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Taro Cocoyam (*Colocasia esculenta*) Meal as Feed Ingredient in Poultry

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Abstract: Ninety six broiler chickens at four weeks of age were randomly allotted in groups of 12 to the eight experimental diets with three replicates in each treatment and four birds per replicate. The dietary treatment contain 0% 25%, 50% and 100% Cocoyam meal. Taro comprised of raw sundried and boiled sundried forms. There was a significant difference ($P < 0.05$) in feed conversion with a linear decrease in boiled taro cocoyam meal as substitution levels of inclusion increased. Higher amounts of feed intake were achieved at 50% inclusion levels. Body weight gain decreases linearly ($P > 0.05$) with increase in Cocoyam meal inclusion levels. The cost of daily feed intake differ significantly ($P < 0.05$) in raw taro cocoyam meal. The levels of some antinutritional factors were also determined in both raw and boiled, sundried taro cocoyam. Boiling reduced ($P < 0.05$) the amounts of the antinutritional factors in the taro cocoyam meal. It was also observed that birds on 100% raw sundried taro passed more watery dropping than those on boiled. In the CCYM, the value for proventriculus, crop and all other cuts parts are significantly higher ($P < 0.05$) as compared with the control. The values of live weight, dressed weight and Eviscerated weight for the cocoyam diet is relatively lower than the control, may be due to effects of antinutritional factors present in cocoyam diets. Thus proper processing of cocoyam meal will effectively replace maize at 25% (raw sundried) and 50% (boiled sundried) as a major source of energy in diets of broiler finishers.

Key words: Boiling, broiler chicken, performance, carcass characteristics, antinutritional factors

INTRODUCTION

The tremendous increase in population and high demand of foodstuff, which causes rapid increase in cost of feed has led to search for alternative cheap energy sources. Durunna *et al.* (2000), reported that maize is the major source of energy in poultry feeds and constitutes about 50% poultry diet. Unfortunately, the rapid growth of human population has intensified the competition between man and livestock for these cereal grains resulting in high cost of feeds and consequently high prices of poultry products leading to very low levels of protein intake in most developing countries. Poultry production especially broiler provides a rapid means of producing animal protein to meet the nutritional needs of the teaming populace (Taiwo *et al.*, 2005). The importance of feed in the poultry industry is generally recognized. In Nigeria, feed cost is estimated to represent over 70% of the total cost of producing poultry intensively (Oluyemi, 1984; Oguntowora, 1984). Therefore, it is necessary to look inwards for alternatives and cheaper sources of feed ingredients.

Cocoyam products are recognized as cheaper carbohydrate sources than grains or other tuber crops (Obioha, 1972). It has high caloric yield per hectare, low production cost (Hahn, 1984) and relatively low susceptibility to insect and pest attack. Similarly, it is reported that cocoyam has readily digestible starch content because of its small particle size (Lyonga and Nzetchueng, 1986; Ezedinma, 1987). The use of cocoyam as food for man and animal has limiting factors such as storage and presence of antinutritional factors.

The antinutritional factors found in taro cocoyam include oxalates, phytates, Tannins and Saponins. (Agwunobi *et al.*, 2002). However, some may serve as defensive mechanism against pests and diseases. Therefore oxalates have been found to be as defense mechanism and a storage reserve for calcium (Smith, 1982). There is limited reference work on the utilization and inclusion of taro cocoyam as an alternative energy source in poultry production. However, Anigbogu (1997) reported that taro meal should not exceed 25% replacement of maize in broiler diets. The objective of this study was to evaluate the performance of birds fed diets containing sundried taro and boiled taro as a substitute for maize.

MATERIALS AND METHODS

100 day-old Anak broiler chicks were used. The birds were subjected to a standard brooding condition and fed with common basal broiler starter diet for a pre-experimental period of 4 weeks during which necessary vaccination were administered. At the beginning of the 5th week (finisher phase), birds were individually weighed and randomly allotted in groups of 12 to each of the eight experimental diets with three replicates in each treatment and four birds per replicate. The cocoyam Corms (taro) were obtained from local markets in Ikom LGA and Odukpanin LGA both in Cross Rivers State. The Cocoyam Corms were divided into two equal parts.

One part was sliced into chips of 5mm thickness and then sundried for 3 days, the second part was boiled for 30 minutes, sliced into chips of 5mm thickness and then sundried for 3 days. The dried chips (unboiled sundried and boiled sundried) were milled separately. Two samples of the test materials, sundried (taro) and boiled (taro) were analyzed in the laboratory for the determination of HCN (AOAC, 1975), Phytates (McCane and Widdowson, 1953), Oxalates (Oke, 1984), Tannins (Burns, 1971) and Saponins (Shukla and Thakur, 1986). Proximate chemical analysis of fresh sundried taro and that of maize were done according to AOAC (1975) procedure (Table 1). A diet containing maize was taken as a control (Table 2). Eight experimental diets were formulated, comprising 4 diets from fresh sundried and another four from boiled sundried form, each replaced maize 0%, 25%, 50% and 100%. All diets were formulated to be Isocaloric and isonitrogenous. A conventional poultry house with deep litter floor pens was used. Feed and water were provided *ad libitum* under identical environmental and management conditions. The design of the experiment is completely randomized design. Routine vaccination and necessary medication, were administered on the birds as and when necessary. Feeding trial lasted for 6 weeks. Weekly records were kept on body weight gain and feed intake. Mortality is recorded as it occurred. At the end of the feeding trial (experiment) i.e at 10 weeks of age 3 birds from control (0%) along with 3 birds from each 100% cocoyam inclusion of the 2 test materials (diets) were selected based on mean average weight, starved for 24 hours weighed and slaughtered by severing the jugular veins, birds were bled, dipped in hot water, defeathered. The Carcass was sorted into parts and also internal organs were sorted separately. All data were subjected to analysis of variance (ANOVA) procedure in determining the significant difference. Duncans multiple range test was used to separate treatment means found to be statistically significant.

RESULTS

The proximate composition of cocoyam (taro) meal and that of maize are shown in Table 1. The performance of the broilers on varying levels of cocoyam meal as a substitute for maize in both boiled and raw sundried (taro) cocoyam are presented in Tables 3 and 4, respectively.

The result on boiled taro indicated that the average daily feed intake is not significantly different (P > 0.05) between treatments. But 50% level of inclusion has the highest value as compared with other cocoyam diet and the control. The average daily weight gain showed no significant difference (P > 0.05), however the values decrease with increase in cocoyam inclusion across the treatments, with control maintaining a higher value. The values indicating feed conversion ratio increased significantly (P < 0.05) with increase in the level of cocoyam meal in the diets with control recording lowest value. Mortality recorded only one bird on 100% dietary treatment of cocoyam meal. The result on raw sundried taro cocoyam meal indicated that the final live weight and the average daily weight gain decreases linearly with increase in cocoyam meal inclusion with control recording the highest value than other dietary treatment groups. There was a significant difference (P < 0.05) in average cost of daily feed intake per bird which decreased linearly with increase in cocoyam meal inclusion with control recording the highest value. Mortality recorded one bird on 50% cocoyam meal inclusion level.

The antinutritional factors analysis in raw and boiled sundried taro cocoyam meals is shown in table 6. The amounts of phytate, Oxalate, Tannin, Saponin and Cynanide (HCN) in the boiled sundried taro cocoyam meal indicated significantly lower values as compared to the amounts on the raw (unboiled) taro cocoyam meals. The Carcass yield analysis indicated a

Table 1: Proximate Composition of Taro Cocoyam Meal and Maize

Parameters	Taro Meal % (DM Basis)	Maize
Dry matter (DM)	31.00	87.46
Crude Protein (CP)	7.87	9.80
Crude Fibre (CF)	4.75	2.04
Ether extract (EE)	0.75	4.80
Ash	6.00	1.39
Nitrogen Free Extract (NFE)	80.63	81.97
*Energy ME (kcal/kg)	3214.91	3665.18

* Calculated using Pauzenga method (1985).

Table 2: Ingredient Composition of Experimental Diets (Broiler Finisher Ration)

	Replacement Level			
Ingredients	0%	25%	50%	100%
Cocoyam Meal	0	12	24	48
Maize	48	36	24	0
Crayfish	2.0	2.0	2.0	2.0
Fishmeal	4.0	4.0	4.0	4.0
Soya bean meal	37	37	37	37
Wheat offal	5.0	5.0	5.0	5.0
Bone meal	2.0	2.0	2.0	2.0
Salt	0.5	0.5	0.5	0.5
Vit. Min Premix	0.5	0.5	0.5	0.5
Palm Oil	1.0	1.0	1.0	1.0
Total	100	100	100	100
Calculated Analysis				
Crude Protein (%)	22.63	22.03	21.43	20.23
ME Kcal/kg	3072.6	2977.8	2883	2793
Calcium (%)	1.24	1.30	1.35	1.46
Phosphorus (%)	0.79	0.82	0.82	0.82
Lysine (%)	1.46	1.48	1.49	1.51
Methionine (%)	0.46	0.45	044	0.42

Table 3: Performance of broiler finisher on varying levels of boiled taro cocoyam meal

	Dietary Treatment Levels			
Parameters	0%	25%	50%	100%
Avg. Initial Live weight (g)	558.00	575.00	558.00	558
Avg. Final Live weight (g)	2880.00	2730.00	2290.00	1880.00
Avg. daily Feed intake/Bird (g)	154.76	150.48	168.81	154.05
Avg.daily weight gain/Bird(g)	53.57	51.43	51.19	31.43
Feed conversion (feed/gain)	2.47^b	3.19^b	3.70^b	6.35^a
Mortality	0	0	0	1
Cost of Production				
Avg. Cost of feed N/kg	51.13	48.97	46.81	42.49
Avg. cost of Daily feed intake /b(N)	6.40	7.37	7.90	6.55
Cost of total feed intake/b(N)	47.48	44.21	47.41	39.27
Cost/Kg weight (250kgflesh)	80.36	77.14	76.79	47.41
Profit	32.88	32.93	29.38	7.87
Cost: Benefit ratio	1.44	1.34	1.61	5.00

^{a,b}means with different superscripts on the same horizontal row differ significantly (P < 0.05).

Table 4: Performance of broiler finisher on varying levels of raw taro cocoyam meal

	Dietary treatment Levels			
Parameters	0%	25%	50%	100%
Avg. Initial Live weight (g)	561.00	558.00	558.00	525
Avg. Final Live weight (g)	2720.00	2100.00	1880.00	1780.00
Avg. daily Feed intake/Bird (g)	157.38	152.62	154.29	135.48
Avg. Daily Weight gain/Bird(g)	51.19	37.62	31.43	29.76
Feed conversion (feed/gain)	4.25	11.40	9.27	6.40
Mortality	0	0	1	0
Cost of production				
Avg. cost of N/Kg	51.13	48.97	46.81	42.49
Avg. cost of Daily feed intake/b(N)	8.56^a	7.47^b	7.22^b	5.76^b
Cost of total feed intake/b(N)	51.35	44.84	43.33	34.54
Cost/Kg weight (250kg flesh)	76.79	56.43	47.14	44.64
Profit (N)	25.44	11.59	3.81	10.10
Cost: Benefit ratio	2.02	3.89	11.37	3.42

^{a,b}means with different superscripts on the same horizontal row differ significantly (P < 0.05).

significant difference (P < 0.01) with lower values in cocoyam meal diets as compared with the control (Table 5). Similarly, a significantly lower values on organ weight of proventriculus and higher values on crop in the cocoyam diets as compared with the control was also indicated in Table 5.

DISCUSSION

The overall result showed that birds consumed higher and gained higher weight in boiled taro due to heat treatment of boiling, while birds consumed lower in raw taro due to toxic effect of unboiled cocoyam. This is in line with the report by Agwunobi *et al.* (2002), indicating that boiling was more effective than sun drying alone in reducing the level of antinutritional factors (phytate, Oxalate, Tannins and Saponin). The low daily feed intake in the control as compared with the other treatment levels of cocoyam meal inclusion in boiled taro could be due to higher energy in maize (control) diet. This agrees with the finding of Stevenson and Jackson (1983) who reported that birds on high energy feed eat less than those on low energy diets to satisfy the energy requirement. The values on feed conversion ratio increased linearly with the increase levels of cocoyam meal, thus indicating that the higher the level of cocoyam meal, the less the utilization of the diets. This was due to inability of the birds to extract required nutrients from the feed because of the effects of anti-nutritional factors which reduced feed digestibility and utilization. This is however, in line with the work of Adama and Ayanwale (1999) who observed poorest feed/gain value in the ration with uncooked cocoyam which could have been due to high oxalate content of the ration. Average cost of daily feed intake significantly decreased (P < 0.05) with increase in the level of cocoyam meal, inclusion in raw sundried taro. The lowest cost of daily feed intake was observed in 100% level of cocoyam meal in raw sundried taro. This was due to reduced feed intake, which indicate economic implications on the level of cocoyam inclusion in the diet. Generally, the cost of

Table 5: Carcass yield of broiler finisher fed taro cocoyam meal

Parameters	0% CCYM Control	100% Raw taro	CCYM Boiled taro	SEM	Level of Significance
Livewieght (kg)	2.72±0.10	1.78±0.24	1.88±0.25	0.34	NS
Dressed weight kg)	1.90±0.29	1.60±0.08	1.50±0.19	0.38	NS
Eviscerated weight (kg)	1.65±0.21	1.33±0.13	1.38±0.13	0.34	NS
Head (g)	64.21±5.62	50.00±1.57	51.29±0.68	1.55	*
Neck (g)	79.92±7.79	52.72±2.23	62.51±2.84	1.86	*
Back (g)	247.60±16.72	172.05±3.37	183.48±5.56	2.66	*
Wing (g)	126.47±6.80	80.02±3.95	120.37±11.88	2.22	*
Thigh (g)	161.17±3.59	120.77±0.91	138.47±4.97	1.48	*
Organ weight of Broilers fed Taro Cocoyam meal (CCYM					
Bile (g)	4.76±1.36	3.50±1.47	3.61±0.10	0.84	NS
Proventriculus (g)	9.83±0.13	7.85±0.26	8.59±0.43	0.40	*
Heart (g)	8.00±1.57	6.58±0.62	6.68±0.18	0.81	NS
liver (g)	44.18±2.20	41.13±4.59	42.17±1.03	1.29	NS
Kidney (g)	3.13±0.29	2.51±0.29	2.77±0.16	1.18	NS
Lung (g)	11.17±2.40	8.69±2.23	9.44±0.64	1.86	NS
Gizzard (g)	54.66 ±9.93	48.55±1.54	55.7±2.78	1.26	NS
Crop (g)	32.45 ±18.13	48.24±4.26	40.69±1.15	4.56	*
Intestine (g)	112.08±22.80	119.8 ±8.98	120.37±15.38	2.35	NS

Values are means of 3 determinations±SD. **Significantly Different (P<0.01). *Significantly Different (P<0.05). SEM -Standard Error of the Mean. NS-Not Significantly different

Table 6: Levels of anti-nutritional factors in raw and boiled, sundried taro cocoyam meals

Parameters	Raw taro	Boiled taro as Determined (mg/100g)	SEM	Level of Significance
Phytate	1.75±0.20	0.62±0.02	0.27	*
Oxalate	45.30±0.02	24.45±0.01	0.10	**
Tannin	1.78±0.01	0.28±0.01	0.08	**
Saponin	7.90±0.01	5.73±0.01	0.08	**
Cyanide	2.10±0.03	0.92±0.02	0.13	**

Values are means of 3 determinations ±SD, **Significantly Different (P<0.01), *Significantly Different (P<0.05), SEM- Standard Error of the Mean

production decreases with increase in cocoyam meal inclusion. This was equally observed by Anigbogu (1997) revealing that the use of cocoyam as substitute for maize is much more economical. In comparison with levels of antinutritional factors in taro cocoyam meal, the raw sundried cocoyam has significantly higher (P < 0.01) toxicants than the boiled cocoyam. This is because the cooking/boiling destroyed the toxicants to large extent. This agreed with the report by Ogun *et al*. (1989), which indicated that cooking and other traditional method of processing cause significant reduction in these toxicants. The results of the analysis on the antinutritional factors shows that Oxalate was the predominant toxic factor in Cocoyam and it is found to render calcium unavailable to the body of animal (Liener, 1989). Mostly the antinutritional factors do not occur freely but combine with food to form complexes. Phytate and Oxalate combine with phosphorus and Calcium, respectively to form complexes and render them unavailable for absorption. Tannin form complexes with protein and reduce their digestibility and palatability (Eka, 1985).

The results on Carcass analysis showed a significant (P<0.01) reduction in weights of neck, back, wing and thigh in cocoyam diets as compared with the control. This is an indications of lower feed utilization at higher level (100%) of substitution. This agreed with the study of Esonu *et al*. (1999) indicating that these limiting factor leads to severe reduction in feed intake, nutrient utilization and weight gain. It was observed that the live weight, dressed weight and Eviscerated weight, showed relatively lower (P > 0.05) development on cocoyam diets as compared with the control. The crop had better development (P < 0.05) on cocoyam diets than on control. This could be due to the nature of feed passing through the digestive tract (Abonyi and Uchendu, 2005) which has profound effect on the development. The Gizzard and intestine, showed no significant effect but higher weight were observed on boiled sundried taro cocoyam diet as compared to control. This indicated that boiling reduced the antinutritional factor in taro to safe levels (Agwunobi *et al*., 2000). No adverse effect on feed on other organs weights was observed within these levels of inclusion. The observation, here on the effect of cocoyam on organ development gives an indication that feeding broiler finishers within this level of replacement poses no serious consequences on some organ development and function. The weight on neck in boiled cocoyam though lower than control but indicated better development on boiled sundried than raw sundried, this revealed that temperature (40^{O}C) on sun drying may not be high and effective as the heat from boiling water in reducing the level of antinutritional factors present (Agwunobi *et al.,* 2002). Mortality did not show a trend attributable to diets.

Conclusion: It is concluded that boiling decreased the level of antinutritional factors which in turn enhances digestibility and metabolism of feed taken by the animals. Therefore, this indicates that boiled taro could only substitute maize upto 50% without detrimental effect on the performance of the birds, while raw sundried taro could only substitute maize conveniently at 25% level of inclusion in broiler chicken diets without detrimental effect.

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