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Original Article

Investigation of the Effect of Maize Substitution with Fermented Cashew Apple Residue on Broiler Chicken Growth

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Abstract

In this study, the effect of substitution of maize with fermented cashew apple residue (CAR) on the growth of broiler chicken was investigated. Cashew apple residue was subjected to fermentation with *Lactobacillus plantarum,* and then used to formulate broiler starter diet by substituting/mixing it with maize in the ratios 0:100, 50:50 and 100:0 for maize and CAR respectively. The diet was fed to four groups of day old broilers for six weeks during which feed intake and weight gained were monitored. The bacterial count increased from 5.6×10^6 at the beginning of the fermentation to 31.5×10^6 cfu/g at 72 hr. Also, the pH of the CAR was reduced gradually over the 72 hours period of fermentation coupled with increase in the total titratable acidity. The nutritional composition analyses of the compounded diets showed no significant difference ($p \leq 0.05$) between the crude protein content of the formulated feed (21.02±0.15 - 21.12±0.15%) and the commercially available feed (21.50±0.00). However, the crude fibre content of the control (3.10±0.00) was lower than the content of the formulated diets. After feeding the chicks for two weeks, there was no significant difference in the average weight gained by the chicks fed the control diet and those fed with fermented CAR-based feeds. The cumulative feed consumption in the groups ranged from 2.57 kg (diet C) to 2.91 kg (diet A). These results suggest that fermented CAR may be used as alternative to maize in broiler feed formulation.

Keywords: broilers; cashew apple residue; diet; fermentation; nutrition

Introduction

In poultry production, especially broilers (meat) production, feeding form the largest portion of expenses which is usually in the region of 60% of the total cost of raising the birds (Khan *et al*., 2008). The broilers diet should contain appropriate level of nutrients to allow optimum growth of the birds. Usually, the broiler diet contains correct balance of energy, protein, amino acids, minerals and fatty acids which are supplied by different sources of these ingredients. The major source of energy in broilers feed in Nigeria is maize (corn) because of its high energy and starch contents. In addition to these, this important food crop is widely cultivated in the country and it is by far the major grain crop in Nigeria (Adebayo and Adeola, 2005). However, with the increase in the maize price in the country since the escalation of the Boko Haram insurgence in the year 2014 which displaced many farmers from their farms, preventing them from cultivating this most important cereal, there have been efforts to look for alternative source of energy in the animal feed industry. Since broilers demand a high energy requirement, feed selection must include considerations of energy content and digestibility as well as efficient feed conversion rate.

Alternative energy sources have been investigated for inclusion in poultry feed such alternatives includes sorghum and cassava chips (Aba *et al*., 2005). However, the major problem with these alternatives is that they are part of the major staple food for the human population of the country and with increased pressure on the food demand for humans, their use in animal feed may proof much more costly than maize.

Cashew (*Anacardium occidentale* L.) is a tropical evergreen tree that is widely spread in the tropics where it is a major cash crop behind only cocoa in importance in West African countries such as Nigeria (FAOSTAT, 2013). Cashew is grown majorly for its nuts which are a highly valued commodity for its shell oil also known as cashew nutshell liquid (CNSL). The nut is about 10% of the cashew fruit while the apple is usually left on the farm to rot

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away. There is presently no cashew processing facility in Nigeria as the industry is basically export oriented. Moreover, apart from direct consumption of the apple, there is no reported use of the apple in the country. Studies have shown that the nutritional properties of this agricultural waste are comparable to what is obtainable in grains (Akinwale, 2000). This study is therefore carried out to determine the effect of the substitution of maize with fermented cashew apple residue (CAR) on the growth of broiler chicks with a view to developing standard poultry feed from the residue.

Materials and Methods

Collection and preparation of plant samples

Fresh cashew fruits (*A. occidentale*) were harvested from parent plants at a Farm Plantation in Iyere, Owo, Ondo State Southwest Nigeria. The plant material was identified at the herbarium section of the Department of Crop Production Technology and a voucher specimen (XV-201AO) was deposited. The cashew fruits were rinsed in sterile distilled water to remove the debris and sorted to discard the unwholesome ones. Then, nuts were removed manually; apples were sliced, crushed with a blender and the juice filtered. The residue was collected for further analyses.

Fermentation procedure

The cashew apple residue was subjected to fermentation with *Lactobacillus plantarum*. A portion of 1 kg of the residue was added to 2 L of sterile distilled water was added and sterilized in an autoclave at 121 °C for 15 minutes. Thereafter, the container was inoculated with 10^6 CFU inoculum of the lactic acid bacteria aseptically and then covered tightly. The setup was allowed to stand for 72 hr at room temperature with intermittent mixing at 24 hr interval. Samples were taken at 24 hr interval for various assays starting from 0 hr. At the end of the fermentation, the cashew apple residue was oven dried at 62 °C for 6 hr.

Physicochemical analysis

Determination of pH and temperature

Ten g of the sample was dissolved in 100 ml of distilled water. The pH and temperature of the samples were determined using a Geirincharz Thermos pH meter. This was done at 0, 24, 48 and 72 hrs in triplicates.

Determination of titratable acidity

Total titratable acidity (TTA) was determined according to the method described by AOAC (2005). 50 g of the sample was blended, added to 100 ml of distilled water, agitated and allowed to settle. Then 20 ml of the supernatant was titrated against 0.1 M NaOH until a faint pink sharp end point was reached. Acidity was calculated as percentage/100 g of sample. This was done at 0, 24, 48 and 72 hrs in triplicates.

Microbiological analysis

The fermenting samples were subjected to microbiological analysis using serial dilution and pour plated in triplicates on the De Man-Rogosa-Sharpe Soy Agar for estimation of Lactic acid bacteria and incubated at 35 °C for 48 hrs. Discrete colonies were counted and recorded.

Source of Broilers chicks

100 units of day-old broiler chicks were sourced from the CHI Farms, Ibadan, Oyo State Nigeria. They were acclimatized and maintained in a brooding pen of the Poultry Section of the Rufus Giwa Polytechnic, Owo Research farm, with adequate litter filling and a sufficient supply of heat and water for the chicks.

Feeds and ingredients

Broiler mash (Super Starter) and Premix concentrate were procured from the depot of a manufacturer in Owo. Maize (yellow type) and wheat bran were purchased from farmers store located in Owo.

Experimental feed formulation

The experimental feed was formulated by substituting maize with fermented cashew apple residue (CAR) at three levels: 100:0 (Diet A), 50:50 (Diet B), and 0:100 (Diet C) maize to CAR. These were mixed thoroughly with Premix concentrate and wheat offal as instructed by the manufacturer. All the feed samples were analysed for crude protein, crude fibre, crude fat and metabolizable energy according to AOAC (2005).

Feeding trials

The chicks were divided into 4 groups of 25 birds each, separated by craters in the same brood house. Group I (control) received commercial broiler Super Starter diet, Group II received diet A, Group III received diet B while Group IV received diet C. The birds were allowed unhindered access to feed and water *ad libitum* throughout the experiment. Feed consumption as well as body weight gain was monitored throughout the experiment as well.

Statistical analysis

Unless otherwise indicated, results are expressed as means ± SEM of three replicates. Data were subjected to one-way analysis of variance (ANOVA) using SPSS version 16.0. The Duncan's Multiple Range test was used to separate the means at the 5% level of probability.

Results

Lactic acid bacteria performance during fermentation

The growth pattern of the *Lactobacillus plantarum* in the cashew apple residue during fermentation is shown on Fig. 1. There was a steady increase in the population of the organism during the 72 hours fermentation period. The bacterial count increased from 5.6×10^6 at the beginning of the fermentation to 31.5×10^6 CFU/g at 72 hr. The observed increase in the population of the LAB is in consonance with earlier report of increase in the number of starter cultures in a fermentation medium (Rolfe, 2000). The increase in the *Lactobacillus* species number suggests that cashew apple residue can support the growth of *Lactobacillus* species by having a high level of sugars. The high growth performance showed by this organism in CAR makes the meal a potential carrier of probiotic organisms.

These findings correlate with the observations of earlier researchers that these fruits are a veritable fermentable substrate (Ojokoh and Oyetayo, 2015).

Physico-chemical changes during cashew apple fermentation

The results of the physico-chemical parameter changes in the cashew apple residue are shown in Table 1. There was a steady increase in the temperature of the CAR during fermentation. This is in line with the general assertion that fermentation is generally an exothermic process.

The pH of the CAR was reduced gradually over the 72 hours period of fermentation. The drop in the pH values, coupled with observed increase in total titratable acidity of the fermented CAR indicates that a production of organic acids, knowing that acids are produced during fermentation of food materials by the members of *Lactobacillus* genus (Lin *et al*., 2009). Similar observations have been made earlier during the fermentation of cereals (McFarland, 2007). Further, acidification leads to a good storage capacity, since acidity inhibits most bacterial spoilage organisms (Madigan and Martinko, 2005).

Feed formulation from fermented cashew apple residue

In the feed formulation, a simple approach of feed compounding was adopted by mixing a commercially-available ready-made protein and mineral base with various energy sources. The nutritional composition analyses of the compound diets showed (Table 2) that there was no significant difference in the crude protein content of the formulated feed which ranged between 21.02±0.15 (Diet C) and 21.12±0.15 (Diet A); and the commercially available feed (21.50±0.00). However, the crude fibre content of the control (3.10±0.00) was lower than the content of the formulated diets where it was observed that increase in CAR component correspond to increase in fibre content of the feed. Nevertheless, the crude fat content was lower in the CAR-containing feed compared with the values obtained in the control. Moreover, the metabolizable energy was comparable in the control feed sample and diets A and B whereas, it was found to be lower in diet C. These results are similar to the values obtained by other investigators. Swain and Barbuddhe (2007) reported that there is no significant difference in the crude protein of Japanese layer quail feed formulated by substituting maize with cashew apple waste up to 10%. Similar observations were made by Fanimo *et al*. (2003) who reported no significant difference in the protein content of rabbit feed formulated from cashew apple wastes and the control made from maize and wheat bran. Although, their observation of lower fibre content of the cashew waste formulated rabbit feed contrast sharply with the increase observed in this present research. The disparity may be due to the other content of the different feed and the level of the cashew apple in the compounded feed. Therefore, the higher CAR in our own formulated broiler diet may be responsible for the higher fibre content of the diet.

Effect of fermented cashew apple residue on broilers growth

The effect of substituting maize with fermented cashew apple residue in broiler feed is presented in Table 3. The table revealed that after feeding the chicks for two weeks, there was no significant difference in the average weight gained by the chicks fed on the control diet and those fed with fermented CAR based feeds. This suggests that the response of the chicks to all the diets may be similar and the animals' growth may not be hampered if fermented CAR is used to formulate their feed. However, at the end of the six week feeding trial, the chicks fed with diet C had the lowest live weight whereas, those fed with diets A and B as well as the control diet had comparable weights. Also, the cumulative feed consumption in the groups ranged from 2.57 kg in group fed diet C to 2.91 kg in the group fed with diet A.

Table 1. Changes in physicochemical parameters during fermentation of cashew apple residue

Hour	Temperature (°C)	pH	TTA (%)
0	25.17 ± 0.03^{a}	6.25 ± 0.00^{d}	0.47 ± 0.00^{a}
24	27.80 ± 0.02^{b}	5.35 ± 0.10^{c}	0.89 ± 0.20^{b}
48	29.11 ± 0.00^{c}	5.03 ± 0.17^{b}	1.73 ± 0.10^{c}
72	30.27 ± 0.01^{d}	4.89 ± 0.03^{a}	2.03 ± 0.02^{cd}

Values are Mean ± S.E.M, n=3, Values followed by different alphabet along columns are significantly different at $p \leq 0.05$

Table 2. Comparative analyses of nutritional composition of experimental broilers feed formulated from fermented cashew apple waste and commercial feed

Content	Control	Diet A	Diet B	Diet C
Concentrate(kg)	NA	30	30	30
Maize (kg)	NA	65	32.5	0
Cashew apple residue(kg)	NA	0	32.5	65
Wheat offal(kg)	NA	5	5	5
Total weight	NA	100	100	100
Crude protein (%)	21.50 ± 0.00^{a}	21.12 ± 0.15^{a}	21.21 ± 0.10^{a}	21.02 ± 0.15^{a}
Crude fibre (%)	3.10 ± 0.00^{a}	3.21 ± 0.10^{b}	3.72 ± 0.08^{c}	4.11 ± 0.00^{d}
Crude fat (%)	5.10 ± 0.00^{b}	4.80 ± 0.03^{ab}	4.43 ± 0.10^{a}	4.31 ± 0.08^{a}
Metabolizable energy(kj)	3100.00 ± 0.00^{b}	3112.72 ± 4.12^{b}	3091.37 ± 2.18^{b}	2892.85 ± 3.54^{a}

Key: NA= not applicable, Values are Mean ± S.E.M, n=3, values followed by different superscripts are significantly different at p 0.05.

Table 3. Comparative analyses of the weight gained (kg) by broilers fed with experimental diet formulated from fermented cashew apple residue and commercial feed

Content	Week 0	Week 2	Week 4	Week 6	Cumulative feed consumption
Control	0.075±0.01^{a}	0.421±0.18^{ab}	0.907±0.15^{c}	1.35±0.10^{b}	2.62±1.11^{a}
Diet A	0.075±0.00^{a}	0.433±0.10^{c}	0.901±0.07^{c}	1.43±0.00^{bc}	2.78±0.00^{b}
Diet B	0.074±0.00^{a}	0.427±1.00^{bc}	0.887±0.10^{b}	1.30±2.15^{b}	2.91±0.01^{c}
Diet C	0.076±0.00^{a}	0.411±0.01^{a}	0.875±0.58^{a}	1.19±0.10^{a}	2.57±0.00^{a}

Key: Values are Mean ± S.E.M, n=20, values followed by different superscripts along the columns are significantly different at p 0.05.

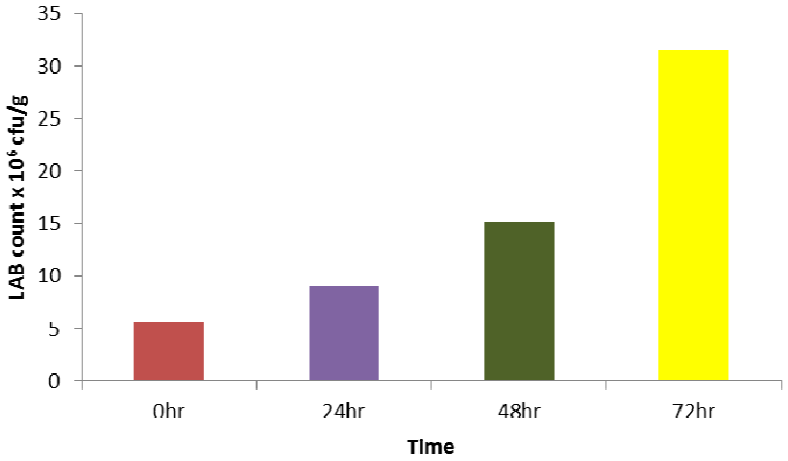

Fig. 1. Lactic acid bacterial count on the cashew apple residue during fermentation

This observation have been made by Swain and Barbuddhe (2007) in their study of the effect of feeding cashew apple waste and cashew nut shell on the performance of Japanese quail layers where they observed a lower feed intake in the birds as cashew apple content of the feed increased. The lower consumption rate observed in the diet C may be linked with the astringent smell of the CAR which has been reported to be a major factor in the rejection of the cashew apple for consumption in human population (Okpanachi *et al*., 2016). Cashew contain some anti-nutrient factors among which tannin is present at high level, its presence has been linked to the astringent taste and odour of cashew apple. Some of these anti-nutrients have been reported to hinder the absorption of nutrients in animals. The fermentation process undergone by the cashew apple may have reduced the level of tannin in the CAR which led to its proper consumption by the chicks. Fermentation has been identified as a good food processing technique that is capable of reducing the anti-nutrient factors in foods.

Conclusions

Results show that substitution of maize with fermented cashew apple residue had no adverse effect on both the nutritional quality of broilers diet and the growth performance of the birds within six weeks of exposure. These indicate that broilers feed may be formulated from fermented cashew apple residue.

Conflict of Interest

The authors declare that there are no conflicts of interest related to this article.

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