematological and serological characteristics of non-ruminants.

Cocoyam (*Colocasia esculenta*) is an edible, highly nutritious and an underutilized crop that belongs to the family, Araceae. About 30 – 40 species of cocoyam have been identified but only 5 – 6 species produce edible parts [6]. *Colocasia esculenta* (L.) Schott commonly known as Taro and *Xanthosoma sagittifolium* (L.) Schott, which is generally referred to as Tannia are the most important species of the family Araceae. They are simply referred to as cocoyam in many parts of the world, especially in Africa. Nutritionally, the tubers contain easily digestible starch and are known to contain substantial amounts of protein, fibre, vitamin C, thiamine, riboflavin, potassium, sodium, phosphorus, magnesium, calcium and niacin. The leaves are rich in iron, folic acid and beta carotene [7-9]. Cocoyams are grown primarily for their edible starch storage corms and cormels called tubers, and secondarily as a leafy vegetable [10]. It is a staple food for millions of people living in the tropics and subtropics [6, 11]. In phytomedicine, the consumption of roasted cocoyam with palm oil for a period of three months can cure diabetes [12].

The forage, *Tridax procumbens*, belongs to the family Asteraceae [13]. The plant bears daisy like yellow-centered white or yellow flower with three-toothed ray florets and are found in fields, meadows, crop lands, disturbed areas, lawns and roadsides in areas with tropical and semi-tropical climates. The forage is the most relished herbage by rabbits [14]. *Tridax procumbens* is a common grass found in the tropics. It is an annual herb with leaves opposites, incised toothed, broadly lance late and with prostrate ascending stems [15]. The Tridax contains up to 26% crude protein, 39% soluble cabohydrates, 17% crude fibre and essential minerals such as calcium, phosphorus, magnesium selenium, iron, sulphur, sodium and chlorine [16]. Amino acids, flavanol, synergic acid, tannin, steroids, polysaccharides, alkaloids, pectin, hemicelluloses and volatile oils [15]. It contains Anti- bacterial [17], Anti-oxidant [18] and Antimicrobial [19] properties. The extract of *Tridax procumbens* also possess ant diabetic effect [20], the leaf juice possesses antiseptic, insecticidal, and parasiticidal properties while its leaves are traditionally used in the treatment of dysentery, bronchial catarrh, malaria, dysentery and high blood pressure [21, 22]. Although extensive studies have been done on fermented cocoyam and *Tridax procumbens*, and [23] observed higher weight gain in rabbits fed mixed regime of *Tridax procumbens* with concentrates than those on sole concentrate. Moreover, the significant effect of dietary treatment on PCV, MHC, Neutrophils and HB. Monocyte value obtained was significant at low crude protein content [24]. Except for WBC, haematological parameters were influenced by dietary treatments [25]. Contrary to these reports, Omoikhojo et al. (2006) [26] found that all haematological and serum chemistry of rabbits fed *Syndrella nodiflora* forage were not significantly affected by the dietary treatments. In a similar investigation it was found that weight gain of weaner rabbits fed graded levels of sweet potato meal were not significant [27]. Also, the effect of *T. procumbens* Powder on the performance of laying birds, [15] and evaluated the phytochemical analysis of *Tridax*, yet there is a dearth of information on *T. procumbens* effect on the performance and blood profile of growing cockerels, which would have reduced a farmers cost of production. The study reported that haematolgical parameters can be used to determine the extent of foreign compounds including plant extracts on the blood [28]. Due to the conflicting reports, it was therefore necessary for further investigation. The experiment was, therefore, conducted to investigate the nutritional efficacy of cocoyam mixed with *T. procumbens* leaf meal on the growth, haematological content, serum biochemistry and carcass characteristics of pigs.

Table 1. Composition of Experimental Diet for Weaner Pig

Ingredients	10%	12%	14%	16%	16%
Maize	40.00	40.00	40.00	40.00	40.00
Cocoyam peels/TPLM	10.23	13.75	27.50	41.25	55.00
Ground Nut Cake	25.60	26.78	27.92	29.06	30.21
Wheat Offal	14.10	12.72	11.51	10.26	9.02
Bone Meal	1.50	1.50	1.50	1.50	1.50
Limestone	2.00	2.00	2.00	2.00	2.00
Palm Oil	1.00	2.00	2.20	2.40	2.60
Weaner Premix*	0.25	0.25	0.25	0.25	0.25
Salt	0.35	0.35	0.35	0.35	0.35
Ronozyme**	0.20	0.20	0.20	0.20	0.20
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Calculated Analysis					
Crude Protein (%)	19.00	19.00	19.00	19.00	19.00
ME(Keal/Kg)	2878	2857	2835	2813	2791
Fibre (%)	5.35	6.99	8.63	10.26	11.90
Ash (%)	5.94	9.11	12.34	15.57	18.80
Calcium (%)	0.80	0.80	0.80	0.80	0.80
Starch (%)	39.20	36.14	32.99	29.85	26.70
Fat (%)	6.48	7.74	8.99	10.25	11.50

* Weaner Premix supplied the following per kg diet: Vit A 10,000,000 IU; Vit D32,000,000IU; Vit E 8,000 IU; Vit K 2,000mg;Vit B12,000 mg; Vit B25,500mg; Vit B61,200 mg; Vit B12 12 mg; Biotin30mg; Folic Acid 600 mg; Niacin 10,000 mg; Pantothenic Acid 7,000mg; Choline chloride 500,000 mg; Vit C 10,000mg; Iron 60,000 mg; Mn 80,000 mg; Cu 8,00mg; Zn 50,000 mg; Iodine 2,000 mg; Cobal 450 mg; Selenium 100 mg; Mg 100,000 mg; Anti-Oxidant 6,000 mg; PKC – Palm Kernel Cake, GNC = Groundnut cake, C.P. = Crude protein, ME = Metabolizable energy.

**Ronozyme Composition of the product, sodium sulfate (52.7%), calcium carbonate (15%), kaolin (9%), dextrin and sucrose (8%), cellulose (6%) and vegetable oil (7%). bulk density of 1,100 kg/m3. The particle size distribution of the product showed that 98% of the particles are between 150 and 1,200 µm in diameter and less than 1% of particles are below

2. MATERIALS AND METHODS

2.1. Location of study

The experiment was conducted at the Swine unit of the Teaching and Research Farm, University of Uyo, Uyo, Akwa Ibom State. Akwa Ibom state is in Nigeria. It is located in the coastal southern part of the country, lying between latitudes 40321N and 50331N, and longitudes 70251E and 80251E. The state is located in the south-South geographical zone, and is bordered on the east by Cross River State and Rivers State, on the west by Abia state, and on the south by Atlantic Ocean and the south-most tip of Cross Rivers State.

2.2. Collection and preparation of test ingredients

Both the Cocoyam and *T. procumbens* were gotten from the research farm. The cocoyam were peeled washed and grated with a locally fabricated conventional cassava grating machine. The resulting pulp was combined with *T. procumbens* leaf meal in a ratio of 3:1 (w/w) and thoroughly mixed manually to achieve a homogenous mass. The mixture was put into plastic drums (50 litres capacity) and tightly closed to prevent gaseous passage in/out of the container. The mass was allowed to ferment for 6 days. On the 7th day the container was opened and the contents were thinly spread (1 cm thick) on a polyethene mat and allowed to sundry into a dry

friable mass. This took a maximum of 3 days. The dried samples were then stored in plastic containers until when needed for diet formulation. All dried fermented samples were used within 21 days of sun drying.

2.3. Experimental diets

Five diets were compounded such that diet 1 (control) contained cocoyam as the major energy source. In diets 2, 3, 4, and 5, the dried fermented mixture of cocoyam root pulp and *T. procumbens* leaf meal were used to replace maize in the proportion of 10%, 12%, 14%, 16% and 16% respectively. The proportions of soybean meal were also adjusted to achieve fairly 25 isoproteinous diets.

2.4. Experimental Animals

A total of 40 grower pigs of large white were used for the study. The pigs were divided into 5 groups based on average initial weights (20-25kg) and each group of grower pigs were respectively allocated to each of the five treatment diets in a completely randomized design (CRD). Each treatment group contained 2 replicates of 4 pigs (2 male and 2 female). These pigs were fed twice daily and water supplied adlibitium. There were five diet groups comprising;

Diet 1 = 10% cocoyam supplemented with *T. Procumbens*
Diet 2 = 12% cocoyam supplemented with *T. Procumbens*
Diet 3 = 14% cocoyam supplemented with *T. Procumbens*
Diet 4 = 16% cocoyam supplemented with *T. Procumbens*
Diet 5 = 16% cocoyam without *T. Procumbens* supplementation (control diet)

2.5. Statistical analysis

Data were subjected to analysis of variance using the procedure outlined by SAS (2002) and significantly different means were separated using the Multiple range test by Duncan (1955).

3. RESULTS AND DISCUSSIONS

Initial live weight of weaner pigs ranged from 8.98kg to 9.05kg, average final weight gain of the weaner pigs obtained are shown in table 3 revealed that, experimental animals were significantly ($P<0.05$) affected by the experimental diets. Increasing levels of cocoyam peel meal in the concentrate feed supplemented with *T. Procumbens* resulted in steady increase in body weight of 28.84g, 30.67g, 35.50g and 38.50g for pigs on diets 1, 2, 3 and 4 respectively. Weight gains of pigs fed concentrate feed deprived of forage (Diet 5) dropped significantly ($P<0.05$) to 20.48g. Therefore, 16% crude protein with *T. procumbens* supplementation supported the highest daily live weight gain in the pigs respectively. Feed intake values were not significantly affected at weaner phase; results were the same across the groups.

Feed conversion ratio differed significantly ($P<0.05$) in the experimental animals, while animals on 12% (2.06) diet gave the best compared to other diets with corresponding values of 10(2.41), 14(2.69), 16(2.80) and 116% (2.96) respectively. Protein efficiency ratio of weaner pigs was significantly ($P<0.05$) influenced by the experimental diets, highest value was recorded in 12 %(2.52) diet, followed by 10% (2.18), 14% (1.95), 16% (1.88) and control (1.78) in that order.

Table 2. Proximate analysis of *Tridax procumbens* leaf and stem

Ingredients	Leaf	Stem
Moisture (%)	70.06	88.40
Ash (%)	0.30	0.60
Crude fibre (%)	0.62	1.94
Crude protein (%)	5.13	4.40
Carbohydrates (%)	5.12	4.80
Crude lipids (%)	0.61	0.11
Metabolized energy Kcal/100g	39.58	39.64

There was no mortality throughout this phase of feeding trial.

The effect of feeding cocoyam peel meal in the concentrate feed supplemented with *T. Procumbens* resulted in steady increase on the Performance characteristics such as average final weight, average total weight gain, average weekly weight gain, feed conversion ratio and protein efficiency. However, the study is in agreement observed that the uses of cocoyam in feeding pigs at level aid in growth increment but when higher than 50% usually resulted to decrease in feed conversion efficiency [4, 23]. The inclusion of cocoyam peels has positive effect on the performance of weaner pigs [5]. This may have resulted from the ability of pigs to utilize up to 14% 0f the protein in the forage plants [29] and the natural tendency to ferment forages in their enlarged caeca and thus able to release the nutrients including protein from the crude fiber. The results for haematology and serum analysis are presented in tables 4.6 and 4.7 respectively. No significant differences (P>0.05) were found for haemoglobin content, packed cell volume and red blood counts while there were significant differences in (P<0.05) among treatments in mean corpuscular volume (MCV), mean cell haemoglobin concentration (MCHC), mean cell haemoglobin (MCH), platelet count, total white blood counts (WBC) and differential white cell counts. Though differences were found in the red cell indices of the experimental pigs, the values were within the normal range published for healthy pigs of similar age and in similar environment. However, no clear trend was established. The leukocyte count of pigs on control and 100 % replacement level were similar whereas those on 14 % replacement levels were lower than the control. This decrease may have been due to the heat stress with affected the birds within that treatment. It is possible therefore that the test material was not responsible for the variations observed. Pigs on 14 % and 16% replacement levels of FCP-mix had significantly (p<0.05) higher levels of lymphocytes and lower levels of heterocytes. Lymphocyte counts are known to increase under stress and infection.

Table 3. Growth Performance characteristics of weaner pigs fed experimental diet

	Levels of inclusion (%)					
	10	12	14	16	18	
Parameters	**1**	**2**	**3**	**4**	**5**	**SEM (±)**
Ave. initial weight(kg)	9.05	8.98	9.00	9.01	9.00	
Ave. final weight(kg)	28.84^{b}	30.67 ^{a}	35.00 ^{c}	38.50 ^{d}	20.84 ^{d}	0.46
Ave. total weight gain(kg)	12.52 ^{b}	23.79 ^{a}	26.00 ^{d}	30.50 ^{cd}	15.84 ^{d}	0.44
Ave. daily weight gain(kg)	2.07 ^{b}	2.40 ^{a}	1.86 ^{c}	1.78 ^{cd}	1.69 ^{d}	0.64
Feed intake(kg)	35.00	35.00	35.00	35.00	35.00	0.01
Feed conversion ratio	2.41 ^{c}	2.06 ^{d}	2.69 ^{b}	2.80 ^{b}	2.96 ^{a}	0.68
Protein efficiency ratio	2.18 ^{b}	2.52 ^{a}	1.95 ^{c}	1.88 ^{cd}	1.78 ^{d}	0.08
Mortality (%)	-	-	-	-	-	-

a , b, c, d, e means along the same row with different superscripts are significantly (p< 0.05) different from each at her, Ave: Average, SEM: Standard error of mean.

Table 4. Haematological indices of pigs with different level of FCP mix

Parameters	A	B	C	D	E	SEM
HB(g/dl)	8.97	8.77	9.68	9.73	9.25	0.88
PVC (%)	33.08	31.63	31.88	31.88	34.10	2.66
RBC(x106/UL)	2.56	2.59	2.69	2.53	2.69	0.27
MCV (fl)	131.98 ^{a}	125.18 ^{b}	126.85^{ab}	126.85^{ab}	130.73^{ab}	5.23
MCH (pg)	38.88 ^{a}	38.88 ^{b}	37.53 ^{b}	37.53^{b}	38.07ab	1.19
MCHC (%)	29.03 ^{b}	31.02 ^{a}	29.33 ^{b}	29.55^{ab}	29.55^{ab}	1.38
PLT (x103/UL)	22.67 ^{a}	20.83 ^{a}	18.33 ^{a}	20.50 ^{a}	19.87 ^{a}	1.37
WBC (x103/UL)	83.78 ^{a}	73.13 ^{ab}	82.00 ^{ab}	75.33 ^{b}	83.08 ^{a}	6.15
LYM(%)	77.67 ^{c}	83.83 ^{abc}	81.00 ^{bc}	87.67^{ab}	90.67 ^{a}	7.76
NEUT (%)	22.33 ^{a}	16.17 ^{abc}	19.00 ^{ab}	12.33^{bc}	9.33 ^{c}	8.00

a,b,c Means in the same row with different super script are significantly different

The cholesterol level were not significantly different (P>0.05) among treatments. The least cholesterol level was recorded for the enzyme supplemented diet, some reports suggest that enzyme significantly (P < 0.05) influence fat deposition in broilers. The level of glucose, triglyceride (Trig), bicarbonate chlorine, potassium, sodium, total bilirubin (TB), conjugated bilirubin (CB), alkaline phosphatase (ALP), alanine aminotransferase (ALT) and aspartate aminotransferase (AST) among treatments were not significantly different (P>0.05) across treatment groups. Pigs on control diet had significantly (p<0.05) elevated levels of Aspartate aminotransferase. No clear trend in relation to dietary treatment was established and apparently none of the pigs suffered any metabolic or physiological adversity. These results therefore suggest that 100% replacement of maize with FCP- mix in swine diets would not result in any physiological disorders or impediments. However, this finding is consistent that haematological parameters in monogastirc animals were influenced significantly by dietary treatments. It

Table 5. Serum chemistry of experimental Pigs

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
Calcium (Mg/dl)	10.15 ^{a}	9.72 ^{a}	8.97 ^{b}	8.43 ^{b}	8.72 ^{b}	0.52
Phosphate (Mg/dl)	2.65 ^{ab}	2.13 ^{bc}	2.68 ^{a}	2.09 ^{c}	2.55 ^{ab}	0.45
Glucose (Mg/dl)	143.07	152.50	156.02	145.00	149.20	27.08
Uric acid (Mg/dl)	2.80^{b}	2.32 ^{c}	3.57 ^{a}	2.18 ^{c}	2.30 ^{c}	0.46
Cholesterol (Mg/dl)	92.52	99.18	105.85	106.37	95.87	15.77
Triglyceride (Mg/dl)	20.42	24.90	27.25	24.38	21.05	35.88
Cl (Mmol/L)	119.40	112.70	104.83	104.77	103.95	21.47
Na (Mmol/L)	145.00	143.77	135.68	137.72	137.13	20.30
K (Mmol/L)	5.30 ^{a}	4.88 ^{ab}	3.98 ^{b}	4.37 ^{ab}	4.60 ^{ab}	0.88
HC03 (Mmol/L)	28.83	28.50	26.50	28.33	28.17	2.15
Urea (Mg/dl)	10.40 ^{c}	12.03 ^{ab}	12.50 ^{a}	12.40 ^{a}	11.83 ^{bc}	1.45
Creatinine (Mg/dl)	0.24^{b}	0.35 ^{a}	0.28 ^{ab}	0.30 ^{ab}	0.28 ^{ab}	0.06
Total Bilirubin (Mg/dl)	0.11	0.13	0.07	0.13	0.05	0.08
Conj. Bilirubin (Mg/dl)	0.05 ^{a}	0.06 ^{a}	0.03b ^{c}	0.02 ^{c}	0.03 ^{c}	0.01
ALT (IU/L)	2.50	2.42	2.50	2.42	2.33	0.211
AST (IU/L)	35.22 ^{a}	22.27 ^{c}	32.38 ^{ab}	21.00^{c}	27.27b ^{c}	0.63
ALP (IU/L)	175.10	163.40	157.90	156.31	147.52	553.30

a,b,c Means that do not share a letter are significantly different.

further lends support to the finding of Ahamefule *et al.* (2006) [24] that there were significant differences in PCV, WBC, and Neutrophil of rabbits fed sun-dried, ensiled and fermented cassava peel based diets. The pattern of the haematological characteristics of the rabbits is traceable to the diets as rabbits deprived of forage (Diet) produced significantly least values of PCV, HB and monocyte. The higher haematological obtained by the pigs fed on diets containing 14% and 16% crude protein supplemented with *T. Procumbens* is noteworthy. It showed that the right combination of protein and forage is to be located in these diets. Serological analyses revealed that dietary treatments produce significant effect on serum chemistry of the young pigs. This result, however, does not agree with some earlier report that dietary treatment of concentrate feed supplemented with varying levels of *Syndrella nodiflora* forage did not significantly affect the serum chemistry of rabbits [26]. All the serological parameters evaluated were significantly higher in rabbits fed diet 3 except for blood sugar value which was highest in rabbits on diet 5 (control diet). The higher concentration of sugar is attributed perhaps to higher intake of concentrate which is usually high in starch since the diet was deprived of forage. The starch digestion in rabbit as in other livestock results finally in the release of sugar which in principle is absorbed in situation [30].

The carcass and internal organ characteristics of pig fed graded levels of FCP- mix is shown in table 5. Significant differences were found for percentage slaughter weight ($P<0.05$ and also for dressing percentage ($P>0.05$) showing that, the replacement of maize with cocoyam peel supplemented with tridax leaf meal in the diets of growing pigs did affect the resulting cold carcass weights of the pigs when slaughtered. This was not in agreement with some findings [31] who also reported that, multi-enzyme addition did not affect carcass characteristics of pigs used in their study.

4. CONCLUSION

A total of 40 grower pigs of large white were randomly selected and were divided into 5 groups based on weights allocated with each of the five treatment diets in a completely randomized design (CRD). It was concluded from the test that the dietary treatment had effect on the feed conversion ratio and feed cost per unit weight gain. The findings of this study therefore implies that cocoyam peel supplemented with *T. procumbens* leaf meal can be a great meal in for all monogastric animals as it will increase the body weight, aid growth and promote large meat production. Also, it will reduce the cost expenses on the farmers as the cost of making or getting this feed is relatively easy and low. It is therefore recommended that fermented cocoyam mixed with *T. procumbens* leaf meal;

1. Should be encouraged in the feeding of pigs to reduce over dependence of maize feeds by our farmers which have led to high cost of raising monogastrics specifically pigs which thereby discouraged farmers from investing in the swine business.

2. Public extension/ advisory staff should be mobilized to convey these results to practicing farmers.

3. Further studies on different methods processing cocoyam peels as livestock feeds should be conducted.

4. Fermented cocoyam can be used to feed monogastrics devoid of adverse effects on performance.

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NA

6. CONFLICT OF INTEREST

The author has declared that there is no conflict of interest.

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