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Growth, Carcass and Internal Organ Characteristics of Finisher Broiler Chickens Fed Processed Roselle (*Hibiscus sabdariffa* L.) Seed Meal Diets

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Abstract
A 28 - day feeding trial was conducted using 165 unsexed, five weeks old broiler (Hubbard) chickens to determine the nutritional potentials of variously processed roselle (*Hibiscus sabdariffa*) seeds in broiler finisher diets. Five diets were fed to the chicks in groups of 33 chickens per diet, subdivided into 3 replicates of 11 birds each in a completely randomized design. The diets consisted of a control which contained no roselle seed, and four other diets, in which 50% of the full-fat soybean was replaced with unprocessed, soaked, sprouted, and boiled roselle seed meals. The superiority of soybeans and boiled roselle seeds was restricted to feed conversion and efficiency of feed utilization. There were no differences between treatments with respect to meat yield, meat distribution among carcass cuts, or the proportional weights of the major visceral organs, except that unprocessed roselle seeds resulted in heavier gizzard and pancreas, which is attributable to stress on the pancreas to produce more enzymes to compensate for enzyme inactivation by anti-nutrients present in the unprocessed seeds. It was concluded that at 50% replacement level, soaked, sprouted and boiled roselle seed meals were as suitable as soybeans for use in finisher broiler diets without detriment to optimum growth.
Keywords: Finisher broilers, processed roselle seeds, growth, carcass, internal organs.

1. Introduction

The demand and cost of soybeans, the major and most widely utilized protein ingredient in poultry diets have risen over the years. This has necessitated the search for alternative unconventional feedstuffs to remedy the competition between man and animals for the available conventional sources, since cost of feeding accounts for about 70 – 80% of the cost of poultry production in Nigeria (Oluyemi 1984). Roselle (*Hibiscus sabdariffa* L.) is a leguminous shrub well adapted to the Guinea and Sudan savanna vegetation belts of Nigeria (Alagbejo 2000). The calyces have been the most utilized part of the plant used for making jam, jelly (Morton, 1987), soup and the popular '*zobo*' beverage in Nigeria. The seeds are fermented to make a cake referred to as sorrel 'meat' or '*iyu*' as it is called by the *Taroh* people of Plateau state, Nigeria. Roselle seed contains high amount of protein, dietary fiber, and minerals such as phosphorus, calcium and magnesium (Ismail *et al*. 2008). The seeds from Nigeria contain about 35.90% crude protein, 10.14% ether extract, 10.09% ash and 15 - 17% crude fiber (Dashak & Nwanegbo 2002; Kwari *et al.* 2011). The seed also possesses anti-oxidative and anti-hypercholesterolemic properties (Ismail *et al.* 2008; Mahadevan *et al.* 2009). It is a potential source of protein for poultry (Diarra *et al.* 2011).

The unprocessed seed has been reported to contain tannin, hibiscin and hydroxyl flavone as major anti-nutritional factors (Duke 1983; Mahadevan *et al.* 2009). However, the most commonly reported anti-nutritional factors are total phenols, tannins and phytic acid, and these have been shown to have detrimental effects on the health and performance of animals (Diarra *et al.* 2011; Kayembe 2011). Effective utilization of roselle seeds by non ruminant animals will necessitate processing to inactivate anti-nutritional factors (Soetan & Oyewole 2009). Processing methods such as soaking, fermenting, cooking and sprouting have been reported to be effective in doing this. This study is intended to determine the effects of feeding variously processed roselle seeds on the production parameters of finisher broiler chickens.

2. Materials and Methods

2.1 Experimental Site

The study was conducted at the Livestock Farm Complex, Plateau State College of Agriculture, Garkawa, east of Shendam (Latitude 8◦ 53'N, Longitude 9° 32'E, and 853m above sea level) (Wikipedia 2010) in the northern Guinea Savanna vegetation belt of Nigeria.

2.2 Source and Preparation of Test Ingredients

Roselle seeds were purchased from the market in Mangu, Plateau state, Nigeria. The seeds were thoroughly

cleansed of dirt by winnowing and sieving. 16kg of the seeds were simply milled ready for inclusion in the experimental diet. Another 16kg seeds were soaked in 20liters of water for 24 hours, drained, and sun-dried until crisp. 16kg of the seeds were added to 40liters of already boiling water over fuel wood and cooked for 30 minutes after returning to the boil according to method described by Kwari *et al*. (2010) when feeding cockerels with roselle seeds. The water was drained and the seeds were sun-dried until crisp. 16kg of the seeds were soaked in 20liters of water for 24 hours, drained and packed into jute sacks and stored at room temperature for 48 hours to sprout. The sprouted seeds were then sun-dried until crisp. All the seeds were crushed separately in a hammer mill to the required particle size and incorporated into experimental diets.

2.3 Experimental Diets

Five isonitrogenous and isocaloric broiler finisher (20% crude protein and 3000kcal/kg metabolizable energy) diets were formulated. Diet 1(control) was based on full-fat soybean meal. In diets 2, 3, 4 and 5, 50% of the soybean was replaced by unprocessed roselle seed meal, soaked roselle seed meal, sprouted roselle seed meal and boiled roselle seed meal respectively (Kwari *et al*, 2011).

2.4 Experimental Animals and Housing

One hundred and sixty five (165) healthy 5-week old broiler (Hubbard classic) chickens were balanced for weight and randomly assigned to five treatments in a completely randomized design. Each treatment consisting of 33 birds was divided into three replications of 11 birds each. The birds were raised on deep litter within compartments measuring 1.95 x 1.31m each in a house with concrete walls, wide, netted open windows for proper ventilation and roofed with zinc coated metal sheets. Conventional management practices were adopted.

2.5 Experimental Procedure and Data Collection

The chickens were balanced for weight and randomly assigned to five treatments. Known quantities of broiler finisher diets were fed to the chickens, and left over were weighed. Feed and drinking water were given *ad libitum* throughout the period of experiment which lasted for 4 weeks. Mean daily feed consumption and daily body weight gain were determined. At 9 weeks of age, two birds were randomly selected from each replicate and fasted for 11 hours to decrease fecal contamination during evisceration (Gomez *et al*. 2008), and then weighed to obtain fasted live weight. They were slaughtered by slitting the throat. They were scalded in hot water for 60 seconds (Oluyemi & Roberts 2000), plucked and then eviscerated. Slaughter weight, plucked weight, dressed weight, weights of cut-up parts and internal organs were determined using a sensitive electronic scale and their proportion expressed as percent of live weight. The length of intestine was measured by placing a string alongside them, which was subsequently straightened over a measuring tape.

2.6 Chemical Analysis

Unprocessed and processed roselle seeds, and the experimental diets were analyzed for proximate composition, calcium and phosphorus content according to methods described by AOAC (1980). Phytic acid was determined by the method described by Reddy *et al*. (1982), while tannin content and trypsin inhibitor activity were determined by the methods described by Allen *et al.* (1974) and AOAC (1980) respectively.

2.7 Statistical Analysis

Data generated were subjected to Analysis of Variance (ANOVA) using the SPSS (2012) software. Significant differences in the treatment means were separated using the Duncan's Multiple Range Test as outlined by Steel and Torrie (1980).

3. Results and Discussion

3.1 Performance of Finisher Broiler Chickens

Performance of finisher broiler chickens is presented in Table 2. Feed intake obtained was slightly lower than reported by Duwa *et al.* (2012) for finisher broiler chickens fed processed roselle seeds. It was significantly ($P<0.05$) high for birds fed diets containing sprouted and boiled roselle seeds, while birds on the control diet recorded the least consumption. Despite higher crude fibre contents of the roselle seed based diets, voluntary feed intake was not depressed. It has been demonstrated that the inclusion of moderate amounts of different fibre sources in the diet improves digestive organ development and increases HCl, bile acids, and enzyme secretion (Mateos *et al.* 2012). These changes might result in improvements in nutrient digestibility, growth performance, gastrointestinal tract health, and eventually, animal welfare (Dairo *et al*. 2010).

Feed conversion ratio obtained are slightly higher than reported by Duwa *et al.* (2012) (2.61 – 2.85) for finisher phase of broilers, but similar to a range of 2:1 (Oluyemi & Roberts 2000) and 3:1 (Banerjee 1998) for 9 week-old broilers. A significantly ($P<0.05$) high value was obtained for birds fed diets containing the sprouted seeds. This implies poorer feed utilization. Kwari *et al.* (2011) reported similar outcome for 9 week- old broiler

chickens. Duwa *et al*. (2012) did not find significant difference in feed conversion ratio of finisher broilers among birds fed raw, roasted, boiled and soaked roselle seed containing diets. Feed conversion ability was adversely affected by sprouting, while both soaking and sprouting significantly (P<0.05) reduced protein efficiency ratio, implying poorer utilization of protein. However, this did not ultimately affect final weight of birds.

3.2 Economic Analysis

Table 3 shows the economic analysis of feeding finisher broilers with diets containing unprocessed and processed roselle seed. Feed cost and feed cost per weight gain were not significantly (P<0.05) affected. Contrary to this report, Duwa *et al*. (2012) reported a higher (P<0.05) cost for birds fed diets containing boiled roselle seeds. Cost of broiler chicken production by all the processing methods was similar to the control, except for birds fed the unprocessed seeds which had the least (P<0.05) cost and this is attributed to lack of processing cost.

3.3 Carcass Characteristics

Carcass weights of the chickens expressed as percent of live weight are presented in Table 4. Yield of carcass and cut-up parts was not significantly affected among the dietary treatments. Yield of carcass and cut-up parts was not significantly affected among the dietary treatments. The dressed weights were within the 65 – 77% reported by Jourdain (1980) and Oluyemi & Roberts (2000) for 9 weeks old broilers. Kwari *et al*. (2010) reported slightly lower dressing percentage for broilers fed unprocessed roselle seed diets. The yield of drumsticks, thighs, wings, and breasts obtained are slightly less than 11.67, 12.95, 8.21, 17.40% respectively reported by Oluyemi & Roberts (2000). The weights of the back are higher than 12.05% reported by Oluyemi & Roberts (2000). Contrary to the findings of this study, Duwa *et al.* (2012) had found significant (P<0.05) differences in weights of the parameters considered. The result of this study reveals that replacing 50% of full-fat soybeans with unprocessed, soaked, sprouted, and boiled roselle seeds in finisher broiler diets did not have any negative effect on carcass weights of finished broilers. This confirms the similarity in final weights obtained for all treatments.

3.4 Internal Organ Characteristics

Internal organ weights of finisher broiler chickens expressed as percent of live weight is presented in Table 5. Significant (P<0.05) differences were observed in the weights of empty gizzard and pancreas among the treatments. Empty gizzard weight was significantly (P<0.05) increased in birds fed diets containing soaked and sprouted seeds. The gizzard weights obtained were higher than the 1.2% of live weight reported by Hubbard breeders (2013). Duwa *et al*. (2012) had reported higher (P<0.05) gizzard weights for birds fed boiled and soaked roselle seed meal diets. Pancreas weight was significantly (P<0.05) high in birds fed unprocessed roselle seeds attributable to stress on the pancreas to produce more enzymes to compensate for enzyme inactivation by anti-nutrients present in unprocessed seeds. However, sprouting and boiling were more effective (P<0.05) at decreasing pancreas size, an indication of inactivation of anti-nutritional factors than by other processing methods studied.

4. Conclusion

Use of roselle seeds, up to 16% in finisher broiler diets had no adverse effects on growth rate. Processing methods did not adversely affect the weights of carcasses and cut-up parts, and internal organ measurements. Replacing soybeans with roselle seeds in finisher broiler diets did not increase cost of broiler chicken production.

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Table 1. Ingredients and Calculated Nutrient Composition of Broiler Finisher Diets Containing Unprocessed and Variously Processed Roselle (*Hibiscus sabdariffa* L.) Seeds.

Ingredients	Dietary treatments				
	1	2	3	4	5
Yellow corn	49.12	48.12	48.12	48.12	48.12
Full-fat soybeans	33.08	16.54	16.54	16.54	16.54
Roselle seed meal	-	16.54	16.54	16.54	16.54
Fish meal (63%)	2.00	5.00	5.00	5.00	5.00
Wheat offal	12.00	10.00	10.00	10.00	10.00
Bone ash	3.00	3.00	3.00	3.00	3.00
Iodized salt	0.25	0.25	0.25	0.25	0.25
Vit-min Premix*	0.30	0.30	0.30	0.30	0.30
Methionine	0.25	0.25	0.25	0.25	0.25
Total	100.00	100.00	100.00	100.00	100.00
Calculated nutrient content					
Crude protein (%)	20.00	20.35	20.78	20.47	20.41
Metabolizable energy (kcal/kg)	3059	3050	3050	3055	3054
Crude fiber (%)	3.84	7.55	7.31	7.56	6.13
Ether extract (%)	8.43	8.17	8.00	8.28	9.15
Calcium (%)	1.33	1.51	1.51	1.53	1.50
Available phosphorus (%)	0.79	0.76	0.76	0.76	0.77

*Vitamin-mineral premix (BIOMIX™) supplying per kg diet, Vit. A 5000IU; Vit. D3 888000IU; Vit. E 12000mg; Vit. K3 15000mg; Vit. B1 1000mg; Vit. B2 2000mg; Vit. B6 1600mg; Niacin 12,000mg; Pantothenic acid 2000mg; Biotin1000mg; Vit B12 3000mg; Folic acid 15000mg; Choline chloride 60,000mg; Manganese,10000mg; Iron, 15000mg; Zinc 800mg; Copper 400mg; Iodine 80mg; Cobalt 40mg; Selenium, 8000mg.

Table 2. Performance of Finisher Broilers Fed Diets Containing Unprocessed and Variously Processed Roselle Seeds Meals.

	Dietary treatments					
Parameter	1	2	3	4	5	SEM
Initial body weight (g/bird)	946.53	949.20	964.47	937.50	955.54	50.69^{NS}
Final body weight (g/bird)	2200.29	2148.94	2194.50	2133.23	2228.92	71.68^{NS}
Weight gain (g/bird/day)	44.78	42.85	43.93	42.59	45.48	1.90^{NS}
Feed intake (g/bird/day)	120.23^{d}	121.58^{cd}	125.92^{bc}	134.25^{a}	130.66^{ab}	2.15^{*}
Feed conversion ratio	2.69^{a}	2.84^{a}	2.87^{a}	3.16^{b}	2.85^{a}	0.12^{*}
Protein efficiency ratio	1.86^{a}	1.73^{ab}	1.68^{bc}	1.55^{c}	1.72^{ab}	0.07^{*}

a, b, c, Means within the same row bearing different superscript differ significantly (P<0.05); SEM=Standard Error of Means; NS=Not significant (P>0.05); *=Significantly different (P<0.05).

Table 3. Economics of Feeding Unprocessed and Variously Processed Roselle Seed Diets to Finisher Broilers

	Dietary treatments					
Parameter	1	2	3	4	5	SEM
Feed cost (₦/kg)	103.16	94.00	94.74	94.74	95.24	0.91^{NS}
Feed cost (₦/kg gain)	277.78	267.09	271.97	299.32	271.73	11.56^{NS}
Cost of production (₦/bird)*	493.14^{a}	465.87^{b}	485.29^{a}	501.11^{a}	494.29^{a}	7.01^{*}

a, b, c, Means within the same row bearing different superscript differ significantly (P<0.05); SEM=Standard Error of Means; NS=Not significant (P>0.05); *=Significantly different (P<0.05).

Table 4. Carcass Characteristics of Finisher Broilers Fed Unprocessed and Variously Processed Roselle Seed Meal Diets Expressed As Percent of Live Weight.

	Dietary treatments					
Parameter	1	2	3	4	5	SEM
Live weight (g)	1990^{a}	1840^{c}	1871.66^{c}	1958.33^{ab}	1933.33^{b}	18.35*
Slaughter weight (%)	98.32	98.03	97.13	96.77	97.21	1.23^{NS}
Plucked weight (%)	90.36	88.76	91.99	89.20	91.24	4.44^{NS}
Dressed weight (%)	74.57	72.23	72.54	72.08	73.54	1.33^{NS}
Breast (%)	16.87	16.73	15.24	15.66	17.88	1.10^{NS}
Back (%)	14.03	13.06	13.72	12.48	14.84	1.17^{NS}
Wings (%)	8.35	8.20	8.14	7.79	8.81	0.45^{NS}
Thighs (%)	12.40	12.07	11.77	12.18	14.21	0.98^{NS}
Drumsticks (%)	10.15	10.49	10.41	10.19	11.95	0.82^{NS}

a, b, c, Means within the same row bearing different superscript differ significantly (P<0.05); SEM=Standard Error of Means; NS=Not Significant; *=Significantly different (P<0.05).

Table 5. Internal Organ Weights of Finisher Broiler Chickens Fed Unprocessed and Variously Processed Roselle Seed Meal Diets.

Parameter	Dietary treatments					
	1	2	3	4	5	SEM
Empty gizzard (%)	1.66^{b}	1.53^{b}	1.78^{ab}	2.02^{a}	1.55^{b}	0.14*
Liver (%)	2.25	2.16	2.47	2.53	2.12	0.15^{NS}
Lung (%)	0.60	0.65	0.66	0.61	0.63	0.08^{NS}
Heart (%)	0.47	0.46	0.52	0.46	0.50	0.05^{NS}
Proventriculus (%)	0.42	0.41	0.56	0.50	0.48	0.06^{NS}
Pancreas (%)	0.24^{ab}	0.28^{a}	0.25^{ab}	0.21^{b}	0.21^{b}	0.02*
Spleen (%)	0.17	0.11	0.17	0.13	0.16	0.03^{NS}
Small intestine (%)	4.40	4.89	5.03	4.44	4.37	0.33^{NS}
Cecum (%)	0.74	0.71	0.76	0.71	0.73	0.10^{NS}
Intestine (cm)	198.80	212.30	192.10	184.82	191.26	8.70^{NS}
Abdominal fat (%)	1.75	3.03	2.09	2.23	2.64	0.52^{NS}

a, b, c, Means within the same row bearing different superscript differ significantly (P<0.05); SEM= Standard Error of Means; NS=Not significant; *=Significantly different (P<0.05)

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