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Carcass and organ morphometry of broilers fed graded levels of microbial fermented cassava peel and cassava starch residues

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ABSTRACT

The current cassava initiative by Nigerian government has led to the generation of huge cassava tuber wastes (CTWs). These wastes, which contribute to environmental pollution, can however be harnessed as very cheap alternatives to the expensive conventional animal feedstock, especially when they are subjected to microbial fermentation. This experiment was therefore conducted to investigate the effects of using two microbial fermented cassava tuber wastes (MFCTWs) feedstock on carcass and organ morphometry of broiler birds. Seven experimental diets designated as Diet 1 (0% MFCTWs), Diet 2 (20% MFCP), Diet 3 (40% MFCP), Diet 4 (60% MFCP), Diet 5 (20% MFCSR), Diet 6 (40% MFCSR) and Diet 7 (60% MFCSR) were fed to the birds. The carcass and organ parameters were taken at the end of eight weeks of experiment. The results showed that carcass and organ morphometry differed significantly among the treatment diets. Carcass morphometry revealed that the breast, drumstick and thigh were not significantly affected when the two CTWs were used up to 40% level for MFCP and 20% for MFCSR respectively. The small intestine of birds fed CTWs were longer than those fed the control diet while the large intestinal length showed a progressive decrease with increasing dietary levels of CTWs. It was concluded that these CTWs may be included up to 40% level without adversely affecting choice portions of the carcass. Their utilization could however result in an increase the length of the small intestine and the relative weight of the kidneys, proventriculus and pancreas.

Keywords: Cassava tuber wastes, environment, fermentation, unconventional feedstock, broiler birds.

INTRODUCTION

Inadequate supply and prohibitive prices of cereal grains, especially maize, has led animal scientists to search for cheaper alternative sources of feed for livestock. In recent times, diversion of cereal grains (especially maize) for biofuel production has further pushed the price of these grains beyond the reach of an average livestock producer especially in the emerging economies of the world (Aro *et al.,* 2009). This has led to a serious shortfall in the supply of animal protein and consequential animal protein malnutrition in these emerging economies. For instance, in spite of the enormous natural and human resources at her disposal, Nigeria still remains amongst the least consumer of animal protein in Africa (Obioha, 1992). Therefore, there is the need to boost livestock production to satisfy the growing demand for meat and milk. The acute shortage of animal protein in Nigeria and the rapidly increasing demand for livestock products could substantially be alleviated through broiler production. This can however be achieved by lowering the cost of broiler production for which feedstock alone account for about 70 % of total production cost (Metayoba *et al*., 2011).

The by-products of cassava harvesting and processing like cassava peels, leaves and starch residues constitute about 25% of the cassava plant (Iyayi and Losel, 2000). Utilization of these in non-ruminant feeding is limited because of their low protein and high fibre levels (Iyayi and Tewe, 1994), coupled with their high cyanide content. Microbial fermentation has been reported as an effective means of breaking down the crude fibre components of agro-industrial wastes to increase their metabolizable energy and their nutritive value in general (Onilude, 1999). Aro *et al.* (2010) reported an enhanced performance and reduction in the cost of production in pigs fed with cassava peel fermented with a consortium of micro-organisms. Attempt to investigate if such benefits could be advanced to broiler birds necessitated this study, with particular emphasis on the carcass parameters of the birds as response criteria.

MATERIALS AND METHOD

The experiment was carried out in the Broilers' Unit of the Teaching and Research Farm (Livestock Section) of the Federal University of Technology, Akure, Nigeria, located on latitude 7º 15′ N and longitude 5º 12′ E. The mean annual temperatre of the study area ranges between 26-28ºC while the total annual rainfall averages 1500mm with a bimodal distribution characteristic of the hot, wet equatorial climate.

The rainy season spans nine months of the year during which high relative humidity well above 85% is often recorded. The fermentation trays and chambers used for the experiment were constructed following the specification of Aro (2010). Briefly, the fermentation trays were made of plywood with the following dimensions; length: 54 cm, breadth: 39 cm and depth of 3.4 cm (Plate 1). Six of these trays were fitted into a fermentation chamber: a box-like contraption made of plywood measuring 54 cm x 39 cm x 65 cm for length, breadth and height respectively. The inner chamber, measuring 54 cm x 39 cm x 56 cm for length, breadth and height respectively, was divided horizontally into five equal parts such that six trays could be easily slid in. Each chamber is finished with a swing door which could be opened and closed to allow loading and offloading of the chamber with the fermentation trays (Plate 2). Nineteen of such fermentation chambers were used for the experiment.

Plate 1: Fermentation tray already charged with the fermenting substrate.

Plate 2: Fermentation chamber with the six-tier arrangement of the fermentation trays. The six trays were partly drawn out step-wisely to show the layered arrangement.

Cassava peels were collected fresh from a cassava (gari) processing community in Igbatoro area of Akure, Ondo state and sun-dried for 5-7 days. Igbatoro is a suburb of Akure with same latitudinal and longitudinal location and similar edaphic characteristics.The peels were then packed in jute sacks and stacked on a wooden platform awaiting microbial inoculation. Also, cassava starch residues were collected and packed into sacks and pressed down to reduce the water content. The starch residues were then sun-dried for 5-7 days to reduce the moisture content to between 10-12%. They were then packed in jute sacks prior to inoculation with selected microorganisms.

Preparation of Microbial Fermented Cassava Peel (MFCP) and Cassava Starch Residue (MFCRS)

2 kg of dried cassava peel (CAP) were weighed and mixed with 1,500 ml of water and packed into water-proof cellophane bags. The bags were steam-sterilized in a cauldron at 100ºC for 30 minutes, allowed to cool to about 37ºC and then poured into trays which have been laid with transparent nylon sheets. The CAP was then inoculated with 15 ml each of pure culture of *Lactobacillus delbrueckii* and *Lactobacillus coryneformis* and 30 ml of *Aspergillus fumigatus* and properly mixed together in a lamina flow chamber. The microbial inoculated samples were allowed to ferment in covered fermentation trays within the fermentation chambers for five days according to the method described by Aro *et al.* (2008). After the fifth day, the trays were brought out and the fermented cassava peels sun-dried for 3-5 days after which they were packed and stored prior to their incorporation in compounded broiler diets. 2kg of dried cassava starch residue (CSR) was similarly weighed and mixed with 2000 ml of water and packed into water proof cellophane bags before being steam-sterilized in a cauldron. All other procedures were as observed under the preparation of the microbial fermented cassava peels (MFCP). Seven (7) experimental diets were formulated, Diet 1did not contain any microbial fermented cassava starch residues (MFCSR) or MFCP served as the control diet. Diets 2 to 4 contained 20%, 40% and 60% MFCP respectively while Diets 5 to 7 contained 20%, 40% and 60% MFCSR, respectively.

Management of Experimental birds

Two hundred and ten (210) day-old Abor Acre broiler birds were randomly allotted to the seven dietary treatments of 30 birds per treatment. Each treatment was replicated thrice comprising 10 birds per replicate. The birds were given feed and water *ad libitum*. Data collection in respect of feed and water intake were taken daily while weight gain and live weight of the birds were taken weekly during the course of the experiment.

The birds were slaughtered at the eighth week of the experiment. Prior to slaughtering, three birds were selected per replicate (9 birds per treatment). Feed was then withdrawn from them for 18 hours after which they were weighed to determine their live weight. The birds were stunned and thereafter slaughtered. They were de-feathered and weighed to determine their dressed weight, they were then eviscerated and their eviscerated weight taken. The carcasses were then cut into their individual parts while the viscera organs were dissected out. The carcass parts and the organs were weighed; also the dimension (length in centimetres) of some of the carcass parts and organs was taken as part of their morphometric studies.

The experimental design was a completely randomized design comprising seven treatments and three replicates of ten birds each per treatment, resulting in two hundred and ten (210) observations. Data obtained were subjected to one-way analysis of variance using SPSS (2006) Version 15. Treatment means found to differ significantly were separated using Duncan's multiple Range Test.

RESULTS AND DISCUSSION

The relative organ weights (Table 1) showed that birds fed 20% MFCP had the heaviest heart (0.48%) and the observed trend was a decrease in the size of the heart as the dietary levels of cassava tuber wastes CTW increased. Mohammed *et al.* (2009) reported a similar but insignificant decrease in the size of the heart with increase in the dietary level of yam peels in broilers diets. The physiological implication of an abnormally small heart would be the curtailment of heart rate and cardiac output with a resultant reduction in respiratory functions, poor nutrient metabolism and poor growth performance. The same trend was observed for the relative weights of lungs and abdominal fat pad. Igene and Ekundayo (2010) also reported a progressive decrease in abdominal fat as they replaced soybean meal with boiled pigeon pea in broilers diets. Hence, these unconventional feed sources, apart from reducing the cost of production (Aro *et al.*, 2013) will at the same time improve the lean to fat ratio of broiler meat. The relative weights of the kidneys, proventriculus, pancreas, small intestine and large intestine increased with increase in the dietary levels of CTW. The carcass morphometry of the birds is presented in Table 2. All parameters considered were longer in the control relative to the MFCTW diets. For example, the breast length ranged from 10.33 cm in birds feed 60% MFCSR to 12.07 cm in birds fed control diet. The carcass morphometry however revealed that the breast, drumsticks and thighs were not significantly (P>0.05) adversely affected when the two fermented CTW were used up to 40% level for MFCP and 20% for MFCSR. Since the drumsticks, thighs and the breast are the choicest portions of the carcass of broiler birds, it could be reported that the utilization of fermented CTW at those recommended levels will not adversely affect consumers' appeal for those choice portions.

Table 1: Relative organ weights (%) of broiler birds fed microbial fermented cassava tuber waste diets

Parameters	Control	20% MFCP	40% MFCP	60% MFCP	20% MFCSR	40% MFCSR	60% MFCSR	±SEM	P
Heart	0.42^{b}	0.48^{a}	0.40^{bc}	0.37^{cd}	0.41^{b}	0.35^{d}	0.35^{d}	0.01	0.02
Lungs	0.47	0.53	0.55	0.51	0.45	0.44	0.44	0.03	0.13
Kidneys	0.38^{cd}	0.29^{d}	0.33^{d}	0.35^{cd}	0.47^{cd}	0.58^{ab}	0.62^{a}	0.04	0.02
Liver	1.88	2.08	1.99	2.09	1.86	1.84	1.95	0.10	0.08
Gizzard	2.00^{b}	3.75^{a}	2.39^{ab}	2.41^{ab}	2.08^{b}	2.06^{b}	1.82^{b}	0.08	0.04
A. fat	0.72^{a}	0.80^{a}	0.57^{a}	0.00^{c}	0.45^{ab}	0.14^{bc}	0.00^{c}	0.09	0.03
Spleen	0.17^{a}	0.16^{ab}	0.14^{ab}	0.15^{ab}	0.14^{ab}	0.13^{b}	0.14^{ab}	0.01	0.04
Provent	0.50	0.43	0.54	0.57	0.48	0.44	0.75	0.09	0.10
Pancreas	0.22	0.26	0.44	0.25	0.24	0.22	0.26	0.05	0.09
S. intestine	3.74^{bc}	4.73^{ab}	4.86^{ab}	5.52^{a}	3.46^{c}	3.67^{bc}	5.56^{a}	0.37	0.03
L. intestine	0.17^{c}	0.48^{c}	0.41^{c}	0.27^{c}	1.17^{b}	1.08^{b}	1.72^{a}	0.12	0.03
Caeca	0.55^{e}	0.69^{cde}	0.58^{de}	0.80^{abc}	0.95^{ab}	0.77^{bcd}	1.00^{a}	0.05	0.02

a,b,c,d,e = Means on the same row but with different superscripts are statistically (P<0.05) significant.
MFCP = Microbial Fermented Cassava Peel; MFCSR = Microbial Fermented Cassava Starch Residue.
S. intestine = Small intestine; L. intestine = Large intestine; Provent = Proventriculus; A. fat = Abdominal fat.

Table 2: Carcass morphometry (cm) of broilers fed fermented cassava tuber wastes

Parameters	**Control**	**20% MFCP**	**40% MFCP**	**60% MFCP**	**20% MFCSR**	**40% MFCSR**	**60% MFCSR**	±SEM	P
Left shank	14.7^{a}	14.1^{abc}	14.4^{ab}	13.1^{cd}	13.7^{abcd}	13.3^{bcd}	12.5^{d}	0.33	0.02
Right shank	15.0^{a}	14.0^{ab}	14.4^{ab}	13.3^{ab}	12.8^{b}	13.5^{ab}	13.1^{b}	0.44	0.04
Left thigh	9.60^{a}	8.07^{b}	8.67^{ab}	8.23^{b}	8.47^{b}	8.00^{b}	7.73^{b}	0.30	0.04
Right thigh	9.60^{a}	8.33^{bc}	8.63^{b}	8.00^{bc}	8.33^{bc}	8.03^{bc}	7.57^{c}	0.23	0.03
Left drumstick	10.9^{a}	10.9^{a}	10.2^{ab}	9.53^{bc}	10.2^{ab}	9.83^{bc}	9.30^{c}	0.25	0.03
Right drumstick	10.9^{a}	10.7^{ab}	10.1^{bc}	9.7^{c}	10.4^{ab}	9.63^{c}	8.83^{d}	0.21	0.03
Breast	12.1^{a}	11.2^{ab}	11.4^{ab}	11.2^{ab}	11.0^{ab}	11.3^{ab}	10.3^{b}	0.30	0.04

a,b,c,d,e = Means on the same row but with different superscripts are statistically (P<0.05) significant.
MFCP = Microbial Fermented Cassava Peel; MFCSR = Microbial Fermented Cassava Starch Residue.

Table 3: Organ morphometry (cm) of broilers fed fermented cassava tuber waste

Parameters	Control	20% MFCP	40% MFCP	60% MFCP	20% MFCSR	40% MFCSR	60% MFCSR	±SEM	P
S. intestine	148	213	200	185	190	189	183	16.15	0.09
L. intestine	10.30^{a}	9.90^{a}	9.63^{a}	9.43^{a}	10.20^{a}	9.90^{a}	8.33^{b}	0.58	0.04
Provent.	5.00^{ab}	6.17^{a}	4.83^{ab}	4.67^{ab}	4.93^{ab}	4.57^{ab}	4.20^{b}	0.34	0.04
Caeca	23.19	22.50	23.4	20.74	19.10	21.01	22.74	0.39	0.08

^{a,b} = Means on the same row but with different superscripts are statistically (P<0.05) significant.
MFCP = Microbial Fermented Cassava Peel; MFCSR = Microbial Fermented Cassava Starch Residue
Provent. = Proventriculus.

The organ morphometry (Table 3) revealed that the small intestines of birds fed fermented CTW were longer than those fed the control diet but showed a linear decrease in both the MFCP and MFCSR diets with increasing dietary inclusion of these fermented wastes while the proventriculus and large intestinal length showed a progressive decrease with increasing dietary levels of the fermented CTW. Similar elongation of the small intestine was reported by Olaseinde *et al.* (2010) on broiler birds fed different dietary fibre sources.

The change in the lengths of the various organs associated with digestion in the birds could be ascribed to physiological adjustment to the nature of the feed and their physico-chemical properties (Canibe *et al.*, 2005). The length of caeca ranged from 9.1 cm in the birds fed 20% MFCSR diet to 13.39 cm in birds fed 40% MFCP diet. Caeca length thus showed a linear increase with increasing levels of MFCSR in the diet while in the MFCP, it increased up to 40% level before declining at 60% inclusion level. Abdulrashid *et al.* (2010) reported such elongation of the large intestine of boilers fed graded levels rice offal in their diets thus substantiating the influence of the nature of feed on the organ morphometry of broiler birds.

CONCLUSION

Birds fed CTW diets had relatively smaller hearts, lungs and abdominal fat pads. Also carcass morphometry in terms of length of drumsticks, thighs and breast were better in the control than in the CTW diets. The MFCP (up to 40% level) and MFCSR (at 20% level) however compared with the control when the carcass morphometry of the drumstick, thigh and breast were taken into consideration. Feeding birds with the fermented CTW could also result in longer small intestine, shorter proventriculus and shorter large intestine. Consequently, the inclusion of fermented CTW up to 40% in the MFCP and 20% in the MFCSR would not adversely affect the lengths of drumstick, thigh and breast of broiler birds but could lead to the elongation of the small intestine of the birds.

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