Performance and hypo-cholesterolemic response of laying hens fed cassava root sievate - based diets.

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Abstract

A total of one hundred and fifty (150) Nera sex-linked layer strain (32 weeks of age) were used to investigate the performance response, blood plasma and egg yolk cholesterol status of hens fed cassava root sievate (CRS) based - diets. CRS was used to replace wheat offal at 0, 5, 10, 15 and 20% respectively, resulting in five dietary treatments. Each treatment had 3 replicates with each replicate group having five birds. The experiment lasted for 10 weeks. No significant effect of diets was noticed in the body weights, weight gain and daily feed intake. Feed conversion per dozen egg, hen-day egg production and total egg produced significantly declined as CRS levels increased from 0 to 20% in the diets. Diets with 20% CRS had the poorest performance. However, the blood plasma, egg yolk and egg cholesterol concentrations were reduced significantly ($P < 0.05$) with increased level of CRS. Dietary treatment with 20 % CRS had the lowest ($P < 0.05$) cholesterol concentration. Inclusion of up to 20% CRS led to 35% reduction in plasma total cholesterol, while 18 and 17 % reductions were obtained in the egg yolk total cholesterol and total cholesterol per egg respectively. Replacement of up to 10% (w/w) wheat offal by CRS is therefore recommended to effectively reduce cholesterol content of the plasma ,egg yolk and whole egg by 20%, 10% and 17 % respectively at performance level that are comparable with that of the control group.

Keywords: Layers, cassava root sievate, performance

Introduction

The use of wheat offal and maize as the major energy source has been the practice over the years. However, the high cost of conventional energy sources and their high demand as human food stuff has led to search for alternative cheap energy sources. Cassava (*Manihot esculenta*) has been found to be an effective replacement as energy rich feedstuff in poultry feeding (Omole, 1977; Tewe and Egbunike, 1992; Eruvbetine and Oguntona, 1997 and Eruvbetine *et al.*, 2003). The

above workers reported that cassava based diets were adequate in meeting the nutritional requirement of laying chickens. However, cassava also serves as human food item. Out of the estimated 125 million tons of tuber produced yearly, about 90% is used as human food while the remainder is used largely as animal feed and other industrial purposes (Philips, 1983). In the processing of cassava for human consumption, lots of residues such as root peels, root fibre (rinds) and root sievate are produced, which are

often wasted as the processor does not make use of them (Aderemi, 2001). Cassava root sievate (CRS) is a residue obtained after the sundried peeled root is milled and sieved to obtain cassava flour.

Since egg cholesterol is one of the most concentrated source of dietary cholesterol, an extensive research effort has been made to reduce the level of egg cholesterol (Turk and Barnett, 1972; Piliang, 1990; Beycr and Jensen, 1993 and Lorette *et al.*, 1993). These researchers reported that addition of certain plant fibres to laying hen's diet decreased egg yolk cholesterol concentration. The use of CRS could therefore be explored in reducing cholesterol content of the egg since it is high in fibre (Aderemi, 2001). This study is therefore carried out to investigate the performance and hypo-cholesterolemic response of laying hens to CRS based diets.

Materials and Methods

Experimental birds and design.

A total of one hundred and fifty Nera sex-linked layer strain (32 weeks of age) were divided at random into five dietary treatment groups of 30 birds each and each treatment group had three replicate groups of ten birds each. The experiment was arranged in a completely randomized design. The experiment lasted for 10 weeks.

Experimental diets and management

Five experimental diets were formulated to contain 0, 5, 10, 15 and 20 % CRS respectively (Table 1). The experimental birds were kept in a standard battery cage with automatic nipple drinkers and standard feeding trough. Feed and water were provided *ad-libitum* throughout the experimental period. All recommended health and management practices were strictly

observed. Weekly feed intake and body weight were measured from which average feed intake, body weight gain and feed conversion ratio were calculated. The egg production and egg weight data were recorded daily. Average egg production, egg weight, feed intake and feed conversion ratio were calculated for each replicate group at the expiration of eight weeks.

Sample preparation and yolk cholesterol analysis.

Nine eggs (3 per replicate) from each treatment were sampled weekly. Eggs were weighed and hard cooked by immersion in boiling water for 8 minutes. Yolks were individual weighed and oven-dried at 70°C and yolk dry matter was determined individually and expressed as percentage of the fresh-boiled yolk weight. Egg lipid was extracted with chloroform: methanol (2:1 v/v) using the procedure described by Folch *et al.* (1957). Cholesterol determination done using a commercial test kit for cholesterol analysis (Sigma diagnostic cholesterol reagent procedure No 352, Sigma Chemical Co., St Louis, MO, USA). All sample extracts were analyzed in triplicate. Cholesterol concentration were determined from the absorbance read at 500nm using a spectrophotometer (Idowu *et al.*, 2002)

Plasma lipid analysis

At the termination of the experiment, 5ml of blood was drawn from the brachial vein from 9 birds per treatment (3 per replicate) into a heparinized tubes. Plasma was immediately separated by centrifugation for 10 min at 1400 rpm. Plasma triglyceride, total cholesterol, free cholesterol and lipoproteins (LDL and HDL) were determined using enzymatic – colorimetric method (according to Randox diagnostic reagent kit – CHOD – PAP^(R)).

Statistical analysis

Data collected were analyzed by ANOVA using General Linear Model (GLM) procedure of SAS

Table 1: Proximate composition of the test ingredients.

	Cassava Root Seivate	Wheat Offal
Dry Matter (%)	92.5	89.0
*ME (Kcal/kg)	1725	1818
Crude protein (%)	2.0	16.80
Crude fibre (%)	18.0	7.2
Ether Extract (%)	2.3	6.0
Ash (%)	6.23	3.50
NFE (%)	63.97	55.5

*Aduku (1990) and Aderemi (2001)

Table 2: Composition of the experimental diets.

Ingredients	Dietary Treatments				
	1 0% CRS	2 5% CRS	3 10% CRS	4 15% CRS	5 20% CRS
Maize (white)	38.00	38.00	38.00	38.00	38.00
Wheat offal	20.00	15.00	10.00	5.00	-
Cassava Root Sievate (CRS)	-	5.00	10.00	15.00	20.00
Corn bran	9.50	9.50	9.50	9.50	9.50
DBG	5.00	5.00	5.00	5.00	5.00
Soyabean meal	16.00	16.00	16.00	16.00	16.00
Fishmeal	1.00	1.00	1.00	1.00	1.00
Salt	0.25	0.25	0.25	0.25	0.25
Premix (layer)	0.25	0.25	0.25	0.25	0.25
Bonemeal	2.00	2.00	2.00	2.00	2.00
Oyster shell	8.00	8.00	8.00	8.00	8.00
Total	100.00	100.00	100.00	100.00	100.00
Determined composition					
Dry Matter (%)	95	86.5	83.3	86	84.5
*ME (Kcal/kg)	2535	2529	2524	2519	2513
Crude protein (%)	16.2	16	14.9	14.7	12.5
Crude fibre (%)	5.5	6.2	6.8	7.4	7.4
Ether Extract (%)	4.60	4.58	3.78	4.52	3.40
Ash (%)	11.5	12	16	14	14.5
NFE (%)	47.20	47.72	41.82	45.38	46.70
*Ca (%)	3.67	3.66	3.66	3.65	3.60
*P (%)	0.70	0.66	0.61	0.57	0.53

*Calculated values

(1985). Significant differences between treatment means were determined at $P < 0.05$ using Duncan's new multiple range test.

Results and Discussion

Table 1 showed the proximate composition of CRS and wheat offal. The crude protein (CP), crude fibre (CF), ether extract (EE), ash and NFE values determined agreed with the earlier values reported by Aduku (1990), Aderemi (2001) and Idowu *et al.* (2002). However, the CP value of CRS (2.0%) obtained in this study was comparatively low to that of wheat offal (16.80%). The CRS also had higher NFE, CF, and ash values than wheat offals. The wheat offal was richer in EE and ME. The difference (83 ME kcal/kg) in ME value could be attributed to the difference in EE values. The chemical compositions of the experimental diets (Table 2) showed that the metabolizable energy values were between 2513 and 2535 kcal/kg while the dietary CP and EE contents were between 12.5 and 16.2%, and 3.4 and 4.6% respectively. These values decreased with increased levels of CRS in the diets. The fibre content was in a range of 5.5 - 7.5% and the values increased linearly with increased levels of CRS in the diets (Table 2). The ash and NFE values followed no definite trend across treatment groups. All diets had high dry matter (DM) content ranging from 83.3% in the 10% CRS diets to 95% in the control diet (0% CRS). The control diet (0% CRS) was formulated to meet the minimum nutrient requirements of laying hens (NRC, 1994).

Inclusion of CRS in the diets at 5-20% levels did not affect the body weight and weight gain significantly ($P > 0.05$) (Table 2). Birds in the control group had the highest final body weight and weight gain. This implies that CRS inclusion of up to 20% in the layers diet could serve as a good replacement for the wheat offal without any adverse effect on the body weight. It also means

that the inclusion of CRS helped in maintaining bodyweight, which is needed in sustaining efficiency of egg production (Eruvbetine and Oguntona, 1997). No significant difference was noticed between the daily feed intake of the control group and those of other treatment groups. The daily feed intake per bird was between 113g and 120g and the values declined ($P > 0.05$) linearly. This indicates the likelihood of the presence of anti-nutritional factors particularly cyanide which naturally reduce feed intake (Tewe, 1997). The decreased feed intake could also be as a result of high fibre ingestion which could have led to increased water intake that would create a stomach fill sensation and subsequent depression of appetite (Aderemi, 2001).

There were significant differences ($P < 0.05$) among treatment means in the feed per dozen egg laid (FCR). Feed conversion ratio (FCR) of 20% CRS group was poorer ($P < 0.05$) than that of 10% CRS group but was similar ($P > 0.05$) to that of 15% CRS group. Also, birds on 10% CRS diet had poorer ($P < 0.05$) FCR than those on 0% CRS diet which was statistical the same with those on 5% CRS diet. This observation disagrees with the observations of Ngoka (1986) who noticed higher feed utilization efficiency among birds fed whole cassava based diets compared with those on the control diets. Similar trend in variation was observed in the hen-day and total egg production as presented in Table 3. Significant differences were noticed in the values recorded for both hen-day and total egg production. Hen-day egg production was between 68.73 and 79.68% while the total egg produced per dietary treatment was between 144 and 167 eggs. Both hen-day and total egg production decreased proportionately as the proportion of wheat offal in the diets was gradually replaced by 5 - 20% CRS. The cost of feed per kilogramme and cost of feed consumed as well declined in the same fashion.

Table 3: Effect of CRS based diets on the performance characteristics of laying hens and cost considerations of egg production.

Measurements	Dietary Treatments					SEM
	0% CRS	5% CRS	10% CRS	15% CRS	20% CRS	
Initial wt/bird (kg)	1.53	1.54	1.51	1.56	1.56	0.0
Final wt/ bird (kg)	1.85	1.76	1.77	1.73	1.75	0.105
Weight gain/bird (kg)	0.33	0.22	0.27	0.16	0.18	0.02
Total feed consumed (kg)	5.03	5.04	4.93	4.87	4.76	
Feed intake/ bird/day (g)	119.76	120.00	117.95	115.95	113	0.01
Feed conversion per dozen egg	1.80 ^d	1.86 ^{cd}	1.89 ^{bc}	1.94 ^{ab}	1.98 ^a	0.01
Dozen egg/bird	2.79 ^a	2.72 ^b	2.61 ^c	2.51 ^d	2.41 ^e	0.01
Hen day egg production(%)	79.68 ^a	77.62 ^b	75.08 ^c	71.75 ^d	68.73 ^e	0.23
Total egg	167.33 ^a	163.00 ^b	157.67 ^c	150.67 ^d	144.33 ^e	0.48
Price/crate of egg (₦)	270.00	270.00	270.00	270.00	270.00	
Cost/kg feed (₦)	32	31.20	30.40	29.60	28.80	
Cost of feed consumed (₦)	160.96	157.25	149.87	144.15	137.10	
Crate of egg produced	5.6	5.4	5.3	5.0	4.8	
Total price of egg produced (₦)	1512	1458	1431	1350	1296	

^{a,b,c,d,e} : Means on the same row having the same superscript. are not significantly different ($p>0.05$)

CRS : Cassava Root Sievate

SEM : Standard Error of Mean

₦ : Nigeria currency, Naira

N 140:00 : is equivalent to one US Dollar (Year 2004 exchange rate).

Performance of layers on cassava root sievate diets

Table 4: Plasma Cholesterol of birds fed diets containing graded levels of cassava root seivate.

Measurement	Dietary Treatments					
Plasma Cholesterol (mg/dl)	0% CRS	5% CRS	10% CRS	15% CRS	20% CRS	SEM
Total	138.00 ^a	115.00 ^b	110.33 ^b	101.00 ^c	92.00 ^d	0.60
Free	34.00 ^{ab}	36.00 ^a	35.00 ^{ab}	32.00 ^{bc}	29.00 ^c	0.35
Ester	104.00 ^a	79.00 ^b	75.00 ^{bc}	69.00 ^{cd}	63.00 ^d	0.76
LDL	18.00 ^a	15.00 ^b	14.00 ^{bc}	13.00 ^{bc}	12.00 ^c	0.27
HDL	28.00 ^a	23.00 ^b	22.00 ^b	21.00 ^{bc}	19.00 ^c	0.27
VLDL	91.33 ^a	77.00 ^b	74.00 ^b	67.00 ^c	61.00 ^d	0.62
Triacylglycerol (mg/dl)	88.67 ^a	74.00 ^b	71.00 ^c	65.00 ^d	59.00 ^e	0.23

a,b,c,d,e : Means on the same row having the same superscript. are not significantly different ($p>0.05$)

CRS : Cassava Root Sievate
SEM : Standard Error of Mean
LDL : Low density lipoprotein
HDL : High density lipoprotein
VLDL : Very low density lipoprotein

Plasma cholesterol status in terms of plasma (total, free and ester), triacylglycerol and lipoprotein components were significantly influenced by the dietary treatments (Table 4). Highest and lowest plasma lipid values were noticed in the birds fed 0% CRS and 20% CRS respectively. The mean values for free plasma cholesterol in 0, 5 and 10% CRS diets were similar ($P>0.05$). Similarity ($P>0.05$) was also observed in the cholesterol ester values for 5% and 10% CRS groups and also between 10% and 15% CRS groups. Each kilogram of wheat offal replaced by CRS (w/w) (Table 1) increased the fibre content of the

resulting diets by 0.108g . It therefore follows that the replacement of wheat offal with CRS at 0, 5, 10, 15 and 20% respectively (Table 2) resulted in 0, 12.7, 23.6, 34.5 and 36.4% increase in the dietary fibre respectively.

Laying hens fed 5 – 20% CRS based diets ingested more fibre and less fat than the control group chickens. This resulted in a decreasing linear response in terms of the total blood cholesterol and other plasma lipid compositions (Table 4). The hypocholesterolemic effect of CRS based diets was clearly indicated by the

Table 5: Effect of CRS based diets on the Cholesterol Concentration in egg

Parameters	Dietary Treatments					SEM
	0%CRS	5% CRS	10% CRS	15% CRS	20% CRS	
Egg wt (g)	63.33 ^a	59.63 ^b	59.82 ^{bc}	58.58 ^{bc}	55.30 ^c	0.85
Yolk wt (g)	16.33 ^a	14.71 ^b	15.07 ^b	14.38 ^{bc}	13.66 ^c	0.20
Yolk DM (g)	8.47 ^a	7.53 ^{bc}	7.82 ^b	7.37 ^{bc}	7.01 ^c	0.12
Yolk DM (%)	51.86	51.15	51.79	51.26	51.27	0.20
Fat (mg/g)	411.00 ^a	421.46 ^a	410.50 ^a	358.50 ^b	349.17 ^b	7.10
Yolk cholesterol(mg/g)	15.60 ^a	15.21 ^a	14.07 ^b	13.78 ^{bc}	12.81 ^c	0.45
Cholesterol/egg (mg)	122.13 ^a	114.53 ^b	110.03 ^b	101.56 ^c	100.10 ^c	1.37

a,b,c,d,e: Means on the same row having the same superscript are not significantly different ($p>0.05$)

CRS : Cassava Root Sievate
SEM : Standard Error of Mean
WT : Weight
DM : Dry matter

linear decrease in values of plasma cholesterol and the lipoproteins. This is in line with hypothesis that increased dietary fibre often result in reduction in the availability of cholesterol for incorporation into lipoproteins (Story and Furumoto,1990). The presence of glycoside in cassava products (Tewe ,1997) is also suspected to exert hypocholesterolemic influence as glycosides have the ability to interfere with the intestinal absorption of the dietary cholesterol and lipids (Cheeke,1971).

Critical examination of the cholesterol contents of the egg yolk and the whole egg showed that 3-18% reduction was obtained in the yolk

cholesterol content as a result of including 5-20% CRS in the experimental diets while the cholesterol per egg was reduced by 6-17% (Table 5). In some related studies McNaaughton (1978) obtained 13.2% reduction in egg yolk by increasing dietary fibre . Lirette *et al* (1993) also reported 6 – 7 % decrease in egg yolk cholesterol as a result of including oat bran and cotton seed hulls in laying hen's diets.

Conclusion

Replacement of wheat offal with CRS in laying hen's diets significantly reduced the plasma cholesterol , egg yolk cholesterol and cholesterol

per egg. Inclusion of up to 10% CRS in laying hen's diet is recommended to obtain performance level that are comparable with that of the control group and at the same time reduce cholesterol content in the plasma, egg yolk and the whole egg by 20%, 10 % and 9.9% respectively.

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