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Effect of Boiled False Yam Tuber Meal on Feed Digestibility and Egg Laying Performance of Lohmann Brown Layer Chickens

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Abstract— An experiment was conducted to determine feed digestibility and egg laying performance of layer chickens fed diets containing boiled false yam tuber meal (BFYTM). The false yam tubers were peeled with a knife and chopped into small chips (~2 cm), boiled for 2 hours in boiling water, sun-dried to a moisture content of about 12% and ground into a gritty meal. The BFYTM replaced maize at dietary levels of 0, 50, 75 and 100 g/kg in maize-fishmeal based diets. At 20 weeks of age, 16 Lohmann brown layer chickens were randomly allotted to the four dietary treatments in a Completely Randomized Design, with one hen per cage for the digestibility trials using the total collection method. At 19 weeks of age, 240 Lohmann brown pullets were randomly allotted to the four dietary treatments and fed diets containing BFYTM which replaced maize at dietary levels of 0, 50, 75 and 100 g/kg in maize-fishmeal based diets for 16 weeks. Each treatment replicated four times in a Completely Randomized Design, with initial mean live weight of 1.45 kg per bird per replicate. The birds were housed in deep litter pens. Feed and water were provided ad libitum from 19 to 35 weeks of age. Data collected were subjected to one-way Analysis of Variance (ANOVA) using GenStat. There was no significant ($p>0.05$) difference in the dry matter digestibility among treatment groups. The crude protein digestibility was not significantly ($p>0.05$) different between control birds and birds fed 50 g/kg BFYTM diet, but higher ($p<0.05$) than those birds fed diets containing 75 and 100 g/kg BFYTM diets. Hens on the 50 g/kg BFYTM diets exhibited a higher ($p<0.05$) fat digestibility than those on the control diet and their counterparts fed the 75 and 100 g/kg BFYTM diets. Ash digestibility was lower ($p<0.05$) for birds fed the control diets than those birds fed BFYTM based diets, but similar ($p>0.05$) ash digestibility was recorded within the diets containing BFYTM. Mean feed intake of the hens was similar ($p>0.05$) for all treatments. Mean egg weight and mortality were not significantly different ($p>0.05$) among treatments. Mean hen-day egg production, egg mass and feed efficiency of the control birds were higher ($p<0.05$) than those of their counterparts fed the BFYTM-based diets. Based on this study, it can be concluded that 50 g/kg BFYTM in the diet of layer chickens had no adverse effect on nutrient digestibility of feed, but had adverse effect on egg production.

***Keywords*— false yam (*Icacina oliviformis*) tuber, boiling, nutrients, egg production, chicken.**

INTRODUCTION

In Ghana, animal production especially poultry depends on maize as energy feed ingredient. Maize constitutes between 60 and 65% of poultry feed (Atuahene *et al.*, 1989). According to Singh (1990), shortage of maize as a source of energy for feeding poultry may be a serious issue of concern. Maize is also finding its place in many industrial uses causing undue pressure on the poultry industry. Digestibility of feed represents the percentage of the whole or any single nutrient in the feed which is not excreted in the faeces (FAO, 2013), and is therefore assumed to be available to the animal for absorption from the gastro-intestinal tract. The understanding of digestibility of feed for animals could serve as an index for estimating the digestion and absorption of nutrients in the diet given to the animal for optimal production.

There are various anti-nutritional factors such as saponins, lectin, tannins and trypsin inhibitors in feedstuffs which are known to affect digestion and absorption of nutrient in poultry (Liener, 1994) due to reduction in the activity of digestive enzymes (Haslam, 1981). False yam (*Icacina oliviformis*) is a shrubby perennial that forms a large underground fleshy tuber (NRI, 1987) and found wildly growing in the Northern part of Ghana. False yam tuber as a non-conventional feedstuff has the potential to reduce the demand for maize. Moreover, it has been reported that the major limiting factor of false yam tuber is its anti-nutritional factors (gum resin) that can be toxic and reduces palatability of feed when given to animals (NRI, 1987). Preliminary studies involving boiling false yam tuber improved its nutritive value for broilers up to 9% in their diets (Dei *et al.*, 2011).

However, it is not known how boiling false yam tuber meal will influence its nutritive value for layer chickens. Therefore, this study was undertaken to determine the effect of boiled false yam tuber meal (BFYTM) on egg laying performance of layer chickens when substituted at varying levels (0, 50, 75 and 100 g/kg) in their diets.

MATERIALS AND METHODS

A. Experimental site

The experiment was conducted at the Poultry Section of he Department of Animal Science, University for Development Studies, Nyankpala Campus. The average temperature is 15°C (minimum) and 42°C (maximum) with the annual mean temperature of 28.3°C. The mean annual rainfall is 1043mm, which is monomodal and usually begins by the mid of April to late October with a mean annual day-time humidity of 54% (SARI, 2001).

B. Preparation of boiled false yam tuber meal sample

The false yam (Icacina oliviformis) tubers growing in the wild were harvested manually using hoe at Nyankpala irrespective of their age. The freshly harvested false yam tubers were peeled and chopped into small chips (~2 cm) with a knife and boiled in water (1part of fresh tuber to 2 parts of water) for 2 hours. The boiled tubers were rinsed with water to remove the sticky substances and sun-dried on a concrete floor to a dry matter of about 87%. The dried product was ground in a grinding mill into a gritty meal and labeled BFYTM.

C. Chemical analysis of boiled false yam tuber meal

The chemical composition of the BFYTM sample reported by Dei *et al*., (2011) was used for diet formulations. It comprised on dry matter basis, 6.46% CP, 0.98% EE, 43.12% Starch, 32.37% NDF, and 2.76% Ash. The Gross energy content is 4,139 kcal/kg DM. The total resins content is 2.28%.

D. Experimental diets and design

A total number of 16 hens (Lohmann brown) of similar live weights at 20 weeks of age were used in the digestibility trial. The hens were randomly assigned to 16 cages with one hen per cage (0.4mx0.3m=0.12m2). The boiled false yam tuber meal (BFYTM) replaced maize at different levels of 0, 50, 75 and 100 g/kg on weight-by-weight basis. The diets were formulated to be isonitrogenous with similar caloric values (Table 1). Each hen received one of the four dietary treatments which were replicated four times in a Completely Randomized Design for 14 days.

The first 7 days constituted the introductory stage of the trial, where layer chicks were allowed to adjust to their new environment as well as new diets. The last 7 days was used for data collection. During this period, feed and water were provided ad libitum and light was provided 24 hours. During the 7 days of data collection, weighed quantities of the diets were supplied daily and eventual refusals reweighed after 24 hours. Faecal matter was collected on plastic sheets placed under the wire-mesh floor of the cages (total collection method) and was removed every 24 hours, weighed, and stored at 40C in a refrigerator.

At the end of the trial, the daily samples of feed refusal and faecal matter collected from layer chicks in each replicate cage were pooled into one sample per replicate, oven-dried (60oC for 24h), weighed, ground (using a 2 mm sieve) and stored in airtight plastic containers at room temperature for chemical analysis. Triplicate samples of treatment diets and dried faeces were analyzed for proximate components per standard methods described by AOAC, (2000). The values were used to compute apparent nutrient digestibility using the formular below;

$$Apparent\ nutrient\ digestibility = \frac{Nutrient\ consumed - Nutrient\ excreted\ in\ faeces}{Nutrient\ consumed} \times 100$$

The egg laying performance trial was conducted using 240 Lohmann brown layer chickens at 19 weeks of age. The dietary treatments used for digestibility trial (Table 1) was used in the egg laying performance test. Each treatment was replicated four times in a Completely Randomized Design, with mean initial live weight of 1.45 kg per bird per replicate. The hens were housed in deep litter pens (1.8m x 0.9m=0.11m²/bird) and fed one of the four dietary treatments. Feed and water were provided ad libitum from 19 to 35 weeks of age. Light was provided 24 hours. Eggs were picked and weighed from each replicate group every day at 4:00 pm using a digital electronic scale (SP-10016204) and data recorded.

Feed intake of the birds was measured weekly by subtracting the left-over feed at the end of the week from the amount of feed supplied using a digital electronic scale (Jadever, JPS-1050), and mean feed intake calculated. Hen-day egg production was determined as percentage of eggs laid in a day by the number of hens in the cage. Mean egg weight was calculated as total weight of eggs laid divided by the number of eggs laid. Egg mass per hen was calculated as hen-day egg production multiplied by the average egg weight. Feed-to-egg mass ratio was calculated by dividing the mean feed intake per bird by the mean egg mass per bird during the same period. Mortality was recorded.

Table 1. Composition of experimental diets (g/kg)

Ingredients	Dietary inclusion levels of BFYTM (g/kg)			
	(Control) 0	50	75	100
Maize	600	550	525	500
Fish meal	100	100	100	100
BFYTM[2]	0	50	75	100
Soybean meal	154	161	164	168
Wheat bran	58	51	48	44
Oyster shell	80	80	80	80
Vit. /Min. Premix[1]	3.0	3.0	3.0	3.0
Dicalcium phosphate	3.0	3.0	3.0	3.0
Sodium chloride	2.0	2.0	2.0	2.0
Calculated nutrient analyses (g/kg)				
Crude protein	190	190	190	190
Calcium	38	38	38	38
Phosphorus	6.0	6.0	6.0	6.0
Lysine	11	11	11	11
Methionine	4.0	4.0	4.0	4.0
ME (MJ/kg)	11.6	11.4	11.4	11.3

[1]Composition of vitamin/trace mineral premix per kg diet: vitamin A 8000 IU, vitamin D3 1500 IU, vitamin E 2.5 mg, vitamin K3 1.0 mg, vitamin B2 2.0 mg, vitamin B12 00.5 mg, Folic acid 0.5 mg, nicotinic acid 8.0 mg, Calcium pantholenate 2.0 mg, choline chloride 50 mg, magnesium 50 mg, Zinc 40 mg, copper 4.5 mg, Cobalt 0.1 mg, Iodine 1.0 mg and Selenium 0.1 mg. Antioxidant: Butylated hydroxytoluene (BHT) 1.0 mg. [2]ME of BFYTM used for calculation was 11.2 MJ/kg DM (Dei *et al*., unpublished).

E. *Statistical Analyses*

The data were subjected to one-way Analysis of Variance (ANOVA) for a Completely Randomized Design (CRD) using GenStat, 3rd version (Lawes Agricultural Trust, 2005). Significant differences among treatment means were separated using Standard error of difference (SED) and values were considered significant at p<0.05.

RESULTS AND DISCUSSIONS

There were no significant (p>0.05) differences in dry matter digestibility among the treatment groups (Table 2). Generally, values recorded for dry matter digestibility were higher for all treatment groups. The crude protein digestibility of the control birds was similar to that of birds fed 50 g/kg BFYTM diet, but differed (p<0.05) from their counterparts fed 75 and 100 g/kg BFYTM diets (Table 2). The fat digestibility was significantly higher (p<0.05) in hens fed the 50 g/kg diet than their counterparts fed the 75 and 100 g/kg BFYTM diets.

The latter two groups exhibited similar (p>0.05) value as those hens fed the control diet (Table 2). There was a significant (p<0.05) difference between the hens fed the control diet and those hens fed diet containing BFYTM diets in terms of ash digestibility (Table 2), but not within birds fed diets containing BFYTM. Generally, the hens fed 50 g/kg BFYTM diet tended to perform better than their counterparts fed diets containing 75 and 100 g/kg BFYTM in terms of protein and fat digestibility (Table 2).

Table 2. Effect of boiled false yam tuber meal (BFYTM) on nutrient digestibility of layer chicken

Parameter	Dietary inclusion levels of BFYTM (g/kg)				ANOVA	
	Control	50 g/kg	75 g/kg	100 g/kg	±SED	P. value
Dry matter (%)	75.6	74.5	74.2	73.1	1.57	0.509
Crude protein (%)	58.2[a]	57.8[a]	49.5[b]	50.0[b]	2.94	0.015
Crude fat (%)	79.8[b]	83.8[a]	77.1[b]	77.9[b]	1.41	0.002
Ash (%)	48.4[b]	55.5[a]	59.5[a]	56.3[a]	2.89	0.014

SED=Standard error of difference, P-probability, means with the same superscripts in a row are not significantly different (p>0.05).

Mean feed intake of hens was similar (p>0.05) for all treatment groups (Table 3). Mean hen-day egg production and egg mass of the control hens were higher (p<0.05) than those of their counterparts fed the BFYTM-based diets. However, those birds fed 100 g/kg BFYTM-based diets performed poorly (p<0.05) (Table 3). Figure 1 clearly demonstrates the reduction in egg production as the BFYTM was increased in the diets.

The egg weight did not differ significantly (p>0.05) between the control group and the BFYTM-based groups (Table 3). In all the variables measured with the exception of feed intake and mortality, birds fed diets containing 50 and 75 g/kg BFYTM had similar (p>0.05) performance, better (p<0.05) than those fed 100 g/kg BFYTM diet (Table 3). Mortality was generally low in the experimental population (Table 3).

Table 3. Effect of boiled false yam tuber meal (BFYTM) on performance of layers (19-35 weeks of age)

Parameter	Dietary inclusion levels of BFYTM (g/kg)				ANOVA	
	0	50 g/kg	75 g/kg	100 g/kg	±SED	P. value
Feed intake (g/hen/day)	90.1	93.1	92.7	92.8	1.57	0.078
Hen-day egg production (%)	60.3[a]	51.2[b]	47.7[b]	43.1[c]	3.54	0.003
Egg weight (g)	48.6	47.8	48.3	47.8	0.45	0.093
Egg mass (g/hen)	29.5[a]	24.4[b]	23.6[b]	21.2[c]	1.95	0.008
Feed-to-egg mass ratio	3.04[a]	3.85[b]	3.95[b]	4.48[c]	0.34	0.008
Mortality (dead/total)	0/60	1/60	3/60	2/60	-	-

SED=Standard error of difference, P-probability, means with the same superscripts in a row are not significantly different (p>0.05).

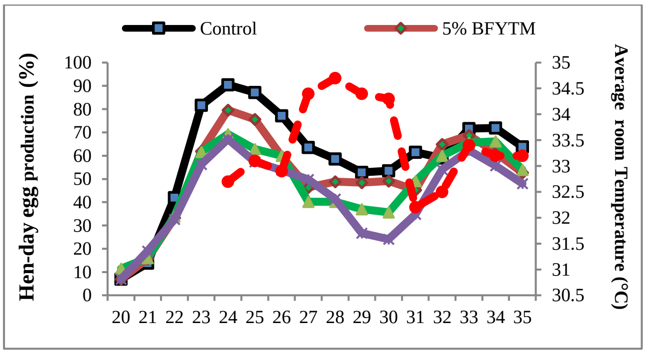

Figure 1. Apparent relationship between ambient temperature in the pen and egg production.

The inclusion of BFYTM above 50 g/kg (Table 2) in the diets of layer chickens significantly affected crude protein digestibility. This may probably be due to activities of anti-nutritional factors present in the BFYTM. These might bind with nutrients, thereby rendering them unavailable to the birds. According to McDonald *et al*., (2002), terpenes actually impair availability of nutrients and reduce performance of animals. The presence of anti-nutritive factors and dietary fiber are some factors that can influence digestibility of feed (Leeson and Summers, 2002).

Dei *et al*., (2011) reported that, boiling reduces the concentration of the gum resins by 39% in the tuber. This suggests that boiling the tuber was more effective in improving the digestibility of crude fat and ash of the feed rather than protein. Abiola (1999) noted that, heat treatment such as cooking enhances the availability of some nutrients in feedstuffs. In a preliminary study, Mohammed and Dei

(2013) attributed the poor digestibility of crude protein and fat of diets containing soaked false yam tuber meal to the effect of residual accumulation of anti-nutritive factors (terpenes).

This suggests that, boiling the tuber improves the nutrient digestibility better, except for crude protein than employing the method of soaking. The similarity in feed intake in all the birds suggests that boiling the tuber has reduced the bitterness of the gum resins and making the diets more palatable to enhance feed consumption. Dei *et al*., (2011) reported that boiling reduces the gum resins in the tuber by 39%, and thereby improving feed intake of birds. The addition of BFYTM to the diets progressively affected hen-day egg production and feed-to-egg mass ratio of birds.

This could be due to the residual concentration of anti-nutritive factors (gum resins) still present in the tuber. According to McDonalds *et al*., (2002), terpenes actually interfere in availability of nutrients and reduce performance in animals. This might hinder availability of major nutrient (protein and fat) which are the major components of egg, hence reduction in efficiency of feed availability. In a previous study, Mohammed and Dei (2013) attributed the low egg production of layers fed diets containing soaked false yam tuber meal at similar levels tested to the effect of residual accumulation of anti-nutritive factors (terpenes), which affected protein and fat digestibility which are major component of eggs.

Generally, egg production of all the birds were lower than expected, which could be due to high ambient day-time temperatures during the study period which ranged from 32 to 35°C (Figure 1). The Guinea Savanna zone is known to be characterized by high environmental temperatures (Kasei, 1988), particularly in the dry season (November to April). The mortality recorded was within the tested population of hens fed BFYTM-based diets. Post mortem examination revealed that bird's condition was as a result of liver rapture suspected to be fatty liver haemorrhagic syndrome (FLHS). This condition associated with laying hens and the predisposing factors, include high ambient temperature, overcrowding, irregular eating pattern (AHVLA, 2012). However, the mortalities observed in the groups fed BFYTM-based diets might be related to the anti-nutritional factors aggravating the condition in those groups.

CONCLUSIONS

From the results of this study, it is concluded that boiled false yam tuber meal included at 50 g/kg in layer chicken diet had no adverse effect on nutrient digestibility of the feed. But beyond 50 g/kg had adverse effect on their egg laying performance.

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