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Growth and serological assessment of broiler chickens fed differently processed castor *(Ricinus communis* Linn.) kernel cake based diets

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Castor seeds were subjected to three processing methods (boiling, fermentation and lye treatment) defatted and fed at 10% rate replacing groundnut cake in a 56-day experiment involving 150 day-old Anak 2000 broiler chicks to evaluate growth, consumption, hematological parameters and serum metabolites of the broilers served. There were five dietary treatments: treatment 1 was a control diet, void of castor bean cake (CBC) while treatment 2 to 5 contained raw, boiled, fermented or lye treated CBC. The birds were randomly distributed into five groups with three replicates of ten birds each in a completely randomized design. Birds on control diet had highest feed consumption and weight gained followed by birds on lye treated CBC while feed intake of birds on untreated CBC declined drastically (P<0.05). Feed gain ratio were similar (P>0.05) in control and treated CBC groups but significantly different (P<0.05) from untreated group. The haematological indices (red blood cell, haemoglobin concentration and mean corpuscular measurements) were affected (P<0.05) declining from treated CBC to untreated CBC. There was significant increase (P<0.05) in urea and creatinine levels in untreated CBC while activities of enzymes Alanine transaminase and Aspartate transaminase in the serum of the chickens differ significantly across the treatments (P<0.05). In case of shortages groundnut cake, use of lye treated CBC below10% may be used in broiler's diet.

Key words: Processing methods, castor bean cake, growth, serum.

INTRODUCTION

Poultry industry is known to depend more on compounded ration than many categories of livestock. In Nigeria for instance, poultry consumes about 90% of the total commercially produced feeds compared to pigs (3%), cattle, sheep and goats (3%), fish (2%) and rabbits (1%) (FDL, 2005). Hence, the industry is always severely affected in situations of high prices or unavailability of feed ingredients. At present, the astronomical rise in the prices of conventional plant protein ingredients (soya bean and ground nut cake) and their irregular supply are seriously affecting the profitability of the industry. In the country, while 51% of the groundnut requirements are met, it is only 30% for soyabean (Longe, 2006).

Nutritionists are searching for additional or

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Alternative sources to these conventional proteins sources in an attempt to mitigate the effects of competition, rising cost and irregular supply (Odunsi et al., 2002).

Previous research has shown the potential of defatted castor bean meal in livestock feeds (Ani and Okorie, 2009; Akande et al., 2011, 2012), however with some limitations. Castor bean cake contains about 32 to 48% crude protein depending on levels of decortications and deoiling (Rama Rao, 2004) and the whole seed contains 2.9 to 3.28 kcal/kg true ME (Nsa and Ukachukwu, 2007). It was indicated that rats can tolerate inclusion of processed castor bean cake up to 5% without any deleterious effect on performance (Akande et al., 2011). Since all animals are susceptible to castor poisoning with poultry having relative high tolerance, it is important not only to re-examine such claim but also to develop the novel seed (castor bean) for the fast growing poultry industry as additional cheap source of protein. The need to detoxify castor cake provides basis for increasing the utilization of the castor bean cake, especially when considered it is not used as a human staple. The objectives of this study were to evaluate the response of broiler chickens fed differently processed castor bean cake in terms of performance, haematology and serum components.

MATERIALS AND METHODS

Seed collection and processing

The large seeded variety was collected from local dealers in Ogbomoso, Oyo State, Nigeria. The seeds were dehulled manually by breaking the seed on two hard surfaces to severe the fibrous seed coat from the kernel. The broken seeds were winnowed and handpicked to remove seed coat from the kernel. The sun dried kernels were pressed with a hydraulic press to extract the oil. The residue after oil extraction is referred to as castor bean cake. Different batches of the castor bean cake were made to undergo the following treatments, lye, fermentation and boiling.

Lye treatment

Lye water was prepared by passing water over gray ash in a barrel. Hot water was poured on the ash and a brown liquid dripped at the base of the barrel. This brown liquid represents the lye water used in this study. The pH of the lye water was determined with a pH meter and was 9.5. Castor bean cake was then soaked in the lye water for 12 h. It was removed by rinsing with clean water and then sun-dried. The sundried product was then milled to produce lye treated castor bean cake, LCB.

Fermentation

Another batch of the cake was placed in a muslin bag and then completely submerged in clean water for 3 days under air-tight condition. The water was drained on the 3rd day and the fermented seed sun-dried. It was then milled to produce fermented castor bean cake (FCBC).

Boiling

Another portion of the castor bean cake in a muslin bag was boiled in water at 100°C for 20 min, after which it was drained and dried (BCBC) the fourth batches represented the untreated castor bean cake.

Birds and management

A total of 150 DOC broiler chickens Anak strain were used, raised on deep litter system for 8 weeks. The birds were fed with a commercial broiler starter mash (24%CP/2900 ME kcal/kg) for 1 week adaptation. During this time, the lighten regime of 23 h light and 1 h darkness was observed for the first 3 days and subsequently reduced by 2 h daily. After the 7 day adaptation, the birds were weighed and randomly allotted to the five dietary treatments in triplicate lots of 10 chicks each at 1.0ft^2 spacing per bird in a completely randomised design. 15 h lighting regime was observed at 8 to 14 day old and subsequently adjusted to normal daylight of 12 h daylight throughout the experiment. The diet formulation is as shown in Table 1.

Data collection

Performance characteristics

Initial body weights of the birds were taken at the start of the study and thereafter on a weekly basis. Weekly feed intake was also recorded on replicate basis. The average weight gain, total feed intake and feed to gain ratio were also calculated.

Haematological and serum biochemical Studies

Blood samples were collected (early in the morning at 24°Cby severing the jungular vein) from three birds per treatment at the expiration of the experiment. The following haematological parameters were determined: red blood cell (RBC), white blood cell (WBC) counts, and haemoglobin (Hb) concentration (Table 3). The mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH) and mean corpuscular haemoglobin concentration (MCHC) were also calculated. The serum biochemical constituents determined were total protein, globulin determined by Kjedahl method as described by Kohn and Allen (1995); creatinine, urea, bilirubin, and the activities for enzymes aspartate transaminase (AST) and alanine transaminase (ALT) were determined using the spectrophotometric method described by Rej and Holder (1983).

Statistical analysis

Data were subjected to a one way analysis of variance using statistical package of SAS institute (1990) software and the mean separated by Duncan's Multiple Range Test option of the same computer software package.

RESULTS AND DISCUSSION

Performance of broiler chickens fed differently treated castor bean cake (CBC)

The result of performance characteristics is shown in Table 2 which has been partly indicated in earlier

Table 1. Diet composition for Broiler fed differently treated CBC.

Ingredient (%)	Control diet	Untreated CBC	Lye treated CBC	Fermented CBC	Boiled CBC
Maize	48	48	48	48	48
Soyabean meal	23.5	23.5	23.5	23.5	23.5
Groundnut cake	10	-	-	-	-
Untreated CBC	-	10	-	-	-
Lye CBC	-	-	10	-	-
Fermented CBC	-	-	-	10	-
Boiled CBC	-	-	-	-	10
*Concentrate	18.5	18.5	18.5	18.5	18.5
Total	100	100	100	100	100
Calculated analysis (%)					
ME, kcal/kg	2822	2885	2875	2868	2873
Crude protein	23.47	23.07	23.03	23.00	23.04
Crude fibre	3.9	3.75	3.71	3.81	3.77
Crude fat	3.45	3.83	3.75	3.80	3.78

*Concentrate: wheat offal=10, fish meal=4.0, Bone meal=2.5, Oyster=1.0, [1]Premix=0.25, Methionine=0.25, Lysine=0.25, Salt=0.25, CBC-castor bean cake, ME- Metabolizable energy. CP- crude protein, CF-crude fibre,[1]Vitamin and mineral premix contain the following per kg diet: Vitamins A, 10,000 IU; D3,3,000 IU; E, 8.0 IU; K, 2.0 mg; B6, 1.2 mg; B12, 0.12 ⌠g; Niacin, 1.0 mg; Pantothenic acid, 7.0 mg; Folic acid, 0.6 mg; Choline chloride, 500 mg; Minerals: Fe, 60 mg; Mn, 80 Mg; Mg, 100 mg; Cu, 8.0 mg; Zn, 50 mg; Co, 0.45 ⌠g; I, 2.0 mg; Se, 0.1 mg.

Table 2. Feed consumption and growth performance of broiler chickens fed differently processed CBC.

Parameter	Control diet	Untreated CBC	Lye treated CBC	Fermented CBC	Boiled CBC	SEM
IBW	66.67	62.67	69.00	63.33	62.67	0.20
FBW	1672.67^{a}	663.67^{d}	1419.67^{b}	1201.00^{bc}	983.67^{c}	98.50
BWG	1606.00^{a}	601.00^{d}	1350.67^{b}	1137.67^{bc}	921.00^{c}	76.56
ADWG	38.24^{a}	14.31^{d}	32.16^{b}	27.08^{bc}	21.93^{c}	2.50
TFI	4134.45^{a}	1668.50^{d}	3065.15^{b}	2582.95^{c}	2410.43^{c}	350
ADFI	98.44^{a}	39.73^{d}	72.98^{b}	61.50^{c}	57.39^{c}	10.38
FGR	2.58^{a}	3.10^{b}	2.27^{a}	2.27^{a}	2.64^{a}	0.30
MORTALITY,%	0	20	0	0	0	

IBW- Initial body weight, FBW- Final body weight, TFI- Total feed intake, FGR- feed gain ratio, AD-average daily, CBC – castor bean cake.

publication (Akande et al., 2012). Feed consumption was highest for birds on control diet, while feed intake of birds on untreated castor bean cake (CBC) was lowest ($P<0.05$). The results indicated that CBC contains factors that limit the acceptability of the experimental diets which was sensed by the animals and results to lower feed intake. The lye treatment intake was larger than that of the fermentation and boiling treatments ($P < 0.05$) but lower than the control ($P < 0.05$). The results of final body weight followed trend similar to the feed intake. As expected, there was a positive correlation between body weight gain and total feed intake. The reports of Ani and Okorie (2005, 2009) that final body weight, weight gain, feed intake and feed conversion efficiency declined with the increasing levels of castor bean meal in diets of broilers agree the findings of this study. Continued consumption of CBC diets up to finishing phase might have put an increased pressure on the birds of the need for amino acid for detoxification of the castor toxin because some amino acids have been implicated in detoxification process (Delange et al., 1994).

Supplementation of castor bean meal diets with lysine has been reported to improve the performance of broiler chickens at 15 and 20% inclusion (Ani and Okorie 2005, 2009). Differences observed for feed gain ratio showed that birds on untreated castor bean cake (UCBC) had poorer feed conversion, whereas those on lye and fermentation treatments converted the feed as well as the control groups. It can be inferred that lye treated CBC protein could support broilers growth at 10% inclusion as obtained for groundnut cake. Similar trend was reported by Anandan et al. (2005) and on performance of broilers fed CBC based diets by Ani and Okorie (2005, 2009) who attributed poor growth to poor acceptability of CBC based diets. Processing of CBC improved the nutritional response of the broilers to the diets. The feed: gain ration of the birds on the control diet was comparable to that of lye and fermented CBC groups.

Table 3. Haematological parameters of broiler chickens fed differently treated CBC.

Parameter	Control	Untreated CBC	Lye treated CBC	Fermented CBC	Boiled CBC	SEM
Haematological indices						
Pack cell volume, %	30.33^{a}	22.67^{b}	29.00^{a}	21.01^{b}	23.22^{b}	2.55
Red blood cell, x 10^9/L	3.60^{a}	2.46^{b}	3.46^{a}	2.55^{b}	2.68^{b}	0.34
White blood cell x 10^6/L	16.50	14.77	16.10	15.83	15.57	1.05
Haemoglobin, %	10.20^{a}	7.83^{b}	8.70^{ab}	7.87^{b}	9.00^{ab}	0.50
MCV, fl	84.67^{b}	92.15^{a}	83.82^{b}	82.39^{b}	86.67^{ab}	3.50
MCH, pg	28.33^{ab}	31.83^{a}	25.67^{b}	30.85^{a}	33.58^{a}	3.10
MCHC, %	29.88^{a}	28.95^{ab}	32.65^{a}	26.71^{ab}	25.87^{b}	3.25
Platelet, %	86.33^{b}	115.00^{a}	98.33^{ab}	88.33^{b}	94.00^{ab}	6.50
Neutrophil, %	55.00	47.00	46.67	40.00	37.67	6.50
Eosinophil, %	0.60	2.33	0.67	2.00	0.33	0.20
Lymphocytes, %	44.33	50.62	52.67	57.6	62.00	7.80

M -mean, C-cell, V-volume, H- haemoglobin.

Table 4. Serum composition of broiler chickens fed differently treated CBC.

Parameter	Control diet	Untreated CBC	Lye treated CBC	Fermented CBC	Boiled CBC	SEM
Total protein, g/dl	57.67	54.00	53.67	54.67	57.67	1.55
Globulin, g/dl	26.67	26.67	25.33	24.67	28.33	3.12
Albumin, g/dl	31.01	27.33	28.33	30.00	29.33	2.00
Urea, mg/dl	2.60^{b}	3.10^{a}	2.73^{b}	2.77^{b}	2.83^{ab}	0.21
Creatinine, mg/dl	38.67^{b}	48.67^{a}	43.00^{ab}	46.50^{a}	40.67^{b}	3.03
Total bilirubin, mg/dl	10.17	6.47	11.03	4.03	5.83	2.55
Conj. bilirubin, mg/dl	0.7	0.13	0.67	0.10	0.05	0.05
ALT, iu/l	11.00^{ab}	17.33^{a}	16.33^{a}	6.67^{b}	10.67^{ab}	3.33
AST, iu/l	25.12^{ab}	37.01^{a}	18.78^{b}	25.55^{ab}	26.33^{ab}	6.25

ALT- alanine transaminase, AST- Aspartate transaminase.

The high mortality of 20% on untreated CBC showed that raw castor bean cake results not only in growth losses but also lethargic. At 10% inclusion lye treatment was comparable to control, and showed some level of superiority over fermented and hot water treatment.

Blood profile of broiler chickens fed differently treated CBC

The haematological indices (RBC, Hb, and mean corpuscular measurements: MCV, MCH and MCHC) decreased ($P<0.05$) (Table 4) from the control to treated CBC and finally untreated CBC. This is an indication of inhibition of erythropoiesis of the experimental birds particularly on untreated CBC. It is well known that a reduced quantity and quality of erythrocytes and a decreased haemoglobin level lead to a deteriorated oxygen supply and predispose the animal to anaemia. Other haematological indices such as WBC, Haematocrits, neutrophill etc were not significantly affected ($P>0.05$) by feeding of castor bean cake.

The significant increase ($P<0.05$) in urea and creatinine levels particularly in untreated CBC is a classical sign that the kidney was adversely affected by the exposure arising from intake of CBC based diets. Elevation in plasma levels of urea could also be attributed to increase in the activities of urea enzymes, ornithine carbomoyl transferase and arginase (not determined) mostly associated in liver damage in many animal species, since the urea cycle is confined to the liver (Kubena et al., 1998). The blood concentration of excretory and electrolyte constituents is an important tool in assessing the functional capacity of the kidney because it demonstrates the presence or absence of active lesions in the kidney (Dyer et al., 2000). Urea, creatinine and electrolytes are the most sensitive biochemical markers employed in the diagnosis of renal damage because urea and creatinine are excreted through the kidney. Therefore marked increase in serum urea and creatinine as noticed confirms an indication of functional damage to the kidney. The activity of ALT and AST in the serum of the chickens was significantly different ($P<0.05$) among the treatments which indicate a pathological change. ALT is a key

enzyme in the biotransformation and detoxification of various toxicants, reactive oxygen species, and endo - and xenobiotics. Some studies have suggested that the detoxification pathways of some toxicants may be connected to antioxidative defense mechanisms (Abdel-Wahab et al., 2003). Ordinarily, bilirubin is excreted from the body as the chief component of total and direct bilirubin and are usually measured to screen for or to monitor liver or gall bladder problems. Elevated liver enzymes usually means the liver is not functioning properly and some liver cells may be damaged. It is evident that the control groups and boiled treated group followed by lye treated group share many similarities in terms of blood composition. There appear to be both thermo-stable and thermo-labile factors in castor bean cake as earlier reported (Breese Jones, 1947; Jackson et al., 2006).

Conclusion

The positive correlation established between total feed consumed and body weight gain among dietary treatments elicited the fact that processing techniques used were not effective enough to completely mask the effect of castor toxin except for the lye treatment (novel processing) which is somewhat comparable to control treatment. The serological and haematological indices indicated an inhibition of erythropoiesis of the experimental birds fed CBC based diets while increased serum urea and creatinine indicated functional damage to kidney. Largely, changes in blood component of birds fed treated CBC diets were attributed to expression of adjustment and residual toxins. In case of shortages groundnut cake, use of lye treated CBC below 10% may be used in broiler's diet. Although, no mortality occurred in birds on treated CBC, low response in growth calls for concerted efforts in getting rid of castor residual impediments before substantial application in diets of broiler.

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