EFFECTS AND ECONOMICS OF FEEDING DIFFERENTLY PROCESSED YELLOW COCOYAM CORM MEAL ON TURKEY GROWER POULT.

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ABSTRACT

The high cost of maize as the key energy source in poultry production is very alarming and calls for use of alternative energy sources which however are beset with anti-nutrients. Therefore, to utilize the nutitional benefits of the alternative feedstuffs, it has to undergo some processing in other to reduce the ant-nutrients to a tolerable limits.

Present study was carried out to investigate the impact and economics of differently processed yellow cocoyam corm meal on turkey grower poult. Cocoyam corms were cut into pieces, some were sundried raw, some were cooked and sundried and others were fermented for three days and sundried. The cocoyam corms were ground in a hammer mill to make yellow cocoyam corm meal. The differently processed yellow cocoyam corm meal was used to compound seven experimental diets represented as $T_1 0$, $T_2 R_{15}$, $T_3 C_{15}$, $T_4 F_{15}$, $T_5 R_{25}$, $T_6 C_{25}$, and $T_7 F_{25}$. The $T_1 0$ represented the control containing 100% maize, R in T_2 and T_5 represented raw and dried cocoyam at 15% and 25% dietary inclusion level, respectively. The C in T_3 and T_6 represented cooked and dried cocoyam at 15% and 25% dietary inclusion levels respectively and F in T_4 and T_7 represented fermented and dried cocoyam at 15% and 25% dietary inclusion levels, respectively. Seven (7) groups of 15 turkey growers per group were assigned to one of the treatment diets in a completely randomized design (CRD). At the end of the 56 days feeding trial, performance indices result showed that there was significant differences ($P<0.05$) in average weight changes, average daily weight gain and feed conversion ration. The best feed conversion ratio was $T_7 F_{25}$ which was statistically similar ($P>0.05$) only to $T_3 C_{15}$ and $T_4 F_{15}$. The indices for economics of production showed that $T_7 F_{25}$ had high earnings for revenue and gross margin with reduced cost/kg weight gain. Nutrient retention showed that $T_4 F_{15}$, $T_6 C_{25}$, and $T_7 F_{25}$ were best and similar statistically ($P>0.05$) in crude protein digestibility. The haematological and serum indices were not affected significantly. It was concluded that fermented cocoyam corm meal should be included in turkey ration at 25% level due to its heavier weight gain, better feed conversion ratio, cost effectiveness and increased revenue and profit margin.

Key words: Effects, economics, turkey, processed, alternative feed, yellow cocoyam, Performance, Haematology, Serum, nutrient retention

INTRODUCTION

Poultry production has been observed as one of the means of increasing animal protein intake in Nigerian diets. Poultry, particularly turkey birds have numerous advantages over others due to their fast growth rate and they are also very prolific. They are affordable, available and have no taboos. They can be seen everywhere in Nigeria and many other countries around the world and can survive easily in any environment, (Ekenyem *et al.*, 2006 ; Iheukwumere, 2008 ; Obidimma and Anyaehie, 2010).

Scarcity and high cost of livestock feed is one of the major limiting factors against the growth of the livestock and poultry industry in Nigeria. The escalating cost of conventional energy feedstuffs such as maize has immensely contributed to the observed declining animal protein and animal production in Nigeria, (Ogbonna *et al.*, 2000). This is a result of a stiff competition between man and livestock for maize. FAO, (2018) urges that hunger and malnutrition should be fought beyond political undertone. FAO, (2000), also observed that across regions and sub-regions in Sub-Sahara Africa including Nigeria cereals such as maize, oat, sorghum etc. constitute the bulk of the source of energy in livestock and human diets. With respect to proteins, only in the developed world have animal products contributed and still contribute to a large proportion to the total supply within the same period. In Nigeria as a whole, cereals and legume crops contribute about 55% of the total supply, while animal products contribute only 25%, (FAO, 2000).

Yellow Cocoyam (*Xanthosoma sagittifolum*) is a corm and ranked third in importance after cassava and yam among the root and tuber crops (Ekwe *et al.*, 2012). They contain digestible starch, good quality protein, vitamin C, thiamine, riboflavin, niacin, and high scores of essential amino acids (Lewu and Adebola, 2010). Utilisation of the corms as energy source for poultry have been reported (Onu *et al.*, 2001), leaves and foliage as source of protein for pigs (Buntha *et al*., 2008) and as a soup ingredient for humans (Agwunobi *et al.*, 2002; Hang *et al*., 2011). Abdulrashid and Agwunobi (2009) reported that cocoyam meal contained 7.87% crude protein, 31% dry matter, 4.75% crude fiber, and 3214.91 Kcal/kg metabolisable energy on dry matter basis. Despite the high nutritional attribute of this root crop, it is highly neglected and underutilized due to the presence of anti-nutritional factors. Alcantara *et al*. (2013) reported that cocoyam contains anti-nutritional factors such as oxalate, phytates, saponin, tannin and flavonoids. The effective utilization of the nutrients in cocoyam will require processing to make the nutrients available to animals without being toxic. This will make cocoyam very useful in monogastric nutrition especially turkey. Fermentation is one of the traditional and most effective old known ways of detoxifying feed items before use. Fermentation is known to have added value to foods and has been reported to increase the soluble phenolic content of legumes, thereby enhancing its anti-oxidant activities (Oyarekua, 2011). Torres *et al.*, (2006) reported a remarkable improvement in the nutritive value and quality of legume seeds through fermentation. Igbabul *et al*., (2012) also reported that fermentation increased the protein content, moisture and crude fibre content of the *Mucuna sloanei* flour. Cooking is also one of the most effective means of detoxifying feed ingredients. Ukachukwu and Obioha (1997) recommended detoxification by cooking for 90 minutes or toasting for 60 minutes. Given the potentials of cocoyam as an alternative source of energy, and its availability and low price, it is predictated to have the potentials to reduce the cost of production of turkey. If cocoyam could be well utilized in turkey production as an alternative source of energy to maize, it will go a long way to reduce the cost of maize, turkey meat, egg, and other by-products making them available and affordable too.

This study therefore, was aimed at evaluating the response of turkey broiler grower to differently processed yellow cocoyam corm meal on their performance, nutrient retention, haematological, serum biochemical indices and its cost effectiveness.

MATERIALS AND METHODS

The studys was carried out at the Imo State University, Faculty of Agriculture Teaching and Reaearch farm,Owerri. Owerri is located within the South-Eastern agro-ecological zone of Nigeria. Owerri lies between latitude 5º29'' North and longitude 7º20'' East. It is almost 73m above sea level with annual rainfall, temperature, and humidity ranging from 1,500mm to 2,200 mm, 28 ºC and 75 – 90% respectively (Accuweather, 2015).

The yellow cocoyam corms used for this experiment were bought from rural areas and markets from Atta in Njaba L.G.A. and Egbu in Owerri North L.G.A. of Imo State Nigeria. These areas do not use yellow cocoyam corms as food and this has resulted to its trying to go into extinction. The cocoyam corms were cut into pieces and peeled. Some of the cocoyam corms were cut into pieces and sundried, some were cooked and sundried while some were fermented for three days and sundried. Thereafter the cocoyam corms were ground in a hammer mill to make yellow cocoyam corm meal suitable for incorporation into turkey feeds. The samples of the raw, cooked and fermented cocoyam corm meal were analyzed to determine the proximate and phytochemical composition according to AOAC (2010). Yellow cocoyam corms as well as other conventional feed ingredients for turkey such as fish meal, groundnut cake meal, palm kernel meal, vitamin premix, salt, DL-methionine and lysine were added to balance the diet.

Seven experimental diets were formulated to contain the differently processed yellow cocoyam corm meal. The experimental diets were represented as T_10, T_2R_{15}, T_3C_{15}, T_4F_{15}, T_5R_{25}, T_6C_{25}, and T_7F_{25}. T_10 represented the control containing 100% maize. R in T_2 and T_5 represented raw and dried cocoyam at 15% and 25% dietary inclusion level, respectively. C in T_3 and T_6 represented cooked and dried cocoyam at 15% and 25% dietary inclusion levels, respectively and F in T_4 and T_7 represented fermented and dried cocoyam at 15% and 25% dietary inclusion levels respectively. The experimental diet and calculated nutrient composition for the turkey broiler grower is presented in Tables 1.

Table 1: Ingredients and calculated nutrient composition of the experimental diet

Ingredients	$T_1$0%	$T_2R_{15\%}$	$T_3C_{15\%}$	$T_4F_{15\%}$	$T_5R_{25\%}$	$T_6C_{25\%}$	$T_7F_{25\%}$
Maize	53.18	38.18	38.18	38.18	28.18	28.18	28.18
YCCM	0.00	15.00	15.00	15.00	25.00	25.00	25.00
SBM	9.97	9.97	9.97	9.97	9.97	9.97	9.97
GNC	15.00	15.00	15.00	15.00	15.00	15.00	15.00
Fishmeal	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Bloodmeal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Palm oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00
PKC	7.00	7.00	7.00	7.00	7.00	7.00	7.00
Wheat offal	5.00	5.00	5.00	5.00	5.00	5.00	5.00
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Salt	0.25	0.25	0.25	0.25	0..25	0.25	0.25
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
*Vit. Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	100	100	100	100	100	100	100
Calculated Nutrient Composition							
CP (% DM)	20.00	20.43	20.47	20.35	20.71	20.45	20.58
ME(Kcal/kg)	2947.48	2884.61	2905.68	2897.80	2842.71	2877.81	2864.67
EE (%DM)	6.74	6.77	7.13	7.13	6.79	7.39	7.39
CF (%DM)	3.98	4.95	4.97	4.39	5.60	5.63	4.67
Ash (%DM)	3.16	4.06	3.88	4.96	4.66	4.35	6.15
Ca (%DM)	0.27	5.67	5.67	5.67	9.27	9.27	9.27
P (%DM)	0.46	2.94	2.94	2.94	4.59	4.59	4.59
Lysine (%DM)	0.89	0.90	0.90	0.90	0.90	0.90	0.90
Methionine	0.34	0.32	0.32	0.32	0.31	0.31	0.31

*Provided the following per kg of feed; vitamin A, 1000iu; vitamin D3, 1500iu; vitamin E 51mg; vitamin K, 2mg; Riboflavin, 3mg; Pantothenic acid, 10mg; Nicotinic acid, 25mg; Choline, 350mg; Folic acid, 1mg; Mg, 56mg; Iodine, 1mg; Fe, 20mg; Zn, 50mg; Co, 1.25mg.

Note: YCCM (Yellow cocoyam corm meal); SBM (Soya bean meal); GNC (Groundnut cake); PKC (Palm kernel cake); CP (Crude protein); ME (Metabolizable energy); EE (Ether extract) and CF (Crude fibre)

A total of 105 day old turkey were used for the experiment. The day-old chicks were purchased from a reputable hatchery in Owerri. The day old turkey broiler were brood for four weeks in the brooder house. Thereafter brooding was discontinued and the birds were reared for another four weeks during which they were given turkey starter ration. At the end of the eight weeks starter phase, the turkeys were divided into 7 groups of 15 birds per group and each group assigned to one of the treatment diets in a completely randomized design (CRD). Each of the groups were further divided into three replicates of 5 turkey birds per replicate. The initial weights of the turkey growers were weighed and recorded and weekly thereafter for another seven (7) weeks. Feed intake was recorded daily and the birds weighed weekly after taking the initial body weight. Feed intake was determined by weighing the feed offered and the left-over the following day. The difference between the two values was taken as the feed consumed. Feed conversion ratio was determined by dividing the average daily feed intake by average daily body weight gain. Economic indices determined were average weight changes, average daily weight gain and average daily feed intake. Other indices were calculated as followed (i) cost/kg weight gain was calculated as feed conversion ratio multiplied by cost/kg of feed; (ii) cost of feed consumed was taken as cost of production; (iii) cost of production was calculated as cost/kg weight gain multiplied by average weight changes; (iv) price/kg meat = price of selling one kg of meat; (v) revenue = price /kg meat multiplied by average weight changes and (vi) gross margin (profit) was calculated as revenue minus cost of production.

Blood samples were collected from 3 birds per treatment at the end of the feeding trial from the wing vein of the birds using syringe and needle and placed in the specimen bottles with EDTA (Ethylene Diamine Tetra Acetate) for haematological studies. Blood was analyzed within three hours of collection for haemoglobin (Hb) level, white blood cells (WBC), red blood cells (RBC), packed cell volume (PCV), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concenteration (MCHC), heterophils, basophils, eosinophil, lymphocytes and monocytes as outlined by Ochie and Kolhatkar (2000).

Blood samples collected were placed in the specimen bottles without EDTA for biochemical studies. Serum biochemical indices analyzed were total protein, glucose, urea, creatinine, cholesterol, sodium, potassium, chloride, carbonate and serum enzymes as outlined by Ochie and Kolhatkar (2000).

Data collected were subjected to analysis of variance using the SPSS software (2012). Where analysis of variance indicated significant treatment effects, means were compared using Duncan's New Multiple Range Test (DNMRT) (SPSS, 2012)

RESULTS

Proximate and phytochemical composition of yellow cocoyam corm meal ((*Xanthosoma sagittifolum*)

The proximate and phytochemical composition of the differently processed yellow cocoyam corm meal ((*Xanthosoma sagittifolum*) are shown in Table 2 and 3. The moisture content of the raw cocoyam corm meal on wet mass basis (RWMB) was significantly ($P<0.05$) increased compared to other processing methods. Cooked and dried cocoyam corm meal (CDCCM), fermented and dried cocoyam corm meal (FDCCM) and raw dried cocoyam corm meal (RDCCM) where statistically similar ($P>0.05$). The crude protein content of the FDCCM was significantly increased ($P<0.05$) compared CDCCM and Rwmb. Total carbohydrate for all the different processing methods were statistcally similar ($P>0.05$). The results of the phytochemical composition showed that the saponin, oxalate, phytate, tannin and hydrogen cynanide of the CDCCM, FDCCM and RDCCM were reduced significantly ($P<0.05$) by the different processing methods compared to the RWMB. Olajide *et al*. (2011) reported a similar reduction in antinutrients when subjected to processing methods such as fermentation, cooking and sundrying. Fermentation, cooking and raw dried were similar ($P>0.05$) in the extent to which the the anti-nutritional factors were affected. Fermentation significantly reduced ($P<0.05$) the saponine component of the cocoyam corm meal compared to cooking and raw dried. Data on the performance of the experimental turkey grower birds are shown in Table 3. There was no significant difference ($P>0.05$) in the mean initial weight and the mean final weight. The average weight changes showed that the raw dried at 15% dietary level (T_2R_{15}) was significantly decreased ($P<0.05$) compared to the rest treatment except the control (T_10). The average daily weight gain was significantly decreased ($P<0.05$) at the control (T_10) and raw dried at 15% level (T_2R_{15}) compared to the rest treatment. The mean daily feed intake were statistically the same ($P>0.05$) across treatment. Feed conversion ratio was best at 25% dietary inclusion levels of fermented cocoyam corm meal ($T_{7-}F_{25}$) but similar statistically ($P>0.05$) to 15% inclusion levels of fermented cocoyam corm meal (T_4F_{15}) and cooked cocoyam corm meal at 15% levels (T_3C_{15}). Thus (T_7F_{25}) was significantly better than ($T<0.05$) than T_1O, raw dried at 15% and 25% inclusion levels ($T_2R_{15,}$ $T_5R_{25)}$ and cooked dried at 25% inclusion level (T_6C_{25}). The mean weight changes and mean daily weight were higher in T_7F_{25} and this reflected in a better feed conversion ratio of 3.08. This implies that the diet at 25% inclusion level of FCCM was adequately consumed and efficiently utilized. There was no adverse effect of anti-nutritional factor. Fermentation must have reduced the antinutritional factors to a tolerable limit. The feed conversion ratio of 3.08 was close to the standard reference range 2.7 to 2.8 reported by Ghosh (2015)

Data on the cost and returns of feeding differently processed yellow cocoyam corm meal on turkey grower poult are shown in Tables 5. The feed cost, cost per kg weight gain and cost of production were highest in T_1O. This implies that it costs more to produce one kg of meat compared to others. The feed cost per kg weight gain was best or lowest at T_7F_{25} indicating that it costs less to produce 1kg of meat at 25% dietary inclusion level of FCCM. The revenue and gross margin (profit) was also highest at 25% dietary inclusion level of FCCM. Data available from this research indicates that 25% inclusion level of FCCM was best compared to cooking or raw dried because of heavier body weight changes and heavier mean daily weight gain which culminated in better feed conversion efficiency, reduced cost per kg weight gain, reduced cost of production and higher revenue and profit margin.

Data on the nutrient retention of turkey grower poult fed varying levels of differently processed yellow cocoyam corm meal are shown in Tables 6. Dry matter digestibility was significantly

Table 2 : Proximate composition of the differently processed yellow cocoyam corm meal (*Xanthosoma sagittifolum)*

Sample code	Moisture %	Ash %	Fat %	Crude Fiber	Crude protein %	Total carbohydrate %
CDCCM	$4.84^{b} \pm 0.80$	$6.05^{b} \pm 0.37$	$6.59^{a} \pm 0.28$	$9.31^{a} \pm 0.34$	$10.67^{b} \pm 0.24$	$62.52^{a} \pm 1.49$
FDCCM	$2.78^{b} \pm 1.08$	$7.26^{b} \pm 0.16$	$4.19^{b} \pm 0.10$	$9.19^{a} \pm 0.26$	$11.72^{a} \pm 0.24$	$63.0^{a} \pm 0.77$
RDCCM	$1.98^{b} \pm 0.20$	$13.24^{a} \pm 0.45$	$6.58^{a} \pm 0.07$	$5.47^{b} \pm 0.23$	$11.20^{ab} \pm 0.0$	$60.51^{a} \pm 0.44$
Rwmb	$59.94^{a} \pm 0.39$	$3.43^{c} \pm 0.03$	$1.06^{c} \pm 0.05$	$3.21^{c} \pm 0.08$	$8.26^{c} \pm 0.12$	$24.08^{b} \pm 0.20$
LSD (0.05)	0.71254	0.30636	0.15859	0.24948	0.18503	0.87590

Mean values with different letters on the same column are significant ($p<0.05$); LSD = Least significant different; CDCCM means Cooked and dried; RDCCM means Raw and dried; FDCCM means Fermented and dried Rwmb means Raw wet mass basis

Table 3: Phytochemical composition of differently processed yellow cocoyam corm meal

Sample code	Saponin %	Tannins %	Phytate %	Hydrogen cyanide mg/100g	Oxalate mg/g
CDCCM	$4.37^{C} \pm 0.02$	$2.97^{b} \pm 0.0$	$4{,}43^{b} \pm 0.0$	$5.02^{b} \pm 0.07$	$0.256^{b} \pm 0.003$
RDCCM	$5.36^{b} \pm 0.01$	$3.86^{b} \pm 0.06$	$4.59^{b} \pm 0.24$	$3.10^{c} \pm 0.11$	$0.286^{b} \pm 0.008$
FDCCM	$3.46^{d} \pm 0.07$	$3.46^{b} \pm 0.05$	$3.79^{b} \pm 0.21$	$4.15^{b} \pm 0.07$	$0.233^{b} \pm 0.0$
Rwmb	$8.10^{a} \pm 0.20$	$11.10^{a} \pm 1.24$	$14.22^{a} \pm 0.48$	$33.31^{a} \pm 0.47$	$7.041^{a} \pm 0.28$
LSD (0.05)	0.11112	0.62318	0.28923	0.25197	0.13083

Mean values with different letters on the same column are significant ($p<0.05$); LSD = Least significant different; CDCCM means Cooked and dried; RDCCM means Raw and dried; FDCCM means Fermented and dried Rwmb means Raw wet mass basis

Table 4: The result of the performance of turkey grower offered differently processed yellow cocoyam corm meal

Indices	T_1O	T_2R_{15}	T_3C_{15}	T_4F_{15}	T_5R_{25}	T_6C_{25}	T_7F_{25}	SEM
Av. Initial weight (g)	2377.78	2516.67	2600.00	2016.67	2350.00	2566.67	2500.00	297.07
Av. Final weight (g)	7291.67	7125.00	7750.00	7491.67	7675.00	7805.56	8253.33	324.22
Av. Weight change (g)	4913.89^{ab}	4608.33^{b}	5150.00^{a}	5475.00^{a}	5325.00^{a}	5238.89^{a}	5753.33^{a}	307.40
Av. Daily weight change (g)	87.75^{b}	82.29^{b}	91.96^{a}	97.77^{a}	95.10^{a}	93.55^{a}	102.74^{a}	4.01
Av. Daily feed intake (g)	282.28	334.13	287.82	303.63	307.23	336.95	316.55	27.42
Feed conversion ratio	3.22^{c}	4.06^{a}	3.13^{cd}	3.11^{cd}	3.23^{c}	3.60^{b}	3.08^{d}	0.04

Abcd means within the same row with different superscripts are significantly different ($P<0.05$)

Table 5: Cost and returns of turkey grower offered differently processed yellow cocoyam corm meal

Parameters	T_1O	T_2R_{15}	T_3C_{15}	T_4F_{15}	T_5R_{25}	T_6C_{25}	T_7F_{25}
Feed cost/kg	300	270	273	270	250	255	250
Cost/kg weight gain	966.00	1,096.20	854.49	839.70	812.50	918.00	770.00
Cost of production	4,746.82	5,051.65	4,400.62	4,597.36	4,326.56	4,809.30	4,430.06
Cost of feed consumed	4,746.82	5,051.65	4,400.62	4,597.36	4,326.56	4,809.30	4,430.06
Price/kg meat	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Revenue	7,370.84	6,912.50	7,725.00	8,212.50	7,987.50	7,858.33	8,630.00
Gross margin (profit)	2,624.02	1,860.85	3,324.38	3,615.14	3,660.94	3,049.03	4,199.94

increased (P<0.05) at T_7F_{25} compared to T_I0, $T_2R_{15,}$ and T_5R_{25} but statistically similar to $T_3C_{15,}$ T_4F_{15} and $T_6C_{25.}$ It all implies that the fermented and cooked yellow cocoyam corm meal at 15% and 25% inclusion levels were digested. The dry matter digestibility of T_5R_{25} was significantly decreased (P<0.05) compared to the rest treatment but similar (P>0.05) to the control (T_I0). $T_4F_{15,}$ T_6C_{25} and T_7F_{25} were similar (P>0.05) in terms of crude protein digestibility and significantly increased (P<0.05) compared to T_I0, $T_2R_{15,}$ T_3C_{15} and T_5R_{25}. T_6C_{25} crude fiber digestibility was significantly increased (P>0.05) compared to T_I0, $T_2R_{15,}$ $T_4F_{15,}$ T_5R_{25} and $T_7F_{25.}$ Data on the haematological and serum biochemical indices of turkey grower poult fed diets containing varying levels of differently processed yellow cocoyam corm meal are presented in Tables 7 and 8. Haemoglobin (HB), packed cell volume (PCV), white blood cell (WBC), red blood cell (RBC), erythrocyte sedimentation rate (ESR), and mean cell haemoglobin (MCH) did not show any treatment effect (P>0.05). Mean cell volume was significantly decreased (P<0.05) at T_4F_{15} compared to other treatments but significantly increased (P<0.05) at $T_7F_{25.}$ Mean cell haemoglobin conentration (MCHC) was significantly increased (P<0.05) at T_4F_{15} compared to T_2R_{15}, T_6C_{25} and $T_7F_{25..}$ Serum biochemical indices revealed that urea, creatinine, and cholesterol did not show any significant treatment effect (P>0.05). Total protein was significantly increased (P<0.05) at T_6C_{25} and T_7F_{25} compared to T_5R_{25} but similar to T_I0, $T_2R_{15,}$ $T_3C_{15,}$ and $T_4F_{15.}$ The liver enzymes Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) were significantly decreased (P<0.05) at T_5R_{25} compared to other treatments. T_I0, $T_2R_{15,}$ $T_3C_{15,}$ $T_4F_{15,}$ T_6C_{25} and T_7F_{25} were statistically similar (P>0.05) implying that there was no negative effect of the test diet on the liver functions

Table 6: Nutrient retention of turkey poult fed on varying levels of different processed yellow cocoyam corm meal.

Parameters	T_I0	T_2R_{15}	T_3C_{15}	T_4F_{15}	(T_5R_{25})	T_6C_{25}	T_7F_{25}	SEM
DM digest	67.28^{cd}	70.88^{bc}	72.40^{abc}	74.72^{ab}	64.06^{d}	74.24^{ab}	77.84^{a}	1.80
CP digest	85.97^{b}	85.20^{b}	86.90^{b}	91.16^{a}	88.09^{b}	91.76^{a}	91.24^{a}	1.01
CF digest	51.60^{d}	57.53^{d}	75.36^{ab}	71.32^{bc}	70.92^{bc}	86.50^{a}	61.63^{cd}	4.11
EE digest	87.76	92.36	94.51	96.21	96.82	97.48	97.92	4.21
Ash digest	85.16^{a}	31.27^{c}	42.31^{c}	55.57^{b}	50.80^{b}	51.74^{b}	51.64^{b}	8.01
NFE digest	69.50	69.09	69.07	72.66	58.46	76.38	68.42	5.15

Abcd means within the same row with different superscripts are significantly different (P<0.05)
DM means dry matter; CP means crude protein; CF means crude fiber; EE means ether extract; NFE means nitrogen free extract; digest means digestibility

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Table 7: Haematological indices of turkey grower poults fed diets containing varying levels of differently processed yellow cocoyam corm meal.

Parameters	T_I0	T_2R_{15}	T_3C_{15}	T_4F_{15}	T_5R_{25}	T_6C_{25}	T_7F_{25}	SEM
HB(g/dl)	12.98	13.38	13.30	13.10	13.23	13.00	13.03	0.18
PCV (%)	41.00	44.00	43.00	40.67	42.00	42.33	42.66	0.86
WBC($X10^9$/l)	11.77	12.17	12.10	11.09	12.00	11.97	11.80	0.17
RBC($X10^{12}$/l)	12.63	12.27	13.23	13.00	13.17	12.93	13.00	0.14
ESR($mm^2/1^{ST}$1hr)	26.67	20.00	16.67	20.00	16.67	30.00	26.67	7.87
MCV(fl)	32.27^c	32.77^{ab}	31.83^d	31.20^e	31.77^d	32.47^{bc}	33.07^a	0.12
MCH(pg)	10.23	10.03	10.00	10.07	10.00	9.93	9.90	0.07
MCHC(g/dl)	31.63^{ab}	30.63^b	31.47^{ab}	32.23^a	31.50^{ab}	30.23^b	30.00^b	0.37

abc: means with different superscript on the same row are significantly different ($p<0.05$).
HB – Haemoglobin (g/dl); PCV – Packed Cell Volume (%); WBC – White Blood Cell ($x10^9$/L); RBC – Red Blood Cell ($x10^{12}$/L); ESR – Erythrocyte Sedimentation Rate ($mm^3/1^{st}$ 1Hour); MCV – Mean Cell Volume (fl); MCH – Mean Cell Haemoglobin (pg); MCHC – Mean Cell Haemoglobin Concentration (g/dl).

DISCUSSION

The crude protein content of the yellow cocoyam corm meal on Rwmb was close to the value (7.87% crude protein) reported by Abdulrashid and Agwunobi (2009). The differently processed methods, FDCCM, CDCCM and RDCCM gave a higher value for crude protein compared to the Rwmb. It was an indication that fermention, cooking and drying improved the nutritive value of the test feed or cocoyam. The processing methods may have influenced the release of bound crude proteins. The crude fiber content (4.75%) reported by Abdulrashid and Agwunobi (2009) was also similar to the value of crude fiber for the yellow cocoyam corm meal on raw wet mass basis. The values of crude protein reported by Olajide *et al*. (2011), and Ndabikunze *et al*. (2011) for fermented cocoyam (7.44%), cooked cocoyam (6.11%), soaked cocoyam (6.56%), raw sundried (4.93-7.07%) were lower than the values obtained in this study. The processing method and procedure, the duration of drying, mode of drying, duration of fermentation and cooking, cooking temperature and duration may be respomsible for the variance in crude protein content. The turkey grower performed better at 25% dietary level of the fermented cocoyam corm meal. The superior performance of the birds in mean weight gain, mean daily weight gain and feed conversion ratio was a reflection of the effect of fermentation on the test diet. Fermentation unlocked nutrients that were bound in the cocoyam thus making it available for digestion, absorption and utilization for growth and production. The solubility of proteins and the

Table 8: Serum biochemical indices of turkey grower poults fed diet containing varying levels of differently processed yellow cocoyam corm meal

Parameters	T_10	T_2R_{15}	T_3C_{15}	T_4F_{15}	T_5R_{25}	T_6C_{25}	T_7F_{25}	SEM
Urea (mmol/dl)	3.71	3.74	3.74	3.74	3.71	3.75	3.74	0.008
Creatinine (mmol/dl)	0.08	0.09	0.09	0.08	0.08	0.09	0.08	0.003
Cholesterol (mmol/dl)	168.33	169.33	169.00	169.67	166.33	171.33	170.00	1.64
Total protein (g/dl)	5.70^{ab}	5.60^{ab}	5.83^b	5.70^{ab}	5.57^a	5.80^b	5.77^b	0.05
Albumen (g/dl)	2.35	2,30	2.40	2.40	2.23	2.30	2.30	0.06
Globulin (g/dl)	2.96	3.60	3.47	3.30	3.33	3,50	3.47	0.14
Na+ (mmol/dl)	118.40	117.87	117.63	117.43	117.00	117.67	117.30	0.20
K+ (mmol/dl)	5.50	5.47	5.40	5.50	5.17	5.53	5.55	0.10
HCO3 (mmol/dl)	28.90	28.80	28.47	28.23	27.90	28.73	28.63	0.26

Cl-(mmol/dl)	78.70^{b}	78.43^{b}	78.37^{b}	78.50^{b}	77.23^{ab}	78.27^{b}	77.77^{bc}	0.15
Alk (iu/l)	25.77	25.67	25.58	25.23	25.41	25.49	25.37	0.16
SGOT (iu/l)	45.33^{a}	45.27^{a}	45.13^{a}	45.03^{a}	41.73^{b}	45.30^{a}	44.97^{a}	0.55
SGPT (iu/l)	11.82^{a}	11.67^{a}	11.67^{a}	11.58^{a}	11.27^{b}	11.67^{a}	11.63^{a}	0.09

abcd: means with different superscript on the same row are significantly different ($p<0.05$).
Na – Sodium; K-Potassium; HCO3-Carbonate; Cl-Chloride; Alk-Alkaline Phosphate; SGOT – Serum Glutamic Oxaloacetic Transaminase; SGPT – Serum Glutamic Pyruvic Transaminase.

availability of some micronutrients and limiting amino acids are enhanced by the process of lactic acid fermentation (Rollan *et al*.,2019). Fermentation reduced the anti-nutritional factors in the cocoyam thus eliminating any barrier on nutrient digestion or any deleterious effect on the turkey growth and development. This was also demonstrated in the reduction in the level of pytochemicals in the cocoyam after fermentation. Samtiya *et al*. (2020) reported that fermentation reduced tannins by 50%, phytates and oligosaccharides by 90%. . The feed conversion ratio was better than the control and the raw dried at 15% and 25% dietary inclusion levels. Anti-nutrients in the raw dried cocoyam corm meal may have prevented the release of some nutrients that would have been beneficial for growth and development of the turkey. The feed conversion ratio was within the range 3.85 to 5.02 reported by Adeyeye *et al.* (2022) but higher than the reference range (2.7 to 2.8) recommended by Ghosh (2015) for turkey.

Cost per kg weight gain decreased at 25% inclusion level for all treatments because of the reduced quantity of maize in the meal compared to 15% inclusion levels which had a higher quantity of maize in the ration. The cost per kg weight gain and cost of production were highest in T_1O due to high cost of maize and poor feed conversion ratio. When the feed conversion ratio is poor, it will cost more to produce one kg of meat. Similarly, when the cost of feed ingredient is high, the final cost of production will increase. The feed cost per kg weight gain was at optimum at T_7F_{25} due to reduced cost of test feed ingredient and better feed conversion ratio. Low value for feed conversion ratio or optimum feed conversion ratio leads to low cost of production since it costs less to produce one kg of meat. T_7F_{25} gave higher revenue and gross marginn (profit). This is because 25% inclusion level of fermented cocoyam corm meal produced heavier body weight gain and better feed conversion ratio than the rest (that is, more kilos of meat than the rest treatments) which was sold to generate more money. Fermented yellow cocoyam corm meal generally speaking performed best, was cost effective and yeilded more revenue and profit margin at 25% inclusion level due to reduced cost of test feed item, heavier body weight gain, and better feed conversion ratio.

The increase in dry matter digestibility of the fermented and cooked cocoyam corm meal at 15% and 25% inclusion levels was an indication of high intake of the nutrients with these processing methods. Digestibility rating in this study ranged between 42.31 and 97.92%. Alimuddin (2000) reported that digestibility percent rating is good when above 70%, moderate when between 40 and 60% and very low when below 40%. In this study, the digestibility of dry matter by the turkeys were good for fermented and cooked at both 15% and 25% inclusion levels but best at 25% dietary inclusion levels of the fermented cocoyam corm meal. Crude protein digestibility rating was generally good across treatments but the treatment effect was more on turkey fed 25% and 15% dietary inclusion levels of fermented cocoyam corm meal and 25% cooked cocoyam corm meal. This effect was also reflected on the performance of the birds with 25% inclusion levels having higher treatment effect on feed conversion ratio and consequently higher revenue and profit margin. The digestibility of cocoyam corm meal was influenced by the processing method which involved the hydrolysis of proteins to its constituent amino acids. The digestibility of crude protein increased with the fermented cocoyam corm meal at all levels and cooked cocoyam corm meal at 25% inclusion levels. Adegbenjo *et al*. (2020) observed a similar trend in turkey when hydrolysed feather meal was substituted for fish meal in turkey and attributed the reason for high digestibility to processing method.

The HB indices of turkey on all the treatment diets is within the range (10.8- 12.9) for turkeys reported by Adeyeye *et al*. (2022) but higher than the range 9.10-10.57 and 8.60-11.13 reported by Ajuonuma *et al*. (2013) and Ugwuene and Onunkwo (2016). The pattern of this result across all treatments was an indicator that the efficiency of the turkeys fed the differently processed diets in metabolizing the diets were similar since haemoglobin is responsible for cellular respiration which is important in metabolic reactions (Ugwuene and Onunkwo, 2016). Reduced Hb concentration suggests the presence of a toxic factor which may have an adverse efect on blood formation (Oguntoye *et al*., 2018) The values recorded for WBC (9-31g/l) fell within the physiological range (Nambol *et al*., 2016, Adeyeye, *et al*., 2022). According to Akinmutimi *et al*. (2004), a low WBC count suggests susceptibility to infection. The values recorded for packed cell volume were above the physiological range, 32–35% reported by Nanbol *et al*., (2016), 38.90 and 30.60 (for male and female turkey respectively) reported by Hayet *et al.* (2021) but within the range 31.33- 45.00 reported by Ugwuene and Onunkwo, (2016). The reason that the there was no significant treatment effect on the birds between the control and the treatment diets suggested that there was no deleterious effect from the diets on the birds. The higher values from the HB, RBC, and PCV suggested that the turkeys were healthy and not susceptible to diseases. The Hb and PCV recorded in this study revealed that the turkeys had sufficient blood pigment for proper transmission of oxygen, thus, the birds were healthy. The values obtained for all the diets indicate nutritional adequacy of all diets since values did not indicate under-nutrition or malnourishment (Church *et. al*., 1984). Serum enzyme activities are used for checking toxicity as well as monitoring protein quality (Ukpabi *et al*., 2015). An increase in serume enzyme is a sign of toxicity or damage to organ. The SGOT and SGPT were similar across treatments compared to the control but significantly decreased at T_5R_{25} which was an indication of a liver in its normal physiological state.

CONCLUSION

The result of the trial showed that the different processing methods reduced the antinutrients to a tolerable level.

The study also revealed that the turkey performed best at 25% inclusion level of the fermented cocoyam corm meal.

The study showed that fermentation was the most effective processing method being able to unlock nutrients that were bound to the cocoyam making possibe growth and development.

The study revealed that Fermented yellow cocoyam corm meal was cost effective, yeilded more revenue and profit margin, heavier body weight gain, and better feed conversion ratio at 25% inclusion level.

The result of the trial showed that dry matter and crude protein digestibility was good for all the differently processed methods but nutrient retention was more effective on turkey fed 25% and 15% dietary inclusion levels of fermented cocoyam corm meal and 25% cooked cocoyam corm meal.

The study also revealed that all the differently processed yellow cocoyam corm meal had no visible toxic or deleterious effect on the biochemical and haematological indices of turkey grower poult demonstrating the efficacy of the processing methods.

It was concluded that fermented yellow cocoyam corm meal was cost effective, yielded more revenue and profit margin, heavier body weight gain and superior feed conversion ratio.

RECOMMENDATION

It was therefore, recommended that fermented yellow cocoyam corm meal should be used as energy source in the ration of turkeys at 25% inclusion levels.

In the future, it may be necessary to try this fermented yellow cocoyam corm meal on other poultry and livestocks.

Acknowledgements

We want to acknowledge TETFUND NIGERIA, IMO STATE UNIVERSITY, Owerri that financed this research work completey, Mr. Ignatius Johnbosco and Miss Victoria Uzoma who assisted us greatly in the field work.

Conflict of interest

We declare that there is no conflict of interest in this paper. The work is original document of the authors.

Authors' contribution

Esiegwu, AC, Okonkwo, VN. and Chidiebere-Mark, NM., jointly designed this work. Data collection was done by the three authors. Chidiebere-Mark, NM., carried out the statistical analysis while Esiegwu, AC did the write up. The write up was edited and reviewed by Chidiebere-MarkNneka and Okonkwo, V. N.

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