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Original Research Article

DEVELOPMENT OF LEAST COST DIETS FOR PIGS USING LESSER KNOWN TUBER CROP SUPPLEMENTED WITH YEAST CULTURE ENZYME AS ENERGY SOURCE IN THE HUMID TROPICS

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ABSTRACT

The growth performance and haematological indices of 10-week old growing New-Hampshire cross breed pigs were determined following feeding diets containing graded levels of sundried cocoyam tuber meal - CYM (*Xanthosoma sagittifolium*) supplemented with yeast culture enzyme as a replacement for maize. They were randomly grouped into 4 treatments, each consisting of 6 pigs. In the experimental diets maize was replaced at the rates of 25%, 50 % and 75% with sundried cocoyam tuber-meal supplemented with yeast culture enzyme. The control group had 100% maize. Their blood and body parameters, feed-intake, conversion-ratio and cost-benefit analysis were obtained. Pigs fed 25% CYM supplemented with yeast had highest daily feed intake. The body weight gain of the growing pigs on 25% CYM supplemented with yeast compared favourably with the control group (P > 0.05). Pigs on 25% CYM supplemented with yeast culture enzyme recorded the best feed conversion ratio. The feed conversion ratios of T3 and T4 were similar (P>0.05) but significantly (P<0.05) lower than those on the control diet. The percentages of the internal organs of the pigs were not affected by the treatments. Cost/kg diet showed that the cheapest diet was the 75% CYM (₦438.95) supplemented with yeast while the costliest was the control P<0.05 (₦649.76). Growing pigs on 25% CYM supplemented with yeast recorded the lowest cost of production (₦1, 831.04). In conclusion, sun dried cocoyam tuber meal supplemented with yeast culture enzyme can be used to replace maize for improved productivity in growing pigs.

Keywords: Cost of production; Feed supplementation; Pigs; Yeast

INTRODUCTION

Pig production has depended on maize as the source of dietary energy. However, cost of maize has been escalating within the last 20 years because of the demand pressure arising from its use as staple food for humans, feed for livestock and raw material for some industries (Udedibie, 2003). Maize grain alone accounts for about 15 – 56% of the cost of pig feed (NRC, 1988). Increasing feed cost due to competition between man and animals for cereal grains has stimulated interests in ways of making use of agricultural by-products in livestock diets. The unconventional feedstuffs are food items which are not normally the first choice materials for the supply of respective nutrients when formulating livestock rations (Iyayi, 2008). Therefore, to reduce feed cost, which accounts for 60 – 70% of total cost (Nworgu *et al.*, 2000). Alternatives should have comparative nutritive value and cheaper than the conventional sources.

One of such unconventional feedstuffs is tannia cocoyam (*Xanthosoma sagittifolium*). The tannia is readily available in Nigeria and are in abundance throughout the year as possible energy source to replace maize in poultry and pig diets. *Xanthosoma sagittifolium* contains starch 17 to 34.5 %, the average approximate composition of the edible portion has been quoted as energy 566Kj/100; water 70 – 77 %, protein

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1.3 – 3.7 % , fat 0.2 – 0.4 %, carbohydrate 17 – 20%, fibre 0.6 – 1.9%, ash 0.6 – 1.3%, calcium 30 mg/100 g., iron 1 mg/100g, ascorbic acid 6 – 10 mg/100g.

The cocoyam has been described as possessing nutritional quality which could compare favourably with cassava, potato and yam (Onunkwo *et al*., 2016). *Xanthosoma sagittifolium* is a high yielding, disease resistant crop. It is almost competition free with man in most places as it is eaten only as a last resort when a family can no longer afford garri or yam. It is therefore more likely to be available for use at a lower cost. Its energy content appears moderate when compared with maize. However, like most varieties of cocoyam, problem with *Xanthosoma sagittifolium* is its content of some anti-nutritional factors which could be limitation to its use (Okon *et al.,* 2007). This limiting factor can be removed by processing (Abdulrashid, 2006).

Anyaegbu *et al.* (2019a) reported that *Xanthosoma sagittifolium* could be used up to 25% in the diet of finisher broiler chickens without affecting body weight gain, feed intake and feed conversion ratio. Anyaegbu *et al.* (2019b) reported that cooked cocoyam tuber meal (*Xanthosoma sagittifolium*) could be used up to 25% in diets of starter broiler chicks without affecting performance. Anyaegbu *et al*. (2018) reported that fermented cocoyam tuber meal (*Xanthosoma sagittifolium*) could be used up to 25% in diets of starter broiler chicks without affecting body weight gain, feed intake and feed conversion ratio. Anyaegbu *et al.* (2017) reported that processed cocoyam (*Xanthosoma sagittifolium*) could be used up to 30% in the diets of starter broiler chicks without affecting weight gain, feed intake and feed conversion ratio. There is limited work on the evaluation of growth performance, haematological indices of growing pigs fed diets containing sundried cocoyam tuber meal (*Xanthosoma sagittifolium*) supplemented with yeast.

MATERIALS AND METHODS

EXPERIMENTAL DESIGN

The design of this study was Completely Randomized Design (CRD). The statistical model was:

$$Y_{ij} = \mu + T_1 + e_{ij}$$

Where:

Y_{ij} = Individual Observation, μ = Population mean,
T_1 = Treatment effect, e_{ij} = Random error, assume to be independently, identically and normally distributed with zero mean and constant variance.

EXPERIMENTAL SITE

The experiment was carried out at the piggery section of teaching and research farm of Michael Okpara University of Agriculture, Umudike located at latitude 5°21`N and longitude 7°32`in the rainforest zone in Umuahia, Abia State of Nigeria. This site has a mean daily temperature of between 27°C and 35°C throughout the year and an average rainfall of 200mm per annum and an altitude of 122mm above sea level (NRCRI, Umudike, 2021).

PROCUREMENT AND PROCESSING OF FEED INGREDIENTS

Fresh cocoyam corms (*Xanthosoma sagittifolium*) were obtained from Ehime Mbano Local Government Area in Imo State. The whole fresh corms were washed with clean water and cut into slices of about 0.1 – 0.2cm and dried with microwave oven. The sun dried cocoyam was milled with hammer mill with 2mm sieve and stored in sacks for use. Other feed ingredients (soybean meal, brewers' dried grains, palm kernel meal, fishmeal, maize, vitamin/mineral/premix, bone meal, methionine and lysine) were obtained from Jocan livestock services, Umuahia.

CHEMICAL ANALYSIS OF FEED INGREDIENTS

Samples of fresh cocoyam corms and sun dried cocoyam tuber meal were analyzed for proximate composition according to (AOAC, 2005) to determine their nutrients` composition from which its metabolizable energy (ME) was estimated. All analysis was based on 100 % dry matter. This was done so as to use the value to determine nutrients` composition of the experimental diets which were formulated with them. The components to determine were Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and Nitrogen Free Extract (NFE).

ANTI-NUTRIENT DETERMINATION

The test materials fresh and sun dried cocoyam (*Xanthosoma sagittifolium*) were analyzed for anti-nutrients contents such as oxalate, phytic acid, cyanide, saponin and tannins. Total oxalate was determined according to Association of Official Analytical Chemist (AOAC, 2005). Phytic acid was determined according to Joslyn (1970), saponin was determined according to Brunner (1984), Tannins was determined using the spectrometric method of AOAC (2005).

EXPERIMENTAL DIETS AND MANAGEMENT OF PIGS

Six experimental pig-growing diets were formulated. Diet 1 (control diet) contained 60% maize as the main energy source, while diets 2, 3, and 4 contained 25 %, 50 %, and 75% of sun dried cocoyam tuber-meal (*Xanthosoma sagittifolium*) supplemented with yeast culture enzyme. Other ingredients remained constant in the diets (Table I).

TABLE I: INGREDIENT-COMPOSITIONS OF PIG-GROWING DIETS CONTAINING SUNDRIED COCOYAM TUBER MEAL

Ingredients (%)	Diet 1 (Control)	Diet 2 25 % DCYM	Diet 3 50 % DCYM	Diet 4 75 % DCYM
Maize	60.00	45.00	30.00	15.00
DCYM	-	15.00	30.00	45.00
Palm kernel cake	5.95	5.70	5.70	5.70
Wheat offal	7.20	7.20	7.20	7.20
Soya bean Meal	20.00	20.00	20.00	20.00
Fish Meal	3.00	3.00	3.00	3.00
Bone Meal	3.00	3.00	3.00	3.00
Vitamin/Mineral Premix*	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Common Salt	0.25	0.25	0.25	0.25
Yeast	-	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00
Calculated Nutrient Composition of the Pig Growing Diet				
Crude protein %	20.12	19.18	18.02	17.29
ME Kcal/kg	3002.72	3000.0	3000.0	2900.0

DCYM - Dried Cocoyam Meal
BDG – Brewers Dried Grain
***To provide per kg Diet: Vit. A, 2000000iu; Vit. D3, 4000iu; Vit. E, 80g; Vit K, 0.49; Choline 48.00g; BHT, 32.00g; Manganese, 16.00g; Iron, 8.00mg; Zinc, 72gm; Copper, 0.32g; Iodine, 0.25g, Cobalt, 36.00g; Selenium, 16g.**

24 growing pigs of the New Hampshire cross breed were used for the feed trial. They were assigned to 4 treatment-groups of 6 pigs each. Each treatment has a replicate of 3 pigs each. Each replicate was housed in a 2m x 3m pen. Each group was randomly assigned to an experimental diet using Completely Randomized Design (CRD). Feed were given at 4 % of their body weight. The pigs were weighed at the beginning of the experiment and weekly thereafter for determination of growth performance. They were fed for 12 weeks. Water and feed were provided ad-libitum. Feeding was done daily. The pigs were weighed before the feed-trial and weekly thereafter. Feed intake was recorded daily by weighing quantity of feed given to the groups and the left-overs the following morning.

DETERMINATION OF BLOOD CONSTITUENTS (HAEMATOLOGICAL INDICES)

Blood samples were collected from one pig per group at the end of the growing stage. 5mls of blood was collected intravenously from the jugular vein with hypodermic needles and sterile syringes. 2mls of each blood sample were immediately transferred to a sample bottle containing ethylene diamine tetra-acetic acid (EDTA) and used to determine values of haematological indices like red blood cells, white blood cells, Haemoglobin concentration and packed cell volume. Values obtained were used to calculate the Mean Corpuscular Volume (MCV), Mean Corpuscular Haemoglobin (MCH) and Mean Corpuscular Haemoglobin Concentration (MCHC)

$$MCV = PCV \times \frac{100}{RBC}$$

$$MCH = Hb \times \frac{100}{RBC}$$

$$MCHC = Hb \times \frac{100}{PCV}$$

DETERMINATION OF HAEMOGLOBIN CONCENTRATION (HBC)

Method: Cyanomethaemoglobin Method (Coles, 1986)

Procedure: About 2ml of blood was collected from the heparin- bottle and diluted with 0.1n HCl in the haemoglobin calibrated test tube until the color of the blood matched that of the haemocytometer and then, the value read from the calibrated tube as haemoglobin value.

DETERMINATION OF PACKED CELL VOLUME (PCV)

Method: Micro Haematocrit Centrifugation Method (Coles, 1986) was used.

Procedure: Blood were collected into capillary tube sealed at the base with some seal. After which they spun in the micro-haematocrit centrifuge reader as packed cell volume value.

DETERMINATION OF WHITE BLOOD CELL COUNT (WBC)

Method: Improved Neubauer Haemacytometer (Coles, 1986) was used.

Procedure: Blood was collected from the heparinsed bottle with the use of a white blood cell pipette and was diluted with hayems solution. After diluting the blood, the blood sample was loaded onto the Neubauer chamber and the white blood cell were counted using microscope.

DETERMINATION OF RED BLOOD CELL COUNT (RBC)

Method: Improved Neubauer Haemacytometer (Coles, 1986) was used.

Procedure: Blood was collected from the heparinsed bottle with the use of a red blood cell pipette and diluted with hayems solution. After diluting the blood, the blood sample was loaded onto the Neubauer chamber and the red blood cells were counted using microscope.

DATA COLLECTION

The following parameters were determined: daily feed intake, body weight gain, final live weight, feed conversion ratio and mortality.

DAILY FEED INTAKE (FI)

The quantity of feed given to the pigs was weighed and the leftover of the feed collected the following morning was also weighed and recorded in grams. Daily feed intake was determined as follows:

FI = Quantity of feed given – left over feed

LIVE WEIGHT GAIN (LWG)

This was calculated as the difference between the final body weight and the initial live body weight.

Body weight gain = Final body weight – Initial body weight

DAILY WEIGHT GAIN (DWG)

This was calculated by dividing the body weight gain by the number of days the feeding trial lasted.

FEED CONVERSION RATIO (FCR)

This was determined by dividing the average daily feed intake by average body weight gain. These values were used to determine the total feed intake per pig per day, total weight gain per pig per day and feed conversion ratio.

The following formula was used for calculation:

$$\text{Feed intake/pig/day} = \frac{\text{Quantity of feed given – leftover}}{\text{6 pigs x 63 day}}$$

$$\text{Weight gain/pig/day} = \frac{\text{Final live weight – initial live weight}}{\text{6 pigs x 63 days}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Daily feed intake (g)}}{\text{Daily body weight gain (g)}}$$

ECONOMICS OF THE EXPERIMENTAL DIETS

The economics of the experimental diets was calculated using the following:

$$\text{Cost/kg feed} = \frac{\text{Total cost of producing 100kg feed}}{100}$$

Cost of feed consumed = Cost/kg feed x Total feed consumed

$$\text{/kg weight gain} = \frac{\text{Cost of feed consumed}}{\text{Body weight gain}}$$

Cost of production = Feed conversion ratio x cost of feed/kg

Revenue= Price of 1kg meat x weight gain

Gross margin = Revenue – Cost of production

$$\text{Return of Investment} = \frac{\text{Gross Margin}}{\text{Cost of production}} \times \frac{100}{1}$$

DATA ANALYSIS

Data collected were subjected to one way Analysis of Variance (ANOVA) according to Snedecor and Cochran (1989) and where significant effects were detected from the ANOVA, means were separated using Duncan's New Multiple Range Test (Duncan, 1955).

RESULTS

ANTI-NUTRIENT COMPOSITION OF FRESH AND DRIED COCOYAM TUBER MEAL *(Xanthosoma sagittifolium*)

There were significant differences ($P \leq 0.05$) in Cyanide, Oxalate, Tannin and saponin content of both the fresh and dried cocoyam tuber meals (Table II). The values obtained from the dried samples were lower than those from the fresh samples. There were no significant difference ($P > 0.05$) between the phytic acid and saponin contents of the fresh samples and the dried tannis *(Xanthosoma sagittifolium*) samples though numerically values of the dried cocoyam tuber-meal were lower.

TABLE II: PERCENTAGES OF TANNIN, PHYTATE, OXALATE AND SAPONIN IN FRESH AND DRIED COCOYAM TUBER MEAL *(Xanthosoma sagittifolium*)

Parameters	Fresh cocoyam tuber meal	Dried cocoyam tuber meal
Tannin (%)	28.65[a]	27.92[a]
Phytate(%)	21.67[a]	21.84[b]
Oxalate (%)	34.12[a]	34.06[b]
Saponin (%)	65.21[a]	66.04[b]

[a,b] Means within the same row with different superscripts are significantly different (P≤0.05)

TABLE III: COMPOSITION OF EXPERIMENTAL GROWER-PIGS` DIETS

Parameters	TMT 1 Control	TMT 2 25% CYM	TNT 3 50% CYM	TMT 4 75% CYM
Moisture (%)	14.71	15.57	14.59	13.29
Crude protein (%)	15.75	16.04	17.59	12.83
Ash (%)	6.60	9.01	15.51	24.89
Crude fibre (%)	5.54	5.67	5.93	8.45
Crude fat (%)	0.63	0.76	0.54	0.74
Carbohydrate (%)	56.78	53.14	40.39	39.79
Dry matter (%)	85.29	84.64	69.42	86.74
Energy value (Kcal/kg)	292.67	288.74	252.94	217.13

TABLE IV: RESULTS OF PROXIMATE ANALYSIS OF FRESH AND DRY TUBERS OF COCOYAM*(XANTHOSOMA SAGITTIFOLIUM)*

Parameters	Fresh tuber meal	Dried tuber meal	S.E.M
Dry matter (%)	33.27[b]	51.14[a]	4.92
Moisture (%)	66.73	9.26	0.78
Ash (%)	4.16	4.24	0.34
Crude Protein %	3.25	3.70	0.54
Crude Fiber %	2.62[a]	2.84[b]	1.67
Ether Extract %	0.60	0.11	0.16
NFE %	23.24	40.36	10.72

[a,b] Means within the same row with different superscripts are significantly different (P ≤ 0.05)

Data on the proximate composition of fresh and dry cocoyam tuber meal (*Xanthosoma sagittifolium*) were shown in (Table III). There were significant difference (P<0.05) in the percentage moisture and crude fibre of both fresh and dry cocoyam meal. Cooking and drying reduces the high moisture and crude fibre content to tolerable levels. There were no significant differences (P>0.05) in the percent ash, crude protein, ether extract and NFE of both the fresh and dry cocoyam tubers, showing that drying did not affect the proximate content of the cocoyam.

FEED INTAKE

The daily feed intake of the growing pigs were 387.49g, 392.49g, 385.79g, and 388.96g for the pig treatment 1 (control), 2, 3, and 4 respectively (Table V) significant differences (P<0.05) existed among the TMT groups in their feed intakes. The pigs in TMT 2 (25% CYM) supplemented with yeast recorded significantly (P<0.05) highest daily feed intake than those in other TMT groups. The feed intake of growing pigs in TMT 3 and 4 were similar (P>0.05) and compared favourably with those on the control diet (TMT 1). Generally, the use of yeast improved feed intake of the growing pigs. Some metabolites in yeast are beneficial for stimulating bacterial growth in the digestive tract and optimizing animal feed intake (Zhe *et al*., 2019).

BODY WEIGHT GAIN

The body weight gain of the growing pigs were 15.50kg, 17.58kg, 13.00kg and 12.42kg for the control group (TMT 1) 2, 3 and 4 respectively (Table IV). The body weight gain of the pigs on diet 2 (25% cocoyam meal supplemented with yeast compared favourably with the control group and recorded significantly (P<0.05) higher body weight gain than those on other diets. The body weight gain of the growing pigs in TMT 3, 4 and the control were similar (P>0.05) and significantly lower than those in TMT 2. It appeared that the growing pigs could not tolerate high levels of cocoyam tuber meal supplemented with yeast in their diets.

FEED CONVERSION RATIO

The feed conversion ratios (FCR) of the experimental growing pigs were 3.75, 2.93, 4.32, and 4.80 for treatment 1, 2, 3 and 4 respectively (Table V). Significant differences (P<0.05) existed among the different treatment groups in their feed conversion ratios. Pigs on diet 2 (25% CYM) supplemented with yeast culture enzyme recorded the best feed conversion ratio of 2.93. The feed conversion ratios of pigs on diet 3 and 4 were similar (P>0.05) but significantly (P<0.05) lower than those on the control diet.

The percent internal organ weights of the experimental growing pigs were shown in (Table VI). Significant difference (P<0.05) existed among the various treatment groups in their percent internal organ weights. The percent organs (heart, liver, spleen, lungs, kidney, bile, abdominal fat, intestine, stomach) of the growing pigs ranged from 0.87 – 1.14%, 4.24 – 4.89%, 0.20 – 0.40%, 2.40 – 3.61%, 0.37 – 0.78%, 0.26 – 0.37%, 0.09 – 0.11%, 0.02 – 0.03%, 4.40 – 7.21% respectively. The weights of the internal organs of the pigs were not affected by the treatments (P>0.05). The pigs in TMT 1 and TMT 3 accumulated significantly (P<0.05) more abdominal fat than others indicating higher efficiency of the pigs in converting the carbohydrates of the diets into fat.

The carcass and percent organ weight of the experimental pigs were presented in Tables VI and VII. The dressing weight percentage of the groups ranged from 39.22 to 54.84%. The group on TMT 4 and T3 had the lowest dressing weight percentage which was significantly different (P < 0.05) from those of the other treatment. However, there were no statistical differences among the dressed weight percentage of the pigs on TMT1 and TMT2 respectively.

Table VIII showed the haematological response of the experimental animals fed the treatment diets. Packed cell volume was significantly (P≤0.05) higher for T2 (33.00%), T3 (38.00%) and T4 (43.00%) compared to the control which is T1 (36.00). Significantly (P≤0.05) higher values of haemoglobin were obtained in T3 (11.13), and T4 (13.00) while lower values were obtained in T2 (10.00) (P>0.05) when compared with the control T1 (10.60). Values obtained for red blood cell was significantly (P<0.05) higher and as well increasing progressively from T2 (5.40xl0/mm^3), T3 (6.18x10 /mm^3) to T4 (6.80x10 /mm^3) when compared to the control (5.8^5x10^3/mm^3). Values TWBC also showed a significant decrease (P≤0.05) in T2 (11x10 /mm^3), when compared to the control group T1 (11.4x103 /mm^3).A significance increase was observed from group T3 (12.65x$l0^3$ /mm^3), to Group T4 (14.20 x $l0^J$ /mm^3), when compared to the control. The MCV, MCH and MCHC obtained did not differ significantly (P>0.05) between the treatments and also when compared with the control T 1 (control).

Table IX showed the differential counts of the white blood cells of the experimental animals fed the treatment diets (T2-T4) with the control (Tl). Lymphocytes among the treatment groups, T2 (55%), T3 (58%), and T4 (59.33%), increases significantly (P≤0.05) when compared to the control (53%). Such significant increase (P≤0.05) was also observed in monocytes T2 (4%), T3 (4%) and T4 (3%)) Eosinophils, T2 (1%), T3 (3%), T4 (3%) and Basophils T2 (0%), T3 (0%), T4 (0%) when compared their respective control (Tl). Except for Neutrophils, where the treatment groups - T2 (40%), T3 (35.33%), T4 (35.33) was not significantly different from the control Tl (40%).

TABLE V: GROWTH PERFORMANCE OF GROWING PIGS FED DIETS CONTAINING SUNDRIED COCOYAM TUBER MEAL SUPPLEMENTED WITH YEAST

Parameters	Diet 1 Control (%)	Diet 2 (25% CYM)	Diet 3 (50% CYM)	Diet 4 (75% CYM)	SEM
Initial body weight (kg)	6.84	6.34	5.50	5.62	0.27
Final body weight (kg)	15.50^{ab}	17.58^{a}	13.00^{b}	12.42^{c}	1.93
Body weight gain (kg)	8.66^{ab}	11.24^{a}	7.50^{ab}	6.80^{b}	0.84
Daily body weight gain (g)	103.09^{ab}	133.81^{a}	89.29^{b}	80.95^{b}	10.05
Daily feed intake (g)	387.49^{ab}	392.49^{a}	385.79^{ab}	388.96^{ab}	1.23
Feed conversion ratio (FCR)	3.75^{a}	2.93^{a}	4.32^{b}	4.80^{b}	0.35

^{abc}means on the same row with different superscripts are significantly different at P ≤ 0.05; SEM: Standard Error of the mean

TABLE VI: PERCENTAGE INTERNAL ORGAN-WEIGHTS OF THE EXPERIMENTAL GROWING PIGS FED DIETS CONTAINING COCOYAM TUBER MEAL SUPPLEMENTED WITH YEAST

Percent internal organs	TMT 1 Control	TMT 2 25% CYM	TMT 3 50% CYM	TMT 4 75% CYM	SEM
Live weight (kg)	15.50	12.75	10.75	12.00	0.58
Heart (%)	0.87^{b}	1.14^{a}	1.10^{a}	0.96^{b}	0.06
Liver (%)	4.34^{b}	4.24^{b}	4.89^{a}	4.42^{b}	0.14
Spleen (%)	0.40^{a}	0.33^{b}	0.37^{b}	0.20^{c}	0.76
Lungs (%)	3.61^{a}	2.40^{c}	2.80^{ab}	2.63^{b}	0.61
Kidney (%)	0.73^{a}	0.37^{c}	0.78^{a}	0.60^{b}	17.25
Bile (%)	0.31^{b}	0.26^{c}	0.37^{a}	0.28^{c}	0.06
Abdominal fat (%)	0.11^{a}	0.09^{b}	0.11^{a}	0.09^{b}	0.01
Intestine (%)	0.02^{b}	0.03^{a}	0.03^{a}	0.02^{b}	1.11
Stomach (%)	7.21^{a}	5.74^{b}	6.09^{ab}	4.40^{c}	0.44

^{abc}means on the same row with different superscripts are significantly different at P ≤ 0.05; SEM: Standard Error of the mean

TABLE VII: PERCENT CUT PARTS OF THE EXPERIMENTAL GROWING PIGS FED DIETS CONTAINING COCOYAM TUBER MEAL SUPPLEMENTED WITH YEAST

Parameters	TMT 1 Control	TMT 2 25% CYM	TNT 3 50% CYM	TMT 4 75% CYM	SEM
Live weight (kg)	15.50	12.75	10.75	12.00	0.58
Dressed weight (%)	54.84^{a}	52.94^{a}	39.22^{c}	47.92^{b}	0.75
Head (%)	0.01	0.01	0.01	0.01	2.60
Trotter (%)	3.64^{a}	3.26^{b}	3.27^{b}	3.25^{b}	0.09
Ham (%)	7.52	8.47	7.44	8.75	0.41
Hinds (%)	0.84	0.01	0.01	0.01	0.20
Ribs (%)	6.13	5.33	6.05	7.29	0.40
Shoulder (%)	4.83	7.45	6.74	7.08	0.58
Neck (%)	3.71	3.61	3.68	3.14	0.13
Tail (%)	0.13	0.28	0.26	0.30	0.03
Backfat (cm)	0.40^{ab}	1.60^{a}	0.20^{b}	0.10^{c}	0.34
Half full length (%)	0.03	0.29	0.03	0.03	0.06

^{abc}means on the same row with different superscripts are significantly different at P ≤ 0.05; SEM: Standard Error of the mean

TABLE VIII: HAEMATOLOGICAL PARAMETERS OF PIGS FED DIETS CONTAINING SUNDRIED COCOYAM TUBER MEAL (*XANTHOSOMASAGITTIFOLIUM*) SUPPLEMENTED WITH YEAST

Groups	T1	T2	T3	T4
Hb (g/dl)	10.60 ± 0.40^{c}	10.00 ± 0.60^{c}	11.13 ± 0.21^{b}	13.00 ± 0.40^{a}
PCV (%)	36.00 ± 1.00^{b}	33.00 ± 0.60^{c}	38.00 ± 1.50^{b}	43.00 ± 0.20^{a}
RBC (xl0^{6}mm^{3})	5.85 ± 0.04^{b}	5.40 ± 0.30^{c}	6.18 ± 0.04^{a}	6.80 ± 0.10^{a}
TWBC (xl0^{6}mm^{3})	11.40 ± 0.10^{c}	11.00 ± 0.2^{c}	12.65 ± 0.0^{b}	14.20 ± 0.20^{a}
MCV (fl)	61.53 ± 1.28^{b}	61.20 ± 2.29^{b}	61.50 ± 2.83^{b}	63.24 ± 0.64^{a}
MCH (pg)	18.12 ± 0.56^{b}	18.53 ± 1.05^{b}	18.02 ± 0.45^{b}	19.1 l$\pm 0.31^{a}$
MCHC (g/dl)	29.44 ± 0.29^{a}	30.30 ± 1.62^{a}	29.31 ± 0.64^{a}	30.23 ± 0.79^{a}

Values are presented as mean ± standard deviation (n = 3); and values with different letter superscripts are significantly ($P \leq 0.05$) different from paired mean across the rows.

TABLE IX: DIFFERENTIAL WHITE BLOOD CELL COUNTS OF PIGS FED DIETS CONTAINING SUNDRIED COCOYAM TUBER MEAL SUPPLEMENTED WITH YEAST

Groups	Tl	T2	T3	T4
Lymphocytes (%)	53.00 ± 1.50^{c}	55.00 ± 1.00^{b}	58.00 ± 1.00^{ab}	59.33 ± 2.52^{a}
Neutrophils (%)	40.00 ± 2.00^{a}	40.00 ± 3.00^{a}	35.33 ± 2.52^{b}	35.33 ± 2.52^{b}
Monocytes (%)	5.00 ± 0.30^{b}	4.00 ± 0.10^{a}	4.00 ± 0.40^{a}	3.00 ± 0.20^{c}
Eosinophils (%)	2.00 ± 0.30^{b}	1.00 ± 0.20^{c}	3.00 ± 0.30^{a}	3.00 ± 0.40^{a}
Basophils (%)	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}

^{abc} means within the same row with different superscripts are significantly different ($P<0.05$)
Values are presented as mean ± standard deviation (n = 3); and values with different letter superscripts are significantly ($P<0.05$) different from paired mean across the rows.

TABLE X: ECONOMICS OF PRODUCTION OF EXPERIMENTAL PIGS FED DIETS CONTAINING COCOYAMTUBER-MEAL SUPPLEMENTED WITH YEAST CULTURE ENZYME

Parameters	Diet 1 (TMT 1)	Diet (TMT 2)	Diet (TMT 3)	Diet (TMT 4)
Cost/kg diet (₦)	649.76	624.93	459.93	438.93
Qty of feed consumed (kg)	146.60	148.36	145.83	147.03
Cost of feed consumed (₦)	95,254.82	92,714.61	67,071.59	64,535.88
Cost/kg wt gain (₦)	10,999.40	8,248.63	8,942.88	9,490.57
Cost of Production (₦)	2,436.60	1,831.04	1,986.90	2,106.86
Revenue (₦)	8,660.00	11,240.00	7,500.00	6,800.00
Gross margin (₦)	6,223.40	9,408.96	5,513.10	4,693.14
Return on Investment (%)	255.4	513.86	277.47	222.76

DISCUSSION

Feed-intake of growing pigs in TMT 3 and 4 were similar (P>0.05) and compared favourably with those on the control diet (TMT 1) (Table V). Generally, use of yeast improved feed intake of the growing pigs. Some metabolites in yeast are beneficial for stimulating bacterial growth in the digestive tract and optimizing animal feed intake (Zhe *et al.,* 2019). Inclusion of yeast improved feed intake by improving palatability (Ignacio, 1995; Gao *et al*., 2008).

Generally, use of yeast improved the body weight gain of the growing pigs (Table V). Previous studies indicated that supplementation with yeast additive enhances animal nutrition and health, and that dietary supplementation with yeast additive (*Saccharomyces cerevisae*) could increase body weight and feed efficiency and promote the immune system in animals while decreasing the percentage of abdominal fat in broiler chickens (Gao *et al.,* 2008; Afsharmanesh *et al.,* 2010). Pigs on diet 2 (25% CYM) supplemented with yeast culture enzyme recorded the best feed conversion ratio of 2.93. The feed conversion ratios of pigs on diet 3 and 4 were similar (P>0.05) but significantly (P<0.05) lower than those on the control diet. Use of yeast improves feed conversion ratios (Adejumo *et al*., 2006). Yeast can improve feed conversion ratio without significant difference in feed intake (Mount zouris *et al*., 2010; Shim *et al*., Kim, 2014).

The effects of the diets on the haematological parameters (Table IX) are good indicators of the physiological and health status of the animals as reported by Etim *et al.* (2013). The range of values for PCV, HBC, and MCHC fell within the range reported for apparently healthy pigs in the same environment and elsewhere by other studies. The findings are in agreement with the work of Eze *et al.* (2010), which found a range of 25.0 to 46.0% for PCV, 6.05 to 13.2 g/dl for HBC, and 24.0 to 37.2 g/dl for MCHC in pigs reared intensively in Eastern Nigeria which considerably agreed with the range obtained in present study. Also Stukelj *et al.* (2010) reported reference range for PCV, and HBC as 0.32 to 0.50 gl/l, and 100 to 160 g/1, respectively. Buzzard *et al.* (2013) however reported that values of HBC and PCV above 10.5g/dl, and 32.8%, respectively in 28 day old pigs indicate un-thriftiness. The higher the percentage of PCV, RBC and HB, the better the haematological profile of the animal (Akinduro, 2016). T4 (43%) had the highest PCV, which made it the most preferred among the treatments, though other treatments met the standard percentage required according to Eze *et al*. (2010).

The significant difference indicated different effects of the treatments (T2-T4)) on the haematological parameters, when compared to the control (Tl) (Olumide *et al.,* 2017). The white blood cell count and Differential count in Tables I and II respectively showed normal production systemic defence cells of the white blood cells, with significant difference (P≤0.05) among the treatment group T2- T4, when compared to the control (Tl). However, all the white blood cell count and differential counts had their values within the normal range for healthy pigs and showed significant increase (P ≤ 0.05) among the treatment group when compared to the control, except for Neutrophils (Research Animal Resources, 2009; Etim *et al.,* 2013). Consequently, the non-significant effects of the treatments on Neutrophils values reflected their sustained physiological contributions in the wellbeing of the pigs.

An earlier study demonstrated that inclusion of 0.125% *S. cerevisiae* yeast improved daily gain and gain-to-feed ratio (G: F) in weaning pigs (Shurson, 2018). Additionally, Price *et al.* 2010 noted that 0.2% of dietary *S. cerevisiae* yeast (Diamond V XPC) increased the body weight gain of pigs challenged with salmonella. According to Shen *et al. (*2009), inclusion of 5 g/kg of yeast in the diet of weaning pigs led to a notable enhancement in the apparent total tract digestibility of dry matter, gross energy, and crude protein. Zhang *et al.* 2019 reported that dietary yeast hydrolysate linearly improved daily gain, gain-to-feed ratio, and the digestibility of DM, GE, and nitrogen in finishing pigs. Though previous studies addressed the benefits of adding yeast to weaning pigs, the available data on the addition of yeast products i.e., YH, particularly in weaning and finishing pigs, is still limited; thus, further studies are needed to investigate the different types of *S. cerevisiae* yeast in grow-finishing pigs.

The economics of production of the experimental growing pigs fed the experimental diets is shown in (Table X). It showed that the cost/kg of feed for the growing pigs on control diet (TMT 1) was significantly (P≤0.05) higher than the other treatment groups. Growing pigs fed TMT 3 (50% CYM) and TMT 4 (75% CYM) supplemented with yeast culture enzyme recorded the least cost values. This implied that the higher the inclusion level of CYM supplemented with yeast culture enzyme thus resulting in the decreasing trend in the feed cost. In terms of cost of production/pig, growing pigs in TMT 1 (Control) recorded the highest cost of production, while those in TMT 2, 3 and 4 recorded the least cost of production per pig. The average cost of feed per kg that decreased with increasing level of cocoyam tubermeal was due to the reduced cost of cocoyam (tannia) relative to maize (Uchegbu *et al.* 2010). The lowest cost of feed per kg of pig was achieved with the pigs fed 25%, of CYM supplemented with yeast.

Anyaegbu *et al.,* (2018) also reported that the cost of production per kg cocoyam based finisher broiler diet was cheapest for birds fed 100 % fermented CYM (Tannia) while the costliest was that on maize based diet. Anyaegbu *et al* (2019) also observed that the cost of feed per kg decreases linearly with increase in the level of cooked CYM (*Xanthosoma sagittifolium*). Pigs in TMT 2 (25% CYM)

((*Xanthosoma sagittifolium)* recorded the highest revenue (₦11, 240) per pig and the highest gross margin of ₦9, 408.96 per kg.

CONCLUSION

Results of this study showed that dried cocoyam tubermeal (*Xanthosoma sagittifolium*) supplemented with yeast culture enzyme could be used up to 25 % to replace maize in diets of growing pigs to improve body weight-gain, feed intake, feed conversion ratio, RBC, WBC, PCV and MCHC.

RECOMMENDATION

Therefore, it is recommended that supplementation of sundried cocoyam tuber meal with yeast should be used up to 25 % in the diet of growing pigs.

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