Journal of Animal and Veterinary Advances 5(6) : 472-477, 2006

Evaluation of Livingstone Potato/Rizga (*Plectranthus esculentus* N.Br) and Hausa Potato (*Solenostemon rotundifolius* Poir) as Energy Sources for Broiler Chicken

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Abstract: Two experiments were carried out to evaluate the replacement value of Rizga and Hausa potato for maize in broiler chicken. In experiment 1, three treatment diets with 2 replications each were fed to broiler chickens in a Completely Randomized Design (CRD) using a deep litter management system. The dietary maize of the diets was substituted with Hausa potato at 0, 50 and 100% respectively. The results showed that all the parameters measured were significantly ($p<0.05$) influenced. Mean body weight (g) and realizable revenue (N) were depressed as the substitution level increased from 50 to 100% while feed intake responded in an inverse manner to the increasing substitution of maize for Hausa potato. The experiment lasted 5 weeks. In experiment 2, three treatment diets with 3 replications each were fed to broiler chickens in a completely Randomized Design (CRD) using a one- tier cage design. The dietary maize of the diets was substituted with Rizga at 0, 50 and 100% respectively. The results showed that, of all the parameters considered, only the feed-to-gain ratio and total revenue (N) were significantly (($p<0.05$) influenced. Mean body weight gain (g) was numerically depressed from 1119.50_g(D1) to 1053.00_g (D2) and 889.00g (D3). The feed intake numerically increased from 1665.0g (D1) to 2474.90g (D2) and 2297.52g (D3). The mean total revenue (N) realizable significantly decreased for birds fed diet 3 while diets 1 and 2 are comparable. In conclusion, substituting dietary maize with Hausa potato or rizga in broiler ration as shown in these trials seemed productively and economically inefficient, nevertheless, more research effort is still required so as to improve on the utilization of these neglected and under exploited root crops for efficient poultry production.

Key words: Hausa potato, Rizga, broiler ration, alternative energy sources

INTRODUCTION

According to FAO[1] If the standard for animal protein intake for proper human nutrition and growth is to be met, it therefore, means that animal production need be geared towards meat sources with higher food value, having short duration of production, higher consumer preferences and nutrient quality. This according to Madubuike and Ekenyem[2] makes poultry development an imperative.

The achievement in poultry production directly depends on the availability and supply of foodstuffs to meet both the energy and protein requirements of the animals for optimum production. The major available basal energy feedstuff (maize) is in constant demand for man, animal nutrition and industrial processes[3]. This universal feed grain, maize which is the basis of commercial poultry feeds is utilized at rates between 40-70%[4] and 60-80%[5] and the alarming market price has invariably escalated the market prices of poultry products out of reach of the common man. The massive importation of feed ingredients in recent years which could have alleviated the problem is discouraged by the existence of a currency that is weaker compared to other currencies. Insufficiency of feedstuffs locally and a lower capability to import them have posed a constraint to the development of the livestock industry in Nigeria and Africa as a whole. Thus, making the continual usage of maize at such rate unjustifiable[6].

Today, the focus in the livestock industry is on alternative feedstuff, mostly those which can either substitute directly for maize or can be included at certain level to attain a comparable quality with the conventional maize, but must not be deleterious to the animal's health[7]. Cassava[6] and Cocoyam[8] for instance had been used in poultry ration. Hausa potato and Rizga are also root crops grown for their root for human consumption, as they are rich in carbohydrates like most other tuber crops[9]. FAO[10] gave the nutritive value of Rizga (Table 1) while Alleman and Coertze[11] gave that of Hausa potato (Table 2). Despite their nutritive potential, they are

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Table 1: Nutritional value of rizga (*Livingstone potato*)

Nutrient	Percent
Carbohydrate	18.8
Protein	1.9
Fat	0.4
Fibre	1.0
Ash	0.9
Calcium	18.0 mg 100 g^{-1}
Phosphorous	80.0 mg 100 g^{-1}
Iron	6.4 mg 100 g^{-1}
B-carotene equivalent	54.0 mg 100 g^{-1}

Culled from FAO (2004)

Table 2: Nutritional value of hausa potato tuber

Nutrient		
Carbohydrates	(%)	24.4
Protein	(%)	4.7-5.2
Fat	(%)	3.5
Fibre	(%)	3.5
Calcium	(mg 100 g^{-1})	1.50
Iron	(mg 100 g^{-1})	29.2
Vitamin A	(mg 100 g^{-1})	3.4
Heroine	(mg 100 g^{-1})	0.38
Tyrosine	(mg 100 g^{-1})	0.30
Motioning	(mg 100 g^{-1})	0.13
Valise	(mg 100 g^{-1})	0.25
Phenylalanine	(mg 100 g^{-1})	0.36
Isoleucine	(mg 100 g^{-1})	0.22
Leucine	(mg 100 g^{-1})	0.38
Lysine	(mg 100 g^{-1})	0.24

Source: Allemann and Coertze (1997)

classified among the lesser known and under exploited species of food crop in Africa[9].

The roots of Hausa potato and Rizga are usually processed by peeling off the skin before or after cooking making them a snack or could be fried in palm oil or roasted. They appear to be one of the possibilities for overcoming these high costs of feed in the livestock industry, as they are quite available and cheap. Their cultivation requires no special expertise that applies to cereal production such as sorghum, guinea corn and wheat[9].

This study was therefore, carried out to evaluate the growth performance efficiency of feed utilization and the economic implication of substituting either Rizga or Hausa potato for maize in broiler ration. Such information is necessary to stimulate awareness and adoption of alternative energy sources for performance enhancement in broiler production.

MATERIALS AND METHODS

Preparation of rizga and hausa potato: Rizga and Hausa potato roots (tubers) were harvested from the National Root Crop Research Institute (NRCRI), Umudike. Abia state Nigeria. The tubers were chipped or cut into smaller pieces, sundries on a concrete floor until the pieces were totally dried. They were later milled and after milling, they were spread on the floor under the sun to cool and dry to avoid clumping together of the milled materials. Then, they were bagged and stored for feed compounding.

Table 3: Gross composition of experimental diet for trial 1 (%)

	Experimental diet		
Ingredients	1	2	3
Yellow maize	48.00	24.00	-
Hausa potato	-	24.00	48.00
Maize offal	8.75	8.75	8.75
Groundnut cake	32.00	32.00	32.00
Danish Fish meal	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00
Oyster shell	1.50	1.50	1.50
Salt	0.30	0.30	0.30
Vitamin Mineral Premix*	0.25	0.25	0.25
Methionine	0.10	0.10	0.10
Lysine	0.10	0.10	0.10
Total	100.00	100.00	100.00
Calculated analysis:			
Crude protein (%)	23.41	22.21	21.01
Metabolizable energy (kca kg^{-1})	2863.75	2536.39	2209.03

• Vitamin mineral premix. Provided (per kg of diet): Vitamin A, 1500IU; Vitamin D3, 1600IU; Riboflavin, 9.9 mg; Biotin, 0.25; Pantothenic acid, 11.0 mg; Vitamin K, 3.0 mg; Vitamin B2, 2.5 mg; Vitamin B6,0.3 mg; Vitamin B12, 8.0 mg; nicotinic acid, 8.0 mg Iron, 5.0 mg; Manganese, 10.0 mg; Zinc. 4.5 mg; Cobalt, 0.02 mg; Selenium, 0.01 mg

Table 4: Gross composition of experimental diets for trial 2 (%)

	Experimental diet		
Ingredients	1	2	3
Yellow maize	48.00	24.00	-
Rizga	-	24.00	48.00
Maize offal	8.75	8.75	8.75
Groundnut cake	32.00	32.00	32.00
Danish Fish meal	5.00	5.00	5.00
Bone meal	3.00	3.00	3.00
Oyster shell	1.50	1.50	1.50
Salt	0.30	0.30	0.30
Vitamin Mineral Premix*	0.25	0.25	0.25
Methionine	0.10	0.10	0.10
Lysine	0.10	0.10	0.10
Total	100.00	100.00	100.00
Calculated analysis:			
Crude protein (%)	23.33	22.85	22.37
Metabolizable energy (kcal kg^{-1})	2863.75	2551.75	2239.75

*Vitamin mineral composition: Same with trial 1 (Table 4)

Experimental location, animals and design: The two experiments were conducted at the poultry Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike. Abia State. Nigeria. Umudike is located at the latitude $5^{0}29^{1}$. North and Longitude $1.7^{0}32^{1}$. East in the Forest Zone of Nigeria. The experiment was conducted within the months of May and July in the year 2005.

Experiment 1

Substitution of dietary maize at 0, 50 and 100% levels for hausa potato in broiler diet: The experiment was laid out in 3 treatments with 2 replicates per treatment and the chicks were randomly selected such that each treatment

had 20 birds and 10 birds per replicate (i.e. 60 birds) using deep litter system of management in a completely Randomized Design (CRD). Three diets were formulated and Hausa potato replaced maize at 0, 50 and 100% levels, respectively (Table 3).

A week before the arrival of the birds, the brooder house and the pens were swept, washed and disinfected with izal. All equipments used were also washed and disinfected, then, they were allowed to dry for 2 days. The floor of the brooding house was covered with wood shaving. Kerosene stoves, lanterns and electric bulbs were provided to serve as sources of heat and illumination throughout the brooding period. The house (pens) where they were transferred to is the dwarf type, so polyethylene sheets and tarpaulins were used to cover the sides of the pens to conserve heat and create conducive environment for the birds. The birds were reared for 5 weeks in deep litter and were fed and watered *ad-libitum*. Weekly feed intake and weight changes were noted.

Different vaccines and drugs were appropriately administered to take care of the health of the birds. They include. Newcastle Disease Vaccine (NDV), i/o at the first day, Infectious Bursar disease vaccine (Gomboro) at the 9th and 34th days. Newcastle disease vaccine (Lasota) at the 28th day, Coccidiostat (Prococ WDP and Amprole 200) at the 3rd and 5th week, antibiotics, vitamin supplements and anti-stress drugs (Neo-terramycin, Oxyfuravit and Pantominovit) were also administered to the birds.

Experiment 2

Substitution of dietary maize at 0, 50 and 100% levels for rizga in broiler diet: This trial was laid out in 3 treatments with 3 replicates per treatment and the chicks were randomly selected such that each treatment had 6 birds and 2 birds per replicate in a Completely Randomized Design (CRD). Three diets were also formulated and Rizga replaced maize at 0, 50 and 100% levels, respectively (Table 4). The birds were raised in 1-tier-cages and just like in experiment 1, the experiment lasted 5 weeks. Every other management practices and data collection were carried out using the same procedure as in experiment 1.

Proximate analysis: Samples of Hausa potato and Rizga harvested from various locations in Nigeria were dried, milled and analyzed for their proximate constituents using the methods of A.O.A.C.[12].

Statistical analysis: Data were subjected to analysis of variance of a completely randomized design in both studies. When analysis of variance indicated a significant treatment effect, Duncan's multiple range test was used to differentiate the means using procedures described by Daniel[13].

RESULTS

The results of the proximate composition of the test materials are summarized in Table 5 Rizga has a percent moisture content of between 6.22-8.41, while the percent crude protein, crude f ibre, fat and ash ranged from 7.52-13.89, 9.45-18.38, 0.16-0.34 and 3.32-6.21, respectively. Determined percent calcium and phosphorous ranged from 0.16-0.49 and 0.00-0.54, respectively. Hausa potato, on the other hand, has percent moisture content of between 6.99-8.36 while the percent crude protein, crude fibre, fat and ash ranged from 5.99-9.28, 8.45-22.16, 0.11-0.40 and 5.39-8.21. Determined percent calcium and phosphorous ranged from 0.25-0.56 and 0.16-0.63.

Table 6 revealed the productive and economic response of the broiler chickens fed diets whose maize was, respectively substituted with 0, 50 and 100% Hausa potato. The results showed that all the parameters considered were significantly influenced ($p<0.05$). Mean body weight gain (g) was depressed as the substitution level increased from 50 to 100%, while feed intake responded in an inverse manner to the increasing substitution of maize for Hausa potato. Feed cost/gain (N) also increased as the substitution level increased, thus, reducing the realizable revenue (N) from birds fed diets 2 and 3.

In Experiment 2; Table 7 gave the summary of the productive and economic response of broiler chickens fed diets whose maize was, respectively substituted with 0, 50 and 100% Rizga of all the parameters considered, only the feed-to-gain ratio and total revenue (N) were significantly influenced ($p<0.05$). Mean body weight gain (g) was numerically depressed from 1119.50 g (D1) to 1053.00 g (D2) and 889.00 g (D3). The feed intake numerically increased from 1665.0 g (D1) to 2474.90 g (D2) and 2297.5 g (D3). The mean total revenue (N) realizable significantly decreased for birds fed diet 3 while diets 1 and 2 are comparable.

DISCUSSION

The proximate composition values obtained for the test material used for this trial could have been influenced by the environmental factors within the area of sample collection and cultivation.

The superiority of diet 1 over other diets in trials 1 and 2 is a confirmation of the superiority of maize over

Table 5: Determined percent composition of the test ingredients used in this trial

	Hausa potato (Solenostemon rotundifolius)							
Name of accession	MC	CP	CF	Fat	Ash	NFE	Ca	P
Gami(Zango Kataf)	8.36	9.28	13.10	0.11	5.43	72.08	0.30	0.33
Hyre	7.23	5.99	11.33	0.39	7.11	75.18	0.25	0.33
Gami	8.24	8.50	8.45	0.40	8.21	84.44	0.25	0.16
Gami Kafan Chan)	7.93	9.01	15.60	0.34	6.52	68.53	0.56	0.34
Vu(Hong)	7.78	6.55	11.37	0.29	8.14	73.63	0.25	0.63
Hyre(Ibika)	6.99	6.15	22.16	0.25	5.39	66.05	0.35	0.35
Range:	6.99-8.36	5.99-9.28	8.45-22.16	0.11-0.40	5.39-8.21	66.05-75.18	0.25-0.56	0.16-0.63
Average:	7.76	7.58	13.67	0.30	6.30	71.65	0.33	0.36
RIZGA								
Vat (Jos)	8.0	7.52	11.14	0.25	5.64	75.45	0.49	0.34
Rungwabi (Kachia)	7.31	10.02	9.45	0.16	5.83	74.54	0.16	-
VU 1(Pankshin)	6.22	12.80	12.60	0.27	5.08	69.25	0.37	0.16
Vat Loangat	8.09	13.3	15.04	0.23	3.32	68.11	0.65	0.46
Rizga(Zaria)	8.23	13.89	15.89	0.17	6.21	63.84	0.16	0.54
Nvat Riyom	8.41	8.60	18.38	0.34	4.08	68.60	0.33	0.46
Nvat Beebot	7.97	6.48	10.72	0.20	3.47	79.13	0.38	0.46
Nvat Loangat	8.18	11.12	12.80	0.30	5.23	70.53	0.33	0.46
Riyom	8.21	10.93	20.63	0.26	4.07	64.12	0.22	0.09
Range:	6.22-8.41	7.52-13.89	9.45-18.38	0.16-0.34	3.32-6.21	63.84-79.13	0.16-0.49	0-0.54
Average:	7.86	10.52	14.07	0.24	4.77	70.4	0.34	0.16

Table 6: Response of broiler chicken fed diets containing 0, 50 and 100% substitution levels of Hausa Potato for maize

	Experimental diets			
Response criteria	1	2	3	SEM
Bird's mean initial Body weight (g)	50.00	52.00	51.00	0.00
Mean Final Body weight(g)	1638.00^{a}	1505.00^{a}	860.00^{b}	77.40
Mean Body weight gain (g)	188.30^{a}	1452.90^{a}	808.70^{b}	77.40
Mean Feed intake (g)	1344.00^{c}	1946.67^{a}	1795.83^{b}	32.07
Feed-to-gain ratio	0.85^{a}	1.34^{b}	2.22^{c}	0.028
Feed cost/body weight gain (N)	40.30^{b}	60.17^{b}	94.90^{a}	8.46
Feed cost/kg body weight gain (N)	25.51^{b}	41.97^{b}	125.93^{a}	20.91
Total Revenue (N)	953.00^{c}	871.60^{c}	485.20^{b}	20.91

abc: Figures within same row with different superscripts differ significantly ($p<0.05$); SEM-Standard error of means

Table 7: Response of broiler chickens fed diets containing 0, 50 and 100% substitution levels of Rizga for maize

	Experimental diets			
Response criteria	1	2	3	SEM
Bird's mean initial Body weight (g)	45.50	43.50	43.00	0.00
Mean Final Body weight(g)	1165.00	1096.50	932.00	101.40
Mean Body weight gain (g)	1119.50	1053.00	889.00	63.20
Mean Feed intake (g)	1665.00	2474.90	2297.53	792.50
Feed-to-gain ratio	1.49^{a}	2.35^{b}	2.54^{b}	0.034
Feed cost/body weight gain (N)	127.49	105.72	106.62	6.32
Feed cost/kg body weight gain (N)	114.08	102.16	120.05	6.06
Total Revenue (N)	671.7^{a}	681.80^{a}	533.40^{b}	11.90

abc: Figures within same row with different superscripts differ significantly ($p<0.05$); SEM-Standard Error of means

either Hausa potato or Rizga. According to maize production Manual[14], maize contains about 77% starch, 2% sugar, 9% protein, 5% fat, 5% pentose and 2% ash. The yellow maize is also rich in vitamin A, thiamine, riboflavin, phosphorous, potassium, iron and essential vitamin. The substitution of maize for either Hausa potato or Rizga at 50 and 100%, respectively in trials 1 and 2 diluted and lowered the energy content of the diets. This was responsible for the increased feed intake observed in the birds fed diets 2 and 3 in the two trials. This agrees with the findings of Forbes[15] who stated that the quantity of feed consumed by poultry is inversely related to the concentration of dietary energy. Furthermore, it is also a known fact that energy density in the diet is probably the most important factor affecting feed intake, the requirements of other nutrients, expressed as a percentage of the diet are usually related to the energy content of the diet[16].

The depression of the body weight agrees with the work of Magay[17], Saure[18] and Gerpacio *et al.*[19] that root crop cannot completely replace maize in the broiler ration. Some other authors[20-22] identified the poor utilization of root crop for livestock feed to be due to its sugary taste. Tsou and Hong[23] have also shown that sweet potato

starch is less susceptible to α-amylase hydrolysis than cooked cereal starches. Zhang *et al.*[24] reported how heating has been found to improve starch digestibility by up to 38.8% and that variation in sweet potato genotype does exist. Dietary energy has also been implicated as the primary factor that governs the conformation of chicken which in turn plays a major role in plucked weight determination[24]. Furthermore, Oluyemi and Roberts [5] stated that one disadvantage of non-cereal carbohydrate is the need for processing; another is their low protein content. The percent dietary protein decreased as the percent substitution increased, thus, contributing to the poor performance of birds fed diets 2 and 3, respectively in the two trials.

The input and output economic analysis of the various diets (Hausa potato and Rizga) fed the birds proved to be inefficient and economically disadvantageous. This might not be unconnected with the cost of purchasing the wet Hausa potato and the rizga, which reduced drastically in weight after drying. The poor growth exhibited by the birds fed diets 2 and 3 in both trials (1 and 2) also proved uneconomical.

From the foregoing, it seems that processing of Hausa potato and Rizga (apart from sun-drying) may be necessary. There's also the need to fortify such diets, improve the nutrient density and or pellet such feeds to take care of the dustiness and also increase feed intake which will consequently increase growth rate.

CONCLUSION

In conclusion, the results of both experiments indicates that, for now, the substitution of the dietary maize for Hausa potato or Rizga in broiler ration is economically and productively inefficient. Efforts, should, therefore, be geared towards more research so as to improve on the utilization of these neglected and under exploited root crops for efficient poultry production.

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