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The Effect of Varying Levels of Potassium Hydroxide-Treated False Yam Seed Meal on Growth Performance, Haematology and Serum Biochemistry of Male Broiler Chickens

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ABSTRACT—This study was carried out to evaluate sequential treatment of false yam seeds as substitute for maize in broiler chicken diets on their growth, carcass, haematology and serum biochemistry. Ripped fruits of false yam plants growing in the wild were harvested by hand picking. The fruits were partially sun-dried to reduce their moisture content and facilitate cracking to obtain the false yam seeds (FYS). The fresh FYS were crushed with a stone to reduce size, increase surface area and facilitate processing. The freshly crushed false yam seeds were subjected to multiple-stage processing where seeds were first soaked in ordinary water (i.e., addition of fresh seeds in ordinary water at a ratio of 1:2, wt/vol) for 12 days with water being changed every 3 days. After the 12 days of soaking, the seed sample was washed with clean ordinary water. In the second stage of processing, soaked FYS was soaked in a solution of 1M concentration of potassium hydroxide at a ratio of 1:2 (wt/vol) for 24 hours, after which the sample was washed thoroughly with clean ordinary water. The last stage of processing involved blanching of potassium hydroxide-treated seeds, firstly by immersing the sample in hot water (90^0C) for 20 minutes and then transferring it into cold water (4^0C) for 40 minutes. The treated seed sample was then washed with clean water, sun-dried to approximately 12% moisture on a cement floor and ground into gritty flour using a hammer mill. The treated false yam seed meal was labeled as KOH_T FYSM. At 21 d of age, 128 birds were individually weighed and then randomly assigned to one of four dietary treatments in quadruplicate lots. Each replicate had 8 male broilers. The mean live-weight of birds in each replicate was 883 g (±0.05). The four treatments included the control without KOH_T FYSM; treatments 2, 3 and 4 contained 100, 300 and 500g/kg KOH_T FYSM respectively replacing maize (wt. /wt. basis) in a completely randomized design. The birds were fed various diets for 35 d. The growth response of male broiler chickens fed diets supplemented with varying levels of KOH_T FYSM revealed no significant (P<0.05) difference in all growth parameters measured. Carcass dress weight and carcass dressing showed no significant (P>0.05) difference at 500g/kg. However, the relative weight of organs revealed a significant (P<0.041) increase in the heart weight and a reduction in the weights of the liver and the spleen. Haematological parameters evaluated revealed a significant (P<0.05) decrease in the haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration as KOH_T FYSM was increased in the diets. The economics of replacing maize with KOH_T FYSM in the diets of male broilers revealed that price per kg of feed reduces as the test material was increased in the diets. Inclusion of KOH_T FYSM up to 500g/kg in the diets of male broilers had no adverse effect on their growth performance. However, its inclusion influenced internal organ weights such as the liver, spleen and heart. Economics of feeding KOH_T to broilers did not increase cost of feeding, suggesting that, There is an economic value for using this product for broiler chickens as an alternative to maize during periods of scarcity and can be recommended for use by farmers where this plant is available.

Keywords**: false yam seed, chemical treatment, broiler chicken, growth, blood**

INTRODUCTION

Carbohydrate and protein are the major components of poultry diet which are also the major cost items of feed.
Thus feed cost comes into focus as the greatest problem affecting the productivity and profitability of the poultry enterprise due to increasing prices of feed materials such as maize. Feeding is the most effective means of controlling the cost of production and product quality (Larbier and Leclerq, 1994). Thus it would be cheaper for poultry farmers to prepare their own feed using available feed resources including non-conventional feedstuffs (Tachie-Menson, 1991). Examples of non-conventional feed resources useful for poultry production include cassava (Oluyemi and Robert, 1979), blood (Donkoh et al., 1998) and oilseed cakes (Nelson, 1993).

One of the recently discovered non-conventional feedstuffs for poultry is the false yam (*Icacina oliviformis*) tuber. False yam is indigenous to West and Central Africa. The tuberous root is fleshy and contains about 80% starch (Fay, 1991).

The plant also produces seeds which are edible and serve as food during famine. The seed contains 80.7% carbohydrate, 14% protein and 0.5% fat (Fay, 1991). The dried seeds turn rock hard thus can be stored with negligible loss (Fay, 1991). However, both the seeds and tuber contain bitter substances (gum resins), therefore cannot be eaten directly (Fay, 1991). The bitter substances limit their utilization as food for man and as feed for animals; hence both products are available in abundance. It is known that aqueous solutions can be used in the extraction process of terpenes (Kamphoff et al., 2007).

However, some metabolic activities can take place during soaking which will affect the constituent compounds (Vidal-Valverde et al., 1992). Soaking false yam seed in water for 12 days improved its feed value for poultry over the unprocessed seed (Dei et al., 2012; Mohammed and Dei, 2013). According to Roessler *et al.* (2017), soaking in water removes hydrophilic compounds from the false yams tuber more easily than lipophilic ones.

Chemical treatments that have achieved significant reduction in anti-nutritional factors from plant origin are mostly alkaline in nature (D'Mello and Walker, 1991).

There is little information on how false yam seed treated in water and potassium hydroxide would influence its nutritive value for poultry. Therefore, there is a need for evaluation of the growth response of broiler chickens fed diets containing KOH_T FYSM meal.

MATERIALS AND METHODS

The study was conducted at the University for Development Studies (UDS), Tamale, Nyankpala, northern Ghana. Nyankpala is located in the Guinea Savanna Zone on latitude 09° 25″ N and longitude 00° 58″ N at altitude 183m above sea level. The temperature fluctuates between 19°C (minimum) and 42°C (maximum) with a mean annual temperature of 28.3°C. Rainfall is mono-modal and occurs from April to October with a mean annual rainfall of 1200mm and a mean annual day - time humidity of 54% (Kasei, 1988). The poultry house was open sided to allow for natural ventilation. Light was provided 24 h daily, as is common practice in northern Ghana to stimulate feed intake during cooler night temperatures (Dei *et al*., 2011). The intensity of light was 10 lx. Ethical clearance was obtained from the Ethical Committee on Animal Experimentation of the University for Development Studies (UDS) (code number ANS/FOA/03/25052017). The experiment was conducted in compliance with regulations for animal experiments of UDS, and was closely supervised by a veterinarian.

Ripped fruits of false yam plants growing in the wild were harvested by hand picking. The fruits were partially sun-dried to reduce their moisture content and facilitate cracking to obtain the false yam seeds (FYS). The fresh FYS were crushed with a stone to reduce size, increase surface area and facilitate processing (Dei et al., 2014).

The freshly crushed false yam seeds were subjected to multiple-stage processing where seeds were first soaked in ordinary water (i.e., addition of fresh seeds in ordinary water at a ratio of 1:2, wt/vol) for 12 days with water being changed every 3 days. After the 12 days of soaking, the seed sample was washed with clean ordinary water. In the second stage of processing, soaked FYS was soaked in a solution of 1M concentration of potassium hydroxide at a ratio of 1:2 (wt/vol) for 24 hours, after which the sample was washed thoroughly with clean ordinary water. The last stage of processing involved blanching of potassium hydroxide-treated seeds, firstly by immersing the sample in hot water (90^0C) for 20 minutes and then transferring it into cold water (4^0C) for 40 minutes. The treated seed sample was then washed with clean water, sun-dried to approximately 12% moisture on a cement floor and ground into gritty flour using a hammer mill. The treated false yam seed meal was labeled as KOH_T.

Broiler assay

Mixed sex broiler chicks (Cobb 500) were obtained at day-old from a local hatchery in Dormaa and reared in a deep-litter floored brooder house and fed a starter broiler diet (CP=220.0 g/kg, ME=12.2 MJ/kg) for 21 days. At 21 d of age, 128 birds were individually weighed and then randomly assigned to one of four dietary treatments in quadruplicate lots. Each replicate had 8 male broilers. The mean live-weight of birds in each replicate was 883 g (±0.05). The four treatments (Table 1) included the control without KOH_T; treatments 2, 3 and 4 contained 10%, 30% and 50% potassium hydroxide treated false yam seed meal (KOH_T) respectively replacing maize (wt. /wt. basis) (Table 1). The diets were formulated to contain adequate levels of required nutrients for growing broiler chickens. Feed and water were given *ad libitum.* The experiment lasted 35 days. Each replicate lot of experimental birds was kept in a pen ($0.16m^2$/bird) within an open-sided conventional house in a completely randomized design. Artificial light was provided in the night as a strategy to encourage feed intake at night to check the anorexic effects of the high day time temperatures (as high as 40^0C) in the Savannah regions of Ghana during the experimental period.

Table 1: Composition and nutrient contents of experimental diets

	Treated false yam seed meal levels in diets			
Ingredient (g/kg)	Control	10%	30%	50%
Maize	620	558	434	310
KOH_T	0	62	186	310
Fish meal	115	109	125	141
Wheat bran	98	81	65	49
Soybean meal	137	160	160	160
Vitamin /Min. Premix*	2.5	2.5	2.5	2.5
Di-calcium Phosphate	10	10	10	10
Oyster shell	15	15	15	15
Common salt	2.5	2.5	2.5	2.5
Calculated nutrient analysis				
Crude protein	200	200	200	200
Calcium	16.2	16.8	17.4	18.1
Phosphorus	8.8	8.3	8.3	8.3
Lysine	10.9	11.1	11.3	11.4
Methionine	4.4	4.3	4.3	4.4
M.E (kcal/kg)	2905.2	2882.1	2871.6	2850.5

*Composition of vitamin/trace mineral premix per kg diet: vitamin A (retinyl acetate), 5.2 mg; vitamin D3 (cholecalciferol), 0.125 mg; vitamin E (DL-alpha-tocopherol), 100 mg; vitamin K3 (menadione), 5 mg; vitamin B1(thiamine), 2 mg; vitamin B2 (riboflavin), 9 mg; vitamin B3 (Niacin), 50 mg; vitamin B5 (Calcium pantothenate), 25 mg; vitamin B6 (pyridoxine), 7 mg; vitamin B8 (biotin), 0.3 mg; vitamin B9 (folic acid), 3 mg; Vitamin B12 (cyanocobalamin), 0.24 mg; Fe ($FeSO_4$), 90 mg; Cu ($CuSO_4$), 5 mg; Mn (MnO), 120 mg; Co ($CoSO_4$), 1 mg; Zn ($ZnSO_4$), 100 mg; I ($Ca(IO_3)_2$), 2 mg; and Se (Na_2SeO_3), 0.4 mg. KOH_T = potassium hydroxide treated false yam seed meal.

DATA COLLECTION

Feed intake was obtained by subtracting the left-over feed in the feed trough at the end of the week from the total feed supplied for the week. This was measured weekly by using digital scale (JADEVER JPS-1050) to weigh the feed. Mean feed intake per bird per day was calculated by dividing the feed consumed by the number of birds in the replicate and the number of days in a week. The answer was then multiplied by 1000 to get feed intake per bird per day in grams.

Live-weight of birds in each replicate was measured weekly by weighing them in batches using a digital electronic scale (JADEVER JPS-1050), and weekly live weight gains calculated by dividing total weekly live-weight gain by the number of birds in the replicate and by the number of days in a week. The answer was then multiplied by 1000 to get live-weight gain per bird per day in grams. Feed conversion efficiency was defined as live weight gain per unit feed consumed. This parameter was calculated by dividing daily live-weight gain by the amount of feed consumed per day by each replicate bird. Mortality was recorded as and when they occur. All dead broilers were autopsied by a Veterinary officer of the Department of Veterinary Science.

At the end of the feeding trial, birds were starved for 8 hours and two birds per replicate were randomly selected and slaughtered by jugular venipuncture. Carcasses were then scalded in hot water (about 80^0C), de-feathered and eviscerated to get carcass dress weight. Carcass dressing percentage was calculated by dividing carcass dress weight by the bird's live weight, multiplied by 100. After evisceration, the internal organs were separated and weighed individually. The internal organs weighed included empty gizzard, heart, liver and spleen, and expressed as a percentage of dress weight to a relative organ weight.

Two birds from each replicate treatment were randomly selected for blood sampling. The selected birds were restrained and 2 mL of blood were drawn from their wing veins with a syringe and needle. Blood samples for haematological evaluation were collected into EDTA-containing tubes, while blood samples for serum chemistry evaluation were collected without anticoagulant and span in a centrifuge to generate serum. Samples were kept in cooled condition and transported to the laboratory for analysis.

The following haematological parameters were assessed; packed cell volume (PCV, %), red blood cell count (RBC × 106/µL), white blood cell count (WBC × 103/µL), haemoglobin (Hb, g/dL), white blood cell differentials (heterophils, lymphocytes, eosinophils, monocytes, basophils; all %), mean corpuscular haemoglobin concentration (MCHC, g/dL), mean corpuscular haemoglobin (MCH, pg), and mean corpuscular volume (MCV, µm3) using a haemo-analyser (Sysmex Hematology Analyser, XS-500i, Sysmex Europe GmbH, Norderstedt, Germany). The serum biochemical assay was carried out using spectrophotometry. The liver function parameters included total serum proteins (g/L), albumin (g/L), globulins (g/L), alkaline phosphate (units (U)/L), aspartate transferase (U/L) and alanine transferase (U/L) and the renal function parameters were chloride (µmol/L), creatinine (mmol/L), sodium (mmol/L), potassium (mmo/L) and urea (mmol/L).

STATISTICAL ANALYSIS

All variables measured subjected to one-way Analysis of Variance (ANOVA) and *post-hoc* Tukey's honest significant difference (HSD) test with 95% family-wise confidence level.

RESULTS

The growth response of male broiler chickens fed diets supplemented with varying levels of KOH_T FYSM as shown in table 3 revealed no significant ($P<0.05$) difference in all growth parameters measured.

Table 4 showed the carcass and relative organ weights of male broiler chickens fed KOH_T FYSM supplemented diets. Carcass dress weight and carcass dressing showed no significant ($P>0.05$) difference when maize was supplemented with the treated false yam seed meal at 500g/kg. However, the relative weight of organs revealed a significant ($P<0.041$) increase in the heart weight and a reduction in the weights of the liver and the spleen when the maize was supplemented with treated false yam seed meal beyond 100g/kg (Table 4).

Haematological parameters of experimental birds evaluated revealed a significant ($P<0.05$) decrease in the haemoglobin, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration as the treated false yam seed meal was increased in the diets (Table 5).

The results of the liver function test of birds fed diets supplemented with varying levels of treated false yam seed meal as shown in table 6 revealed no significant ($P>0.05$) difference in all parameters determined except for blood albumin which decreased ($P<0.047$) as the test material was increased in the diets. All the renal function parameters evaluated showed no significant ($P>0.05$) difference in their values as the test material was increased in the diets (Table 7).

The economics of replacing maize with potassium hydroxide-treated false yam seed meal in the diets of male broilers as shown in table 8 revealed that price per kg of feed reduces as the test material was increased in the diets. However, the rest of the economic variables evaluated showed no significant ($P>0.05$) difference.

Table 3: Growth performance of experimental broiler chickens fed control diet and diets containing potassium hydroxide-treated (KOH_T) false yam seed meal

Inclusion levels of KOH_T false yam seed meal (g/kg)							
Variables	**Unit**	**C**	**100**	**300**	**500**	**SEM**	**P**
Initial weight	Kg	0.885	0.881	0.883	0.885	0.012	0.994
Feed intake	G	121.1	125.3	133.3	133.1	4.73	0.235
Weight gain	G	70.6	72.4	70.7	70.3	3.87	0.978
Gain-to-feed	-	0.61	0.59	0.54	0.53	0.031	0.280
Final live-weight	Kg	3.35	3.42	3.36	3.34	0.134	0.980
Mortality	%	0.75	0.75	1.00	1.00	0.498	0.996

C: Control, SEM: standard error of mean, P: Probability. ANOVA test.

Table 4: Carcass, cut up parts and relative organ characteristics of experimental broiler chickens fed control diet and diets containing potassium hydroxide-treated (KOH_T) false yam seed meal

Inclusion levels of KOH_T false yam seed meal (g/kg)							
Variables	**Unit**	**C**	**100**	**300**	**500**	**SEM**	**P**
Dress weight	Kg	2.44	2.27	2.31	2.39	0.063	0.284
Carcass dressing	%	77.65	78.17	77.25	76.72	0.498	0.248
Organs (% live-weight)							
Gizzard	%	1.34	1.28	1.40	1.28	0.045	0.152
Heart	%	0.39^{c}	0.44^{b}	0.40^{c}	0.46^{a}	0.018	0.041
Liver	%	2.02^{a}	1.62^{b}	1.71^{ab}	1.78^{ab}	0.100	0.026
Spleen	%	0.11^{a}	0.07^{b}	0.09^{ab}	0.07^{b}	0.008	0.038

C: control; P: probability; SEM: standard error of the mean; Means with the same superscripts within a row are not statistically different.

Table 5: Haematology of experimental broiler chickens fed control diet and diets containing potassium hydroxide-treated (KOH_T) false yam seed meal

Inclusion levels of KOH_T false yam seed meal (g/kg)							
Variables	**Unit**	**C**	**100**	**300**	**500**	**SEM**	**P**
RBC	$x10^{12}/L$	2.39	2.36	2.33	2.40	0.035	0.429
PCV	%	31.59	31.75	30.75	30.71	0.392	0.146
Hb	g/dL	7.74^{a}	7.10^{ab}	6.99^{ab}	6.75^{b}	0.201	0.010
MCV	fL	132.22^{ab}	135.44^{a}	132.34^{ab}	129.07^{b}	1.059	0.003
MCH	Pg	32.06^{a}	30.21^{ab}	30.23^{ab}	29.06^{b}	0.573	0.006
MCHC	g/dL	24.25^{a}	23.12^{ab}	22.38^{b}	22.12^{b}	0.418	0.013
WBC	$x10^{9}/L$	295.9	297.6	296.1	296.9	9.64	0.999
Lymphocytes	%	59.4	59.8	57.6	57.0	4.13	0.952
Neutrophils	%	28.5	28.4	28.1	30.7	2.04	0.792
Basophils	%	0.080	0.083	0.078	0.078	0.015	0.412
Eosinophils	%	1.16	1.19	1.12	1.14	0.079	0.942
Monocytes	%	7.37	7.29	7.31	7.46	0.319	0.987

RBC: red blood cell count; PCV: packed cell volume; Hb: haemoglobin; MCHC: mean corpuscular haemoglobin concentration; MCH: mean corpuscular haemoglobin; MCV: mean corpuscular volume; WBC: white blood cell count. C: control; SEM: standard error of mean; P: probability. Means with the same superscripts within a row are not statistically different.

Table 6: Liver function test of experimental broiler chickens fed control diet and diets containing potassium hydroxide-treated (KOH_T) false yam seed meal

Inclusion levels of KOH_T false yam seed meal (g/kg)							
Variables	**Unit**	**C**	**100**	**300**	**500**	**SEM**	**P**
Albumin	g/L	16.80^{a}	15.45^{b}	16.00^{ab}	16.10^{ab}	0.320	0.047
Globulin	g/L	18.05	17.96	18.06	17.91	0.550	0.954
Total protein	g/L	34.88	33.94	34.26	33.77	0.823	0.791
ALP	U/L	149.8	149.9	148.2	148.4	3.30	0.973
ALT	U/L	8.80	8.81	8.91	8.91	0.283	0.986
AST	U/L	128.12	126.12	129.12	131.38	1.830	0.257

C: control; ALP: alkaline phosphate; AST: aspartate transferase; ALT: alanine transferase. P: probability; SEM: standard error of the mean; Means with the same superscripts within a row are not statistically different.

Table 7: Renal function test of experimental broiler chickens fed control diet and diets containing potassium hydroxide-treated (KOH_T) false yam seed meal

Inclusion levels of KOH_T false yam seed meal (g/kg)							
Variables	**Unit**	**C**	**100**	**300**	**500**	**SEM**	**P**
Chloride	µmol/L	77.1	77.3	77.6	78.9	3.63	0.985
Creatinine	mmol/L	17.80	18.16	18.21	18.07	0.781	0.982
Sodium	mmol/L	98.7	100.6	100.3	99.6	4.54	0.991
Potassium	mmol/L	2.13	2.12	2.18	2.17	0.128	0.495
Urea	mmol/L	0.71	0.69	0.71	0.71	0.031	0.995

C: control; SEM: standard error of the mean; P: probability.

DISCUSSION

The comparable feed intake between the birds on control diet and those fed diets containing potassium hydroxide-treated false yam seed meal (KOH_T) up to 500g/kg suggest that potassium hydroxide-treated false yam seed-based diets did not contain adequate levels of bitter compounds that could avert adequate intake of such diets. This clearly suggest that the KOH_T was as palatable as maize and had no adverse effect on feed consumption. It further indicates that, sequential use of water, potassium hydroxide and blanching treatment method might have reduced the level of bitter compound identified as terpenes (Vanhaelen et al., 1986) in the seed as reported by Mohammed et al. (2019). Since birds have taste sensors for salt and bitterness (Fairchid *et al*., 2005), it seems evident that, the treatment method engaged in this study had the potential of debittering the toxic compounds and possibly modified the chemical structures of some anti-nutritional factors in the false yam seed meal due to chemical reactivity (Mohammed et al., 2019). The presence of anti-nutritional factors in feedstuffs has been reported to affect feed digestibility and nutrient utilization (Lange *et al*., 2000) and consequently poor performance (MacDonald et al., 1995) of animals that consume diets that contains such feedstuffs.

Processing of false yam tuber using methods such as soaking in water (Dei *et al*., 2013) or boiling in water (Dei *et al*., 2011) have been shown to improve its utilization by broiler chickens. Bitter triterpenoids in neem seed kernel cake were found suitable for feeding broiler chickens (Nagalakshmi *et al.,* 1996, 1999) without affecting their growth and nutrient utilization when treated using an alkali. Potassium nitrate (saltpetre) as an oxidizer, reacts with terpenes found in false yam tuber and seed, because carbon-carbon double bonds in the structure of some terpenes makes the molecules reactive towards oxidizing agents (Pommer, 2003). The comparable growth performance of all experimental birds suggest that sequential use of water, potassium hydroxide and blanching treatment method appropriately dealt with the limiting factor (anti-nutrients) that hinders the utilization of the false yam seed as an alternative energy feed ingredient in the diets of broilers. It also provides an opportunity for the use of the false yam seed meal in the broiler chicken diets in times of hikes in maize price or scarcity.

The reduction in weight of the spleen and liver of birds fed diets containing KOH_T suggest that the residual anti-nutrients found in the seed meal could be implicated. Because, the main target of any toxin in the diets of poultry is the liver which is responsible for detoxifications of toxins (Smith, 1990). The decrease in the values of some haematological parameters in this study could be attributed to the effect of residual accumulation of anti-nutritional factors found in the KOH_T. According to Harvey et al. (1991), hematocrit and Hb concentrations have been shown to decrease when chicks were fed a diet naturally contaminated with 18 mg of deoxynivalenol (DON) /kg for 9 week.

The liver and renal function parameters were comparable in all treatment groups. However, only serum albumin concentrations were similar within the KOH_T treatment groups, but lower compared to the control group. The results are in accordance with Campbell et al. (1983), who observed a decrease only in albumin of broiler chickens fed 2,500g of AFB_1/kg from 1-21 days of age.

CONCLUSION AND RECOMMENDATION

From this experiment, inclusion of potassium hydroxide-treated false yam seed meal up to 500g/kg in the diets of male broilers had no adverse effect on their growth performance. However, its inclusion influenced internal organ weights such as the liver, spleen and heart. Economics of feeding KOH_T to broilers did not increase cost of feeding, suggesting that, There is an economic value for using this product for broiler chickens as an alternative to maize during periods of scarcity and can be recommended for use by farmers where this plant is available.

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CONFLICT OF INTEREST DECLARATION

The authors declare that there are no conflicts of interest.

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