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An investigation on faecal N and lipid excretions in growing broilers fed false yam (*Icacina oliviformis*) tuber meal

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ABSTRACT: This study was conducted to determine the effect of False Yam (*Icacina oliviformis*) on the growth performance, some biochemical alterations of growing broiler. For this experiment, 50, 20-day old growing broilers were randomly allocated to five dietary treatments: Raw tuber- (without alcohol treatment) @ 6%, raw tuber (70% alcohol treated) @ 6%, raw tuber @ 9%- were incorporated in a maize-soy based diet while commercial practical diet was used as control diet. Both control and treatment group were fed 60 gm feed daily (restricted feeding) up to the end of the experiment. The completely randomized design of the experiment was used. Pre-treatment of the meal with ethanol resulted in a significant increase in N intake and apparent digestibility and as well as the body weight gain. However, the Blood Urea Nitrogen (BUN) was found to be increased as compared to those non-alcohol and control groups. Broilers fed on diet based on 9% of the soaked tuber showed an elevated level of fat excretion as compared to those of others. Although, false yam supported the growth, however, apparent N retention could not have been improved by pre-treatment with alcohol and thus, the growth well below those expected. This was partly due to depression in digestion of the false yam protein and possibly to the presence of ant-nutritional factors in the meal that interfered with digestion, absorption and retention of N and lipid. The results showed that there was a significant decline ($p<0.05$) in the values of weight gain as the levels of false yam was increased in the diet. The results also showed that false yam may be added to broiler diets less than 6% without any detrimental effects. Furthermore, false yam may have contained potentially nephrotoxic agents that have been made- available for absorption due to ethanol treatment. Possible involvement of fibre and flatus compounds may have been linked to reduced N retention in broilers.

Keywords: Ant-nutritional factors, broilers, digestibility, *Icacina oliviformis*.

INTRODUCTION

False yam (*Icacina oliviformis* (Poiret) J. Raynal (*Icacina senegalensis* A. Juss) is a wild drought resistant plant native to West and Central Africa (Styslinger., 2011; Mohammed et al., 2015)). The tuberous underground roots are starch concentrates and have served as emergency food in times of drought and famine where other crops have failed (Fay, 1991). The roots may be ground into flour which contains per 100g: water 11.7 g; protein 10.3 g; fat 0.7 g; carbohydrate 74.5 g and ash 2.19 g (AOAC, 2000). The flour of false yam contains per kg dry matter are 44 g crude protein, 16 g crude fat and 845 g carbohydrate (Asoiro and Ani, 2011).

Thus, it has the potential to serve as an alternative energy source to maize, cassava or cereal grains. However, the roots also contain a bitter toxic principle, reported to be a gum resin (Mohammed et al., 2015) ranging in quantity from 0.9 to 2.8 per cent. Soaking apparently is able to remove the bitter principle (Mohammed et al., 2017). Agyemang, (2010) reported the fact that false yam has promise as an energy source for the monogastrics including humans. Thus, in the last 30 years, gum resin, which is also known as terpenoids and act as poisons, growth inhibitors, or deterrents to animals (Gershenzon and Dudareva, 2007) has become main interest of scientific investigations. Hot water was reported to be used to remove toxic agents effectively (Yang et al., 2007) reported to have used. However, significant proportion of the terpenes and or render them inactive and removal is possible using this method, the tubers required sun-drying before being boiled.

It is highly likely that similar to those of legumes such as cowpea, chickpea, black gram, field bean and lentils, tuber crop (false yam) is armed with this kind of anti-nutritional factors. These carbohydrates escape digestion and absorption in the upper digestive tract and instead are fermented by colonic bacteria to yield flatus gases, primarily H_2 and CO_2. Aside from the reserve oligosaccharides, variety of polysaccharides constituting plant cell wall has been found to induce flatus (Nyyssölä et al., 2020). In addition, it has been demonstrated by direct measurement that as much as 20% of the starch in a mixed meal escapes digestion in the small bowel and it may not be an exception for false yam. Although no studies have been found investigating the flatus-inducing substances in false yam, however, significant increase of N excretion in diet based on 6% and the condition was exacerbated due to increase of incorporation of 9% raw tuber meals in the diet. This was in part a result of essential amino acid deficiencies in yam tuber meal, however, may also have been due to the presence of anti-nutritional factors like flatus compounds (Dei et al., 2011). Therefore, the ground, raw and soaked tuber was extracted with 70% ethanol/water (v/v) at 5°C, this condition is favourable for the removal of a number of anti-nutritional factors such as alkaloids and glycosides (Ajibola and Olapade., 2016). The pre-treated meal was incorporated into the diet for growing broilers in proportion to their amount in the untreated meal and their effects upon food intake, efficiency of protein, N digestibility, growth and level of blood urea nitrogen (BUN) have been assessed.

MATERIALS AND METHODS

False yam meal preparation

False yam tubers used in this trial was obtained from Professor Dr. Herbert Dei of the University for Development Studies, Tamale, Ghana. The yam tuber meal was prepared in his laboratory following established techniques. Then the diet was prepared following the Table 1, where maize starch, corn oil, soybean meal, amino acids, minerals and vitamins were bought locally and were of general purpose grade. Test and control diets were formulated by substation of maize starch.

Pre-experimental period

60 day-old Cobb 500 broiler chicks were obtained from local hatchery through a local agent in Mymensingh and were housed on rice husk until 15 day of age. They were fed commercial broiler starter diet *ad libitum* and reared on husk floor. Water was supplied *ad libitum* in plastic water trough. The body weight was monitored daily.

Housing

Adaptation: 50 male Cob-500 broilers, 18 days of ages, were housed in group of five and fed 42 g of control diet for 3 days, while water was given *ad libitum*. Only those birds which had a regular food intake and gained in weight at similar rate during this 3 day adaptation period were subsequently used in the experiment.

Bird husbandry and sample collection

A total of 50 growing broilers, 10 birds in each group were weighed on day 16 weighing 525 ± 18.4 g and randomly allocated to cages. Two broiler birds were placed in each cage. There were a total of three experimental and control diet fed groups. Diets were fed *ad libitum* while water was made available *ad libitum* throughout the study, via plastic water trough. After having a three-day adaptation period from day 16th , the feeding trials started from the day 19th and continued for a period of 10 days to attain conventional slaughter weight. Body weight, feed intake, feed refusal and fecal weights were recorded every day. Cumulative feed efficiency per bird was calculated as the ratio of weight gained to feed consumed. Dry matter of the droppings was determined from the last 10 day of feeding trial by drying aliquots of every day's droppings for 6 hours at 105°C. The number of chicks with sticky droppings adhered to the cloacal area was noted on the same days of excreta collection. Mortality throughout the trial did not occur.

Fractionation procedures: Cold (5°C) aqueous ethanol extraction of raw water soaked tuber meal was carried out as shown in Figure 1. The diets were formulated as shown in Table 1.

Analytical methods

Samples of both meals and droppings were analyzed using standard methods (AOAC, 1990; AOAC International, 2000) for DM (method 934.01), nitrogen (method 968.06). Estimation of total lipid was done after extraction of the ground meal and droppings with chlorofom-methanol (2:1, v/v) at a sample: solvent ratio of 1:200, w/v.

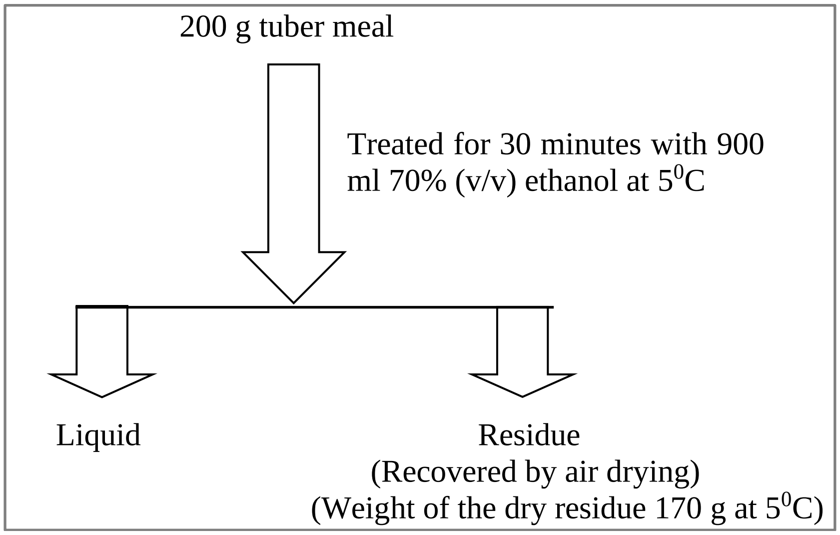

Figure 1. Aqueous ethanol treatment of raw false yam meal.

Table 1. The composition of diets: (g/ kg diet).

Ingredients	Control	6% raw tuber without ethanol treatment	6% raw tuber with ethanol treatment	9% soaked tuber meal
Corn	465	310	405	375
False yam tuber meal	0	30	60	90
Fish meal	110.40	120.40	110.40	110.40
Soybean meal	149.30	159.30	149.30	149.30
Wheat bran	115.0	125.0	115.0	115.0
Oyster shell	10.30	10.30	10.30	10.30
Di-calcium phosphate	50.0	50.0	50.0	50.0
Vitamin-mineral mix	50.0	50.0	50.0	50.0
Salt	50.0	50.0	50.0	50.0
Total (g)	1000	1000	1000	1000
Calculated nutritive value				
Crude protein (%)	21,01	20.81	20.81	20.71
Lysine	1.2	1.1	1.1	1.1
Methionine	0.427	0.418	0.418	0.413
Methionine + cystine	0.766	0.744	0.744	0.744
ME (Kcal/ Kg)	2967	ND	ND	ND

ND – Not done.

Haemato-biochemical parameters

On the 19th day of the experiment, birds were killed by severing the jugular and blood samples were collected in tightly rubber stoppered glass test tubes and serum samples were collected. Serum samples were centrifuged at 3,000 x g for 15 min in a bench top centrifuge. Clear serum samples were analyzed for blood urea nitrogen (BUN) using commercially available Test Kit.

Table 2. Effects of False yam (*Icacina oliviformis*) after being fed to growing broilers (Mean values ± standard deviation).

Dietary groups	Control (10)	6% false yam tuber treated without 70% Ethanol (10)	6% false yam tuber treated with cold 70% Ethanol (10)	9% soaked tuber meal (10)
Starting body weight (g)	643±5.46^{a}	612.5±4.95^{a}	636.0±6.7^{a}	617.8±5.50^{a}
Final body weight (g)	1184±26.9^{a}	873.6±6.1^{b}	943.6±5.1^{b,c}	815.0±7.2^{b}
Body weight gain as % of initial weight	84.2±3.4^{a}	42.6±2.9^{bc}	48.4±2.8^{bc}	31.9±2.1^{bc}
Nitrogen intake (g)/ 100 g diet	3.696^{a}	3.136^{a}	4.032^{a}	3.472^{a}
Apparent N digestibility (%)	86.5^{a}	82.14^{a}	88.9^{a}	77.4^{b}
Faecal N excretion (g %)	0.498^{a}	0.560^{b}	0.448^{b}	0.784^{b,c}
Apparent N absorption (%)	3.19^{a}	2.58^{b}	3.58^{a}	2.68^{b}
Blood Urea Nitrogen (BUN) mg/ dl	0.43±0.04^{a}	0.24±0.03^{b}	0.59±0.07^{b,c}	0.17±0.04^{b}

Values expressed as a mean+SD. Number of rats used is given in parentheses under group designations. ^{a,b} values in a row with a distinct superscript differ significantly at least to a level of 95% confidence P =0.05. For details of the ingredients used to prepare diets, see Table 1. PSD, Pooled Standard Deviation. Number of birds are shown in parentheses.

Statistical analysis

Results of the five experiments were pooled and statistical analysis was done by one-way ANOVA using the Minitab computer program (Minitab Inc., State College, PA 16801, USA). When p-values were <0.05, the significance of difference between groups was estimated by Student's t tests.

RESULTS AND DISCUSSION

In the present experiments, diets prepared from false yam tuber meal along with 70% ethanol/water (v/v) treated meal were tested. The results of feeding trials are shown in Table 2. The average food intake of the growing broilers in this experiment was 60 g diet/bird/day. Evaluation of the effects of extractions showed that a significant amount (15%) of material were extracted out of the soaked and dry tuber meal with cold (5°C) ethanol/water [70% (v/v)]. Although, the weight gain achieved on the diet treated with 70% cold ethanol was found to have improved than those of other two groups fed diets based on tubers, however, showed lesser growth than the corresponding control birds fed standard commercial diet. Furthermore, after 10 days, the birds on the ethanol treated diet were 36 g heavier than the control when the body weight was calculated on the basis of body weight gain as % of initial weight. On the other hand, there was a significant change in body weight gain in alcohol treated meal fed birds than the corresponding non-alcohol treated group and the 9% soaked tuber fed group grew 18 g less than those found in ethanol treated group.

The apparent N digestibility value (%) observed with control, 6% tuber meal without ethanol treatment, 6% ethanol treated and 9% soaked tuber meal fed growing broilers were 86.5, 82.14, 88.9 and 77.4 respectively. The apparent digestibility value of the 9% tuber meal was found to be 15% less than the corresponding standard control diet. Under restricted feeding conditions, treatment with cold ethanol of the tuber meal increased the apparent digestibility value of the diet. This improvement was significantly higher than that achieved under without ethanol treatment and was probably due to more efficient utilization of the restricted dietary N input. The N digestibility of 6% tuber meal was slightly depressed compared with those found upon feeding standard control diet.

As found from our experiments; inclusion of raw soaked tuber meal @ 6% (w/w) in diets for growing broilers showed a considerable limitation in their growth. This was due in part to depression to food intake. In addition, the outputs of faecal nitrogen by these birds were greatly elevated compared with controls fed-corn-soy diets, indicating that digestion of dietary N and retention of absorbed N were both poor. As a result, the accumulation of N in the body of birds given 6% raw tuber diet was low.

In order to improve the N retention, 70% ethanol (v/v) to remove the liming factor(s) from the tuber meal was tried. Evaluation of the effects of extractions showed that a significant amount (15%) of material were driven out of the soaked and dry tuber meal with cold (5°C) ethanol/water [70% (v/v)]. As a result, pre-treatment of the meal in this manner resulted in a significant improvement in the nutritional quality of the tuber meal.

It has been shown that an increase in faecal N excretion has been related to fibre portion in the diet and is due to a. protein associated with fibre itself being undigested and excreted in the faeces (Rahman et al., 1996; Stephen et al., 1983); b. dietary protein not being completely absorbed because of the increased colonic volume caused by fibre (Saunders and Betschart, 1980); c. the fibre decreasing the activity of proteolytic enzymes (Moreno-Osset et al. 1989). All these mechanisms in fact involve a decrease in the dietary protein digestibility. Likewise, incorporation of tuber meal @ 9% dry weight basis to the diet showed a decrease in the N digestibility in broilers. Thus, the increased faecal N may be of endogenous origin, nevertheless whether this comes from augmentation in cellular turnover and or from an increase in digestive secretion is not known.

It was observed that pre-treatment of the meal in this

Table 3. Effects of *Icacina oliviformis* (False yam) on faecal weight, water and lipid content of droppings of broilers (Mean values ± standard deviation).

Dietary groups	Control (10)	6% false yam tuber treated without 70% Ethanol (10)	6% false yam tuber treated with 70% Ethanol (10)	9% soaked tuber meal. (10)
Total dry matter/ 100 g weight droppings	90.5	90.6	90.52	90.42
Water in droppings (%)	9.52	9.37	9.48	9.58
Faecal fat excretion (g)/ 100 g DM	21.0	15.9	19.86	23.36

Values expressed as a mean ± SD. Number of rats used is given in parentheses under group designations. [a,b] values in a row with a distinct superscript differ significantly at least to a level of 95% confidence P =0.05. For details of the ingredients used to prepare diets, see Table 1. PSD, Pooled Standard Deviation. Number of birds are shown in parentheses.

manner resulted in a significant improvement in the nutritional quality of the tuber meal. The food intake and growth of broilers fed on this meal were both higher than the non-treated tuber meal fed birds. As most of the alkaloid and or flatus glycosides are soluble in aqueous ethanol, they ought to have been removed by such treatment. Therefore, they might have been major factors limiting the dietary intake of false yam tuber meal by growing broilers.

Faecal dry matter outputs of broilers fed all the experimental diets were not elevated compared to those of control (Table 3). However, there was a steady increase of faecal fat in broilers fed experimental diets. Although, there was a moderate increase in faecal fat in broilers fed alcohol treated diet which was less than those obtained from the control. However, broilers received 9% tuber diet excreted more fat and was found to be significantly elevated than those of control. It is possible that the effect is due, in part to mal-absorption of dietary lipid. Extraction of the tuber meal with cold ethanol/water did not significantly improve lipid digestion as compared to those of tuber meal that was not treated with ethanol. Thus, that the anti-nutritional factor(s) responsible were neither soluble in 70% (v/v) ethanol/water nor were readily inactivated by using this method.

False yam (*Icacina oliviformis*), is in fact is viewed favorably for their high-yielding ability and wide ecological adaptability. They are usually only consumed as a substitute and or supplements to corn when supplies of these staple foods were low. In West Africa (Roessler et al., 2017; Seidu et al., 2019), the consumption of false yam appears to be inversely proportional to income level, and they are typically viewed as a food to be consumed only for survival (Tsou and Villareal, 1982). Despite having its high sugar content (Dei et al., 2011) of the tuber, it's consumption in large amounts could not have been promoted to use it as a staple food (Tsou and Villareal, 1982) due to both known and unknown anti-nutritional factors (Osei, et al., 2013; Sowley et al., 2019).

The value of blood urea nitrogen (BUN) is presented in Table 2. Serum BUN level of the false yam fed group were found to be significantly decreased when compared to the control. However, it's level was significantly increased when the tuber diet was treated with 70% ethanol/water. Higher BUN values reported in alcohol treated tuber fed birds could be attributed to kidney damage and may be high due to heart failure, dehydration and or a high protein diet. Although, BUN to creatinine ratio is used as an indicator of renal function, however estimation of serum creatinine has not been determined. Blood urea nitrogen (BUN) is also used to evaluate kidney function, and elevations in BUN level are often, but not always, a result of a decrease in GFR (Rahman, 2000).

In conclusion, the main reason for the poor N utilization by growing broilers fed false yam tuber meal seems to be increased excretion of N, suggesting disturbances in systemic N metabolism. The proteins of false yam are not only less nutritious than the corresponding soy and fish meal, but also appears to induce changes in body metabolism, for reasons that are as yet known. The nutritional value of false yam proteins, therefore, should be examined carefully, especially in the light of the present experiment. In addition, that starch and NSP that constitute 74.5g/ 100 g of the tuber meal appeared to have deleterious effects on N metabolism.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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