Microbe-Fermented Cassava Tuber Waste-Based Diets: Effects on Performance and Serum Biochemistry of Cockerel Finishers.

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ABSTRACT

The effects of dietary inclusion of microbe-fermented cassava tuber wastes on growth performance and serum biochemistry of cockerel finishers were evaluated in a 16-week experiment. The birds were randomly assigned to seven dietary treatments comprising thirty birds per treatment. Each treatment was replicated thrice with 10 birds per replicate. The cassava tuber wastes (cassava peels and cassava starch residues) were enriched through microbial fermentation using two different strains of lactic acid bacteria (Lactobacillus delbrueckii and Lactobacillus coryneformis) and a fungus (Aspergillus fumigatus). Seven experimental diets were formulated to contain graded levels of the microbe-fermented cassava peel and cassava starch residue at 0%, 20%, 40% and 60%. Grade 1 (G1), the control treatment, contained 0% microbe-fermented cassava tuber wastes (CTWs), Grades 2 (G2), 3 (G3) and 4 (G4) contained 20%, 40% and 60% microbe-fermented cassava peel (MFCP) while Grades 5 (G5), 6 (G6) and 7 (G7) contained 20%, 40% and 60% of microbe-fermented cassava starch residues (MFCSR) respectively. Results showed that G4 had the lowest final body weight (1002.82±64.56g) while G1 had the highest (1635.19±32.45g). The poorest feed conversion ratio (FCR) of 8.77±0.62 was observed in G4 while the best (4.42±0.17) was recorded in G1. Serum total protein was highest in G6 (40.73±7.86g/l) and lowest in G1 (25.16±7.37g/l). Total protein (TP) in all the treatments with CTWs were higher than that of the control diet. Serum globulin was highest in G2 (28.28±5.14g/l) and lowest in G1 (14.96±7.31g/l). Serum alkaline phosphatase (ALP) in the CTW diets compared well with the control diet (487.60±12.17g/l) with the exception of G7 (243.80±59.80g/l). Alanine aminotransferase (ALT) was highest in G4 (23.67±14.52μ/l) but lowest in G2 (5.00±0.58μ/l). Conclusively, cockerels can be raised and finished on diets containing 20% inclusion of microbe-fermented cassava peels (MFCP) and 40% microbe-fermented cassava starch residue (MFCSR) without any adverse effects on performance and biochemical profile of the birds. At 60% level of both MFCP and MFCSR, poor performance and negative biochemical manifestations which may compromise normal physiological responses in cockerels could be observed.

KEYWORDS:

Biochemistry, Cassava Tuber Wastes, Cockerel, Fermentation, Physiology, Serum.

I. INTRODUCTION

Demand for animal protein has ever been on the increase in developing countries as a result of rapid population growth. FAO (1986) reported that an intake of 35g per head per day is recommended as the dietary protein allowance for man. Nigerians consume about 10g per head per day (Tewe, 1997). Orlu and Egbunike (2010) reported that poultry meat and eggs present the most affordable source to mitigate the problem of malnutrition in Nigeria. Nevertheless, the continued competition between man and his animals for food in developing countries has made the problem of malnutrition almost intractable.

Feed is an important component of poultry enterprise and has been generally known to account for 70 to 80% of the total cost of production (Dairo, 2011). Maize, which is a major component of poultry feed had a 71.16% increase in price within a decade in some parts of Africa (Natalie and Mingan, 2016). These hike in the prices of major ingredients has compelled man to search for credible alternatives to feed his livestock. Aro (2010) canvassed for the use of alternative feed sources such as cassava peel and cassava starch residue in the diets of animals. These peels and residues are regarded as wastes and are usually discarded and allowed to rot. Aro (2008) reviewed the widespread patronage cassava and its by-products have enjoyed in the nutrition of many livestock species such swine, rabbit, poultry and small ruminants.

Cassava however contains the cyanogenic glucosides: linamarin and lotaustralin which upon hydrolysis yield hydrogen cyanide (HCN) – a potentially harmful toxin to both livestock and man. Microbial fermentation have been shown to substantially reduce the level of HCN in cassava products. In fact, Aro *et al*. (2008), reported the detoxification of HCN in CTWs through microbial fermentation in addition to improvement in the nutritional value of the wastes. Hence, the utilization of biotechnologically enhanced cassava wastes in the diet of livestock could be very promising.

The type of diet an animal consumes greatly affects the overall performance of such animal. It is therefore expedient to determine the effects of agro-allied wastes that are presently being explored for feeding livestock on their general performance and wellbeing. This research was therefore designed to investigate the effect of feeding microbe-fermented cassava tuber wastes on the performance and serum biochemistry of cockerel finishers.

II. MATERIALS AND METHOD

Experimental Site

The experiment was conducted at the Poultry Unit of the Teaching and Research Farm, Federal University of Technology, Akure, Nigeria. This falls within the south-western zone of Nigeria and is characterized by hot and humid climate.

Experimental Birds and Experimental Layout

A total of 250 day-old Nera black cockerel chicks were purchased from a reputable hatchery of which 210 were used for the study and were randomly allotted to seven dietary treatments in a completely randomized design. Each treatment was replicated thrice with ten (10) birds per replicate and fed their allotted diet in a sixteen-week experiment. The birds were fed *ad libitum* and water was supplied regularly throughout the experimental period. Routine management practices were duly carried out.

Experimental Diets

The experimental diets were formulated to contain graded levels of microbe-fermented cassava peel and cassava starch residue at 0%, 20%, 40% and 60%. The microbe-fermented cassava peels and cassava starch residues were prepared using the method described by Aro (2010). Grade 1 which served as control diet contained 0%, Grade 2 contained 20% microbe-fermented cassava peel (20% MFC P), Grade 3 contained 40% microbe-fermented cassava peel 40% MFCP), Grade4 contained 60% microbe-fermented cassava peel (60% MFCP), Grade 5 contained 20% microbe-fermented cassava starch residue (20% MFCSR), Grade 6 contained 40% microbe-fermented cassava starch residue (40% MFCSR) and Grade 7 contained 60% microbe-fermented cassava starch residue (60% MFCSR) respectively. The diets were fed at the starter and finisher phases of the experiment divided into eight (8) weeks each. All diets were formulated to meet the physiological needs of cockerel starters and finishers as shown on Tables 1 and 2 respectively.

Data Collection and Statistical Analysis

The birds were weighed at the beginning of the experiment and were subsequently weighed weekly to determine their weight gain. This was used to estimate their growth performance. The final weight was obtained on the last day of the 16th week. Data were also collected on a daily basis to estimate the actual daily feed intake, and mortality rate. Data obtained from the daily feed intake and the weight gain were used to estimate the feed conversion ratio (FCR). At the end of the sixteen (16) week feed-trial the birds were slaughtered and then samples were collected for the evaluation of other parameters. All data were subjected to one-way analysis of variance and statistical significant differences were separated with Duncan's multiple range test of SPSS version 18 (2009) statistical package.

Table 1: Gross Composition of Cockerel Starter Diets.

Ingredients	G1	G2	G3	G4	G5	G6	G7
MFCP	-	20.00	40.00	60.00	-	-	-
MFSCR	-	-	-	-	20.00	40.00	60.00
Maize	52.00	37.75	22.75	-	36.00	20.00	-
Veg. Oil	2.50	2.50	2.00	4.00	2.00	2.50	4.00
Fish Meal	2.00	2.00	1.00	1.00	2.50	4.25	8.00
SBM	10.00	10.00	8.50	-	-	-	-
GNC	18.75	18.00	21.00	30.25	29.75	28.50	23.25
PKC	10.00	5.00	-	-	5.00	-	-
Bone Meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Starter Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100	100	100	100
CP (%)	20.41	20.38	20.39	20.49	20.08	20.13	20.31
ME (MJ/kg)	11.34	11.45	11.39	11.46	11.35	11.48	11.31

G1= Control diet; G2 = 20% MFCP diet; G3 = 40% MFCP diet; G4 = 60% MFCP diet; G5 = 20% MFCSR diet; G6 = 40% MFCSR diet; G7 = 60% MFCSR diet

MFCP = Microbe fermented cassava peel; MFCSR = Microbe fermented cassava starch residue

Table 2: Gross Composition of Cockerel Finisher Diets

Ingredients	G1	G2	G3	G4	G5	G6	G7
MFCP	-	20.00	40.00	60.00	-	-	-
MFSCR	-	-	-	-	20.00	40.00	60.00
Maize	62.00	46.75	32.00	17.00	45.50	29.00	18.00
GNC	19.25	18.75	18.00	17.25	21.50	23.50	8.50
PKC	13.00	8.75	4.25	-	7.25	1.25	-
Fish meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Grower Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total (kg)	100	100	100	100	100	100	100
CP (%)	16.90	16.97	16.95	16.94	16.95	16.94	16.68
ME (MJ/kg)	10.74	10.73	10.77	10.77	10.74	10.72	10.51

G1= Control diet; G2 = 20% MFCP diet; G3 = 40% MFCP diet; G4 = 60% MFCP diet; G5 = 20% MFCSR diet; G6 = 40% MFCSR diet; G7 = 60% MFCSR diet

MFCP = Microbe fermented cassava peel; MFCSR = Microbe fermented cassava starch residue.

III. RESULTS

Table 3: Growth performance of finisher cockerels fed graded level of microbe fermented cassava tuber waste-based diets

Parameters	G1	G2	G3	G4	G5	G6	G7	±SEM
IW/bird (g)	36.48^{ab}	37.50^{ab}	37.50^{ab}	37.50^{ab}	38.89^{a}	38.89^{a}	38.89^{a}	0.37
FW/bird (g)	1635.19^{a}	1582.87^{a}	1214.35^{c}	1002.82^{d}	1470.00^{ab}	1337.57^{bc}	1192.86^{cd}	57.91
TWG/bird (g)	1598.71^{a}	1545.37^{a}	1176.85^{c}	965.32^{d}	1431.11^{ab}	1298.68^{bc}	1153.97^{cd}	57.89
AWG/bird (g)	99.92^{a}	96.59^{a}	73.56^{c}	60.33^{d}	89.44^{ab}	81.17^{bc}	72.12^{cd}	3.62
TFI/bird (g)	7069.49^{c}	7231.29^{c}	7903.77^{ab}	8385.37^{a}	8310.40^{a}	7500.68^{b}	8406.29^{a}	373.13
AWFI/bird (g)	441.84^{c}	451.96^{c}	493.99^{ab}	524.09^{a}	519.40^{a}	468.79^{b}	525.40^{a}	23.32
FCR	4.42^{a}	4.69^{a}	6.69^{bc}	8.77^{d}	5.82^{b}	5.78^{b}	7.27^{c}	0.26
MOR	1.33^{a}	1.67^{a}	2.33^{ab}	4.67^{bc}	5.00^{bc}	2.67^{ab}	6.33^{c}	0.79

a,b,c,d = Means on the same row but with different superscripts are statistically ($P<0.05$) significant. *G1= Control diet; G2 = 20% MFCP diet; G3 = 40% MFCP diet; G4 = 60% MFCP diet; G5 = 20% MFCSR diet; G6 = 40% MFCSR diet; G7 = 60% MFCSR diet*

MFCP = Microbe fermented cassava peel; MFCSR = Microbe fermented cassava starch residue.

±SEM =Mean ± Standard Error of Mean; IW=Initial weight, FW=Final weight, TWG=Total weight gain, AWG=Average weight gain, TFI=Total feed intake, AWFI=Average weekly feed intake, FCR= Feed conversion ratio, MOR=Mortality.

Table 4: Serum Biochemistry of Cockerel Finishers Fed Graded Levels of Microbe Fermented Cassava Tuber Waste-based Diets.

Parameters	G1	G2	G3	G4	G5	G6	G7	±SEM
TP (g/l)	25.16^{d}	39.29^{a}	28.89^{c}	35.53^{a}	32.36^{b}	40.73^{a}	29.76^{c}	5.54
ALB (g/l)	10.20^{ab}	11.01^{a}	11.86^{a}	10.43^{ab}	7.14^{b}	13.61^{a}	13.12^{a}	0.84
GLO (g/l)	14.96^{b}	28.28^{a}	17.03^{b}	25.11^{a}	25.22^{a}	27.12^{a}	16.64^{b}	5.74
GLU (g/l)	7.60^{a}	1.49^{b}	3.16^{a}	1.94^{a}	2.63^{a}	1.35^{b}	1.39^{b}	1.20
ALP (g/l)	487.60^{a}	473.80^{ab}	386.40^{ab}	519.80^{a}	464.60^{ab}	552.00^{a}	243.80^{c}	24.96
ALT (µ/L)	5.00^{b}	5.00^{b}	20.33^{a}	23.67^{a}	5.67^{b}	10.00^{a}	15.67^{a}	6.21
AST (µ/L)	92.67^{b}	105.00^{a}	95.00^{b}	102.33^{b}	95.67^{b}	101.33^{b}	110.33^{a}	10.10

a,b,c,d = Means on the same row but with different superscripts are statistically ($P<0.05$) different. G1= Control diet; G2 = 20% MFCP diet; G3 = 40% MFCP diet; G4 = 60% MFCP diet; G5 = 20% MFCSR diet; G6 = 40% MFCSR diet; G7 = 60% MFCSR diet

MFCP = Microbe fermented cassava peel; MFCSR = Microbe fermented cassava starch residue; ±SEM =Mean ± Standard Error of Mean; TP=Total protein; ALB=Albumin; GLB= Globulin; GLU= Glucose; ALP= Alkaline Phosphatase; ALT= Alanine aminotransferase; AST= Aspartate aminotransferase.

Table 3 shows the performance parameters of cockerel birds fed graded levels of microbe fermented cassava peels and microbe fermented cassava starch residue. Results obtained show that a dietary inclusion of 40% and 60% cassava tuber wastes (CTW) significantly influenced (P<0.05) the performance characteristics of the birds. The total weight gain per bird had mean values ranging from 965.32±63.94g (G4) to 1598.71±3262g (G1). The mean values of birds on G1 (1598.71±32.62g), G2 (1545.37±57.43g) and G5 (1431.11±72.34g) were statistically similar but differed significantly to birds on diets G3 (1176.85±53.82g), G4 (965.32±63.94g), G6 (1298.68±18.79g) and G7 (1153.97±106.03g).

The serum globulin (GLO) fraction showed significant differences among the different dietary treatments as shown on Table 4. The value of globulin was highest for G2 (28.28±5.14g/l) and lowest for G1 (14.96±7.31g/l). All the treatments with dietary inclusion of microbe fermented cassava tuber wastes had higher values than the control treatment. There were marked differences observed in the values obtained for the serum glucose (GLU) with statistical differences among the treatment means. The serum glucose was highest in G1 (7.60±5.94g/l) but lowest in G6 (1.35±0.42g/l).

IV. DISCUSSION

Growth Performance

The final live weight of the cockerel finishers differed significantly (P<0.05) across the different dietary treatments as shown on table 3. Although the highest final live weight was recorded in the control diet (G1), G2 (20% MFCP) and G5 (20% MFCSR) were statistically similar to G1. This means that 20% inclusion level of either MFCP or MFCSR into the diets of cockerels can be utilized without adversely compromising the final live weight of the bird. Birds on G7 (60% MFCSR) and G4 (60%MFCP) performed poorly in terms of final live weight. Similar results were obtained for the total weight gain and the average weekly weight gain where G2 and G5 compared similarly with G1). Birds on G7 and G4 performed poorly in terms of average weekly weight gain and total weight gain.

The total feed intake and the average weekly feed intake of the birds showed no significant difference (P>0.05) among the different diets. The highest total feed intake was recorded in G7 (60% MFCSR), followed by G4 (60% MFCP) and the lowest was recorded in the control diet (G1). This means that diets with inclusion of cassava tuber wastes were more palatable than the control diet as seen in the increased voluntary feed intake with a corresponding increase in the dietary inclusion of the waste. This further confirms the report of Aro *et al.* (2012) who also observed an increase in the feed intake of broilers fed diets with dietary inclusion of cassava tuber waste. Nevertheless, birds on diets with increasing dietary inclusion of cassava tuber wastes performed poorly in terms of feed conversion ratio (FCR) with the exception of G2 which compared favourably with the control diet. This means that an increasing feed intake did not amount to a better utilization of the feed for flesh or other useful products in the birds. Birds offered the control diet (G1) performed best in terms of feed conversion ratio while birds offered 60% MFCP (G4) and 60% MFCSR (G7) had a poor feed conversion ratio. Birds on processed cassava tuber wastes (CTW) consumed more as observed in this research. Similar results were also recorded by Ijaiya *et al.* (2002) who recorded higher levels of feed intake with increasing levels of cassava peel meal (CPM) in the diets of rabbits. The poor performance recorded in G4 (60% MFCP) and G7 (60% MFCSR) despite performing best in total feed intake per bird could be attributed to the high dietary crude fibre level and the toxigenic nature of residual cyanide in the diet (Aro and Falowo, 2011). High dietary crude fibre level due to cassava peel meal (CPM) have been known to increase feed intake without a corresponding feed conversion efficiency (Ijaiya *et al.*, 2002).

The lowest mortality was recorded in G1 (control diet). G2 (20% MFCP) also compared favorably with the control diet. Although a high mortality rate was recorded among birds fed diets containing dietary inclusion of the cassava tuber waste, exogenous factors may have contributed to this, as a Newcastle Disease outbreak (hence mortality), was observed during the course of the research between the 10^{th} and 11^{th} week of the experiment. Aderemi *et al.* (2006) in their research also reported that mortality differed significantly among layers placed on diets containing 10% dietary inclusion of biodegraded cassava root sievate while evaluating the nutritive value of biodegraded cassava root sievate and its utilization by layers but they attributed the significantly different mortality rate to the findings of Ogunlayi *et al*. (1993) who had earlier opined that mortality in cockerels fed cassava based diets could be due to high microbial infestations (mycotoxins and contaminants) of cassava peels during traditional processing. Aro *et al*. (2012) in their research on broilers fed diets with dietary inclusion of cassava tuber waste also recorded the highest percentage mortality (25.33 birds/treatment) among birds on 40% dietary inclusion of microbe fermented cassava peel (MFCP). However, they opined that the dietary treatments may not have influenced the high mortality recorded. There exists a dearth of information on the effect of residual cyanide on the immuno-competence of cockerel finishers fed diets with inclusion of cassava tuber wastes and as such, further research is recommended.

Serum Biochemistry

The serum biochemical values (Table 4) showed that the serum metabolites (total protein, globulin and albumin) and serum enzymes (AST and ALT) were influenced by the dietary treatments. The values of the total serum protein increased significantly in diets with inclusion of cassava tuber wastes. The serum globulin values differed significantly when compared with the control diet. The increased globulin levels may be an indication of reduced immune-competence as a result of residual cyanide in the CTWs. Harper (1982) highlighted that increased serum globulin in infected animal is expected since the globulin fraction of protein is the principal site of circulating antibodies (immuno-globulins).

Serum glucose was observed to be relatively lower in diets with dietary inclusion of the cassava tuber wastes. An initial increase was observed in the serum glucose level of MFCP diets from 20% to 40% inclusion followed by a decrease at the 60% level. The same trend was earlier reported by Aro *et al.* (2012) for broiler chickens fed fermented cassava tuber wastes-based diets. The diets with inclusion of MFCSR did not follow any particular trend in this experiment as far as serum glucose is concerned. Although the values of G3 (40% MFCP), G4 (60%MFCP), G5 (20% MFCSR) and G7 (60% MFCSR) were numerically lower when compared to the control diet, statistically, they compared well with the control diet. This means that the dietary inclusion of the cassava tuber wastes (CTW) would not compromise the glucose homeostasis of cockerels.

The values of AST in both the MFCP and MFCSR diets were higher than that of the control diet and the values of G2 and G7 differed significantly to that of the other treatments. In the MFCP diets, an initial decrease was observed from 20% to 40% inclusion followed by an increase in the 60% inclusion. For MFCSR based diets, the levels of the enzyme AST increased with a corresponding increase in the inclusion level of MFCSR. This is indicative of a possible liver injury. Woreta and Alqahtani (2014) reported that the enzymes AST and ALT are sensitive markers of hepatocellular injury and the degree and pattern of elevation of these aminotransferases may as well point to the cause of a liver injury. Although the numerical increase in these values did not translate to significant differences among the dietary treatments, a liver injury may occur in birds served diets with higher rates of inclusion of cassava tuber wastes than those used in this study. Histological studies carried out by Oniyelu and Aro (2016) on the testes of birds showed that the dietary inclusion of cassava tuber wastes into the diets of birds significantly (P<0.05) influenced the testicular parenchyma of the birds. They observed mass erosion of the seminiferous tubule, necrosis and premature sloughing of cells with an increase in the dietary inclusion of the wastes. Histological studies may as well further explain the reason for such increase in the values of AST as Oboh and Akindahunsi (2005) had earlier reported that increased activities of the enzyme in the serum are diagnostic indicators of liver injury.

The value of the enzyme ALT varied significantly among the treatment diets and a corresponding increase in its value was recorded with an increase in the inclusion level from 20% - 60% for both MFCP and MFCSR. Although the values obtained were still within the normal blood range of 1-37 µ/L for chickens as reported by Ker *et al.* (1982), (cited by Aro *et al.,* 2012), an increase in its value with a corresponding increase in the inclusion level of cassava tuber waste may be indicative of tissue damage and hepatic degeneration as these enzymes are pointers for such (Agbede *et al.,* 2011). The level of serum alkaline phosphatase (ALP) in birds fed the CTW diets were statistical similar to the control diet with the exception of G7 (60% MFCSR) which showed marked significant difference to the control and other treatment diets. The level of serum albumin and globulin in birds fed the cassava tuber waste diets showed no statistical variation when compared with the control diet even though a numerical increase was observed, with the exception of G5 (20% MFCSR) with serum albumin level lower than that of the control diet. Increased serum globulin levels observed may serve as a pointer to an inflammation reaction. This is in accordance with the report of Kristiina and Margo (2010) that globulin levels reflect underlying inflammation and/or antibody production and increased levels of globulins are often associated with infectious diseases, immune-mediated disease, and some types of cancer.

V. CONCLUSION

The results obtained from this research showed that cassava tuber wastes (MFCP and MFCSR) could be properly harnessed through microbial fermentation and used in poultry production. This will help in reducing the menace such wastes pose to the environment and could also serve as substitutes for maize which is sold at exorbitant prices in Nigeria today. The results further showed that day-old cockerels could be raised and finished on diets containing 20% inclusion of microbe fermented cassava peels (MFCP) and 40% microbe fermented cassava starch residue (MFCSR) without adverse effects on the performance and physiological functions of the birds. At 40% MFCP, a reduction in performance may be observed while at 60% MFCP and MFCSR levels, poor performance and biochemical incompetence which may compromise the normal physiological responses of the cockerels could be observed.

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