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Sushree Sangita Boitai
Department of Livestock Production and Management College of Veterinary Science, OUAT, Bhubaneswar, Odisha, India

Lakshman Kumar Babu
Department of Livestock Production and Management College of Veterinary Science, OUAT, Bhubaneswar, Odisha, India

Arun Kumar Panda
ICAR-Central Institute for Women in Agriculture Bhubaneswar, Odisha, India

Correspondence
Sushree Sangita Boitai
Department of Livestock Production and Management College of Veterinary Science, OUAT, Bhubaneswar, Odisha, India

Effect of dietary replacement of maize with cassava root meal on production performance, egg quality and serum biochemical parameters of Vanaraja laying hens

Sushree Sangita Boitai, Lakshman Kumar Babu and Arun Kumar Panda

Abstract
The effect of dietary replacement of maize with cassava root meal (CRM) on production performance, egg quality and serum biochemical parameters were studied in Vanaraja laying hens. Eighty four, 38-weeks old Vanaraja laying hens were randomly distributed into 3 dietary treatment groups of 24 hens each and were reared in deep litter system. Each treatment contained 4 replicates of 7 hens each. Three experimental diets were formulated by using CRM to replace maize at 0 (T1), 50 (T2) and 100% (T3) levels. A measured quantity of each diet was offered to one of the treatment group during the experimental period of 38 to 46 weeks of age. Dietary incorporation of CRM substituting maize upto 100% in the diet of Vanaraja laying hens had no adverse affect on body weight gain, egg production, egg weight, egg mass and feed efficiency. Similarly, none of the egg quality parameters such as albumen %, Yolk %, eggshell weight, Haugh unit, eggshell thickness were influenced due to 100% dietary replacement of maize with CRM. The serum biochemical parameters like total protein, albumin, globulin, uric acid, phosphorus and total cholesterol were not influenced due to complete replacement of dietary maize with CRM in Vanaraja laying hens. However, serum triglycerides concentration decreased significantly due to 100% replacement of dietary maize with CRM. The serum calcium concentration also increased significantly due to dietary incorporation of CRM in the laying hens. It is concluded that maize can be completely replaced with cassava root meal without adversely affecting production performance in Vanaraja laying hens.

Keywords: Maize, cassava root meal, production performance, egg quality, serum biochemical parameters, Vanaraja laying hens

Introduction
Feed cost accounts for 60-70 % of the total cost of poultry production. Maize is a common ingredient of choice for the supply of energy and included around 50-60% in poultry diet. Inadequate supply, exorbitant prices and diversion towards using cereal grains for biofuel production, particularly maize, has led to a constant search for alternative energy sources for poultry and other non-ruminant species [1]. Cassava root meal is rich in carbohydrate. The abundant availability of cassava in certain regions makes it a good alternative to maize and other cereal grains and could help to reduce feed cost [2, 3].
Cassava products contain a wide range of cyanogenetic glycosides, particularly linamarin and to a lesser extent as lotaustralin that are present in the leaf and tuber of the plant [4]. The level of hydrocyanic acid released from the cyanogenetic glycosides limits the utilization of cassava, but with proper processing, the dietary inclusion level of cassava meal can be increased for economic poultry production. The low protein content, essential vitamin and minerals of cassava tubers have been the major factors limiting its use in poultry diets. But the cassava roots are very rich in starch and contain small amounts of calcium (16 mg/100g), phosphorus (27 mg/100g), and vitamin C (20.6 mg/100g). The protein content (2.5%) is lower than that of yellow maize (8.5%). Khajarern and Khajarern [5] reported that cassava could be used as an energy source in layer diets at both pullet and laying stage with comparable production performance as those of maize. Oruwari *et al.* [6] stated that with proper protein balance, cassava meal could completely replace maize in poultry diets. The ICAR-Central Tuber Crop Research Institute, Regional Station, Bhubaneswar has developed low cynaogenic glucoside variety of Cassava (Sree visaksam). The present study was conducted to evaluate the effect of substituting maize with low cynaogenic glucoside containing Cassava root meal (CRM) in layer diets on production performance, egg quality and serum biochemical parameters of Vanaraja laying hens.

Materials and Methods

Experimental design

Eighty four, 38-weeks old Vanaraja laying hens were randomly distributed into 3 dietary treatment groups of 24 hens each and were reared in deep litter system. Each treatment contained 4 replicates of 7 hens each. All the laying hens were kept under uniform managerial conditions for a period of 8 weeks. Three experimental diets were formulated by using CRM to replace maize at 0, 50 and 100% levels (Table 1). A measured quantity of each diet was offered to one of the treatment group during the experimental period of 38 to 46 weeks of age. The ingredient and nutrient composition of the diets are presented in Table 1. This study was duly approved by the Institutional Animal Ethics Committee, OUAT, College of Veterinary Science and Animal Husbandry, Bhubaneswar, Odisha, India.

Preparation of cassava root meal

Cassava root was obtained from ICAR- Central Tuber Crop Research Institute, Regional Centre, Bhubaneswar, Odisha. These roots were sliced into chips by the chips cutting machine and sun-dried for 3-4 days. The chips were milled into flour through a grinder to obtain the cassava root meal. Then, the root meal was kept in an air tight plastic container for feed formulation.

Parameters studied

The individual body weight of laying hens was recorded at the beginning of the experiment and final body weight was measured at the end of the of study. The egg production was recorded daily on individual pen basis and percent hen housed egg production (HHEP) was calculated. The eggs laid by the birds on individual pen basis during the last three consecutive days of each 28 days period were collected to measure the egg weight. The egg mass per day was calculated as follows.

$$\text{Egg mass per day} = \frac{\text{number of egg produced} \times \text{average egg weight}}{\text{Number of birds} \times \text{duration (days)}}$$

The average feed consumption was recorded as g/hen/day and feed efficiency was calculated as grams of egg mass per gram of feed consumed.

Twelve eggs were randomly chosen in each treatment from the eggs laid during the last three consecutive days of each 28-day period to determine the egg quality. Egg, yolk and shell weight were measured using an electronic balance while albumen weight was obtained by difference. The height of egg albumen and height of yolk were measured with help of a spherometer and Haugh unit was calculated. The cleaned egg-shells were dried for 24 h, weighed and expressed as % of whole egg. The shell thickness was measured at three different locations (middle, broad and narrow ends) using micrometer gauge and calculated by taking the average of the three measurements.

Serum biochemical parameters

At the end of experimental period, 3ml of blood was collected from 8 birds (2 birds from each pen) of each dietary treatment and serum was seprated. The serum biochemical parameters such as total protein, albumin, globulin, triglyceride, total cholesterol, uric acid, creatinine, calcium and phosphorus were estimated using diagnostic kits (Crest Biosystems, a division of choral clinical systems, Goa, India) by using autoanalyzer.

Statistical analysis

Data were subjected to statistical analysis under completely randomized design employing one-way analysis of variance [7]. and the means of treatments were compared by Duncan multiple range test [8]. Significance was considered at $P \leq 0.05$ level.

Results and Discussion

The effect of dietary replacement of maize with CRM on production performance of Vanaraja laying hens is presented in Table 2. The body weight gain during the period of study was 50.03g, 81g and 81.64g in the dietary treatment groups containing 0, 50% and 100% cassava, respectively. The body weight gain increased progressively with increasing level of cassava from 0 to 100%, but was found to be non-significant. The hen housed egg production (HHEP) percentage varied from 59.05% to 63.77 % among the different dietary treatment groups and did not differ significantly. No significant difference in egg weight, egg mass and feed efficiency could be noticed among the hens fed with cassava at different levels. The results of the present study suggested that maize can be completely replaced with CRM without affecting the production performance in Vanaraja laying hens. Similar to the findings of present study Saparattananan *et al.* [9] reported that diet with maize or cassava had similar effects on production performance of laying hens. In a 12 week feeding trial, Oladunjoye *et al.* [10] also did not observe any significant affect of dietary inclusion of sun-dried cassava peel meal (replacing 80% of maize in control diet) and lye-treated cassava peel meal on their production performance of laying hens. In another study, Hamid and Jalaudin [11] reported that CRM can be incorporated up to 60% in the diet of laying hens without affecting the egg production performance. In the present study, CRM was incorporated at 58.5% in the diet replacing maize at 100% and inclusion of CRM at 58.5% in the diet did not elicit any adverse affect on production performance.

None of the egg quality parameters (albumen %, Yolk %, eggshell weight, Haugh unit, eggshell thickness) evaluated in the present study (Table 3) was influenced due to 100% dietary replacement of maize with CRM. Concomitant to the findings of this study, Oladunjoye *et al.* [10] also did not find any influence of dietary incorporation of sun-dried cassava peel meal and lye-treated cassava peel meal (LTCPM) replacing maize up to 80% of the control diet on egg quality parameters like eggshell weight, shell thickness, yolk weight, yolk index and albumen weight. Stevenson *et al.* [12] studied the effect of added graded level of CRM (0, 200, 400 and 600g per kg diet) on the egg quality of eggs from laying hens and did not find any adverse affect on egg quality parameters like Haugh unit and eggshell thickness. In another study, Aderemi *et al.* [13] evaluated the effect of inclusion of whole cassava meal (WCM) as a replacement to maize at graded levels (0, 25, 50, 70 & 100%) on the egg quality characteristics of 40 weeks old laying and did not find any influence of replacement of maize with WCM on eggshell thickness, yolk weight and albumen weight during the study period.

The serum biochemical parameters like total protein, albumin, globulin, uric acid, phosphorus and total cholesterol were not influenced due to complete replacement of dietary maize with CRM in Vanaraja laying hens (Table 4). However, serum

triglycerides concentration decreased significantly due to 100% replacement of dietary maize with CRM. Similar to the findings of the present study, Oladunjoye *et al.* [10] reported lower serum triglycerides concentration in serum of laying hens fed diet containing cassava peal meal. In the present study, serum Ca concentration also increased significantly due to dietary incorporation of CRM in the laying hens.

Table 1: Ingredient and Nutrient Composition of experimental diets (as such basis)

		Treatments (parts per quintal)	
Ingredients	**T_1**	**T_2**	**T_3**
Maize	58.50	29.25	0
Cassava root meal	0	29.25	58.5
SBM	20.70	22.70	24.7
DORB	10.20	8.20	6.20
Shell Grit	8.70	8.70	8.70
DCP	1.16	1.16	1.16
DL-Methionine	0.05	0.10	0.15
Salt	0.40	0.40	0.40
Vitamin Premix#	0.05	0.05	0.05
Trace Mineral Premix*	0.12	0.12	0.12
Toxin Binder	0.05	0.05	0.05
Antibiotic	0.05	0.05	0.05
Nutrient Composition (Calculated value)			
ME (kcal/kg)	2619	2620	2621
CP (%)	15.61	14.58	13.60
Lysine (%)	0.78	0.77	0.78
Methionine (%)	0.34	0.34	0.34
Calcium	3.31	3.30	3.29
Non phytate phophorus	0.30	0.30	0.30

#Supplies per kg diet: Vitamin A, 16,500 IU; vitamin D_3, 3200 ICU; vitamin E, 12 mg; vitamin K, 2 mg; vitamin B_1, 1.2 mg; vitamin B_2 10 mg; vitamin B_6, 2.4 mg; vitamin B_{12}, 12 µg; niacin, 18 mg; pantothenic acid, 12 mg;
* Supplies per kg diet: Manganese: 90g, Zinc: 80 g, Iron: 90.0g, Copper: 15.0g, Iodine: 2.0g, Selenium: 300mg.

Table 2: Effect of dietary replacement of maize with cassava root meal on production performance of Vanaraja laying hens

Parameters/Treatments	T1 (0% CRM)	T2 (50% CRM)	T3 (100% CRM)	SEM	P value
Body weight gain (g)	50.03	81.00	81.64	12.01	0.476
Hen housed egg production (%)	59.31	59.05	63.77	1.76	0.517
Egg weight (g)	52.22	52.95	52.51	0.328	0.665
Egg mass/day (g)	30.78	31.19	33.64	1.11	0.575
Feed efficiency (g egg/g feed)	0.195	0.198	0.204	0.007	0.575

CRM-cassava root meal

Table 3: Effect of dietary replacement of maize with cassava root meal on egg quality of Vanaraja laying hens

Parameters	T1 (0% CRM)	T2 (50% CRM)	T3 (100% CRM)	SEM	P value
Albumen (%)	58.25	58.79	59.90	0.406	0.245
Yolk (%)	32.66	32.61	30.98	0.387	0.131
Egg Shell (%)	9.08	8.58	9.10	0.118	0.129
Haugh unit	68.91	70.84	70.98	2.10	0.424
Shell thickness(mm)	0.318	0.316	0.331	0.004	0.348

CRM-cassava root meal

Table 4: Effect of replacement of maize with cassava root meal on different serum biochemical indices of Vanaraja laying hens

Parameters	T1 (0% CRM)	T2 (50% CRM)	T3 (100% CRM)	SEM	P value
Total Protein (g/dl)	3.88	4.42	3.77	0.158	0.200
Albumin(g/dl)	1.70	1.88	1.94	0.062	0.273
Globulin (g/dl)	2.18	2.54	1.83	0.261	0.277
Triglyceride (mg/dl)	643.4^a	587.6^a	403.8^b	14.491	0.006
Total Cholesterol (mg/dl)	123.56	153.00	125.02	8.448	0.288
Uric acid (mg/dl)	6.25	5.72	5.59	0.270	0.597
Creatinine (mg/dl)	2.11	1.99	2.18	0.046	0.293
Ca (mg/dl)	10.13^b	12.88^a	12.30^a	0.461	0.029
P (mg/dl)	4.83	4.79	4.99	0.238	0.386

*Means with different superscripts in a row differ significantly (p<0.05)
SEM- Standard Error of Mean; CRM-cassava root meal

The major limitation of CRM in poultry feed is low protein content and deficiency of essential amino acids [14]. Cassava also contains anti nutritional factor like hydrocyanic acid (HCN). The HCN concentration, resulting from the action of hydrolytic enzyme is influenced by the nutritional status and age of plant [15]. The study of Panigrahi *et al.* [16] showed that

CRM with total cyanide content less than 40mg/kg can be fed to broiler chick at 50% level without any adverse effects. A later study by Panigrahi [17] suggested that low-cyanide CRM may be incorporated in nutritionally balanced poultry diets between 50 and 60% without any reduction in weight gain or egg production. However, an excess of cyanide content at 100mg/kg diet appears to adversely affect broiler performance and laying hens may be affected by levels as low as 25 mg total cyanide per kg diet (Panigrahi, 1996) [16]. The CRM utilized in the present study was a sweet variety with low HCN content and this could be the reason that no adverse effect was noticed in any of the parameters studied. Hence it can be suggested that low cyanide containing CRM could fully replace maize in the diet of Vanaraja laying hens.

From the findings of the present study, it is concluded that maize can be completely replaced with cassava root meal without adversely affecting production performance in Vanaraja laying hens.

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