Global Research Journal of Microbiology Vol.2(1) pp.067 –075 May 2012.
Available online http://www.globalresearchjournals.org/?a=journal&id=grjm

Full length Research.

Performance and carcass characteristics of broiler chickens fed on fungal mixed-culture (*Aspergillus niger and Penicillium chrysogenum*) fermented mango kernel cake.

*Kayode, R.M.O.[a], Sani, A.[b], Apata, D. F.[c], Joseph, J. K.[a], Annongu, A. A.[c], Kolawole, O. M.,[b] Awe, S.[b], Obalowu, M. A.[a] and Arekemase, M.A.[b]

[a] Division of Microbial Biotechnology, Department of Home Economics and Food Science, University of Ilorin, P.M.B 1515, Ilorin, Nigeria.

[b] Department of Microbiology, University of Ilorin, P.M.B 1515 Ilorin, Nigeria.

[c] Department of Animal Production, University of Ilorin, P.M.B 1515 Ilorin, Nigeria.

[*] Correspondence author. E-mail; kayodermosnr@yahoo.com ,Tel: +234-08035850545.

Accepted 17th April 2012

Mango Kernel Cake (MKC) was fermented using a mixed-culture of *Aspergillus niger* and *Penicillium chrysogenum* for 168 hrs. The MKC was autoclaved to terminate the fermentation processes and air dried before use at graded levels in broiler diets. Six diets were formulated as follows: Diet A had 0% MKC (control) while diets B, C, D, E and F were mixed-culture fermented MKC replacing maize at 20, 40, 60, 80 and 100% respectively. Decrease in weight gain and feed intake of the birds with increase in fermented MKC was significant ($p < 0.05$). The weight of birds fed on diet B was higher than others, but not statistically different ($p < 0.05$) from the control at the starter phase. Feed intake and weight gain of the birds fed on diets A, B, and C were higher ($p < 0.05$) at the end of the 4th week (starter phase). While, at the 8th week (finisher phase), birds fed on diets A and B weighed higher ($p < 0.05$) than the birds fed on diets C and D. The weight gain of birds fed on diet F was lower ($p < 0.05$) than that obtained for the other treatments. Feed conversion ratio ranged from 2.45 (diet A) to 3.82 (diet F) during the starter phase and between 2.36 (diet A) and 3.79 (diet F) at the finisher phase. The performance of the birds was better at the finisher phase than at the starter phase. There was a 4.16% mortality among birds fed on diet F. Nutrient retention decreased ($p < 0.05$) with increase in fermented MKC and no significant difference ($p < 0.05$) was observed in percentage carcass parameters. Most of the carcass parameters decreased progressively with increase in MKC. Up to 60% of *A. niger and P. chrysogenum* fermented MKC could be used to replace maize in broilers diet without deleterious effect.
Key words: mixed-culture fermentation, performance, nutrient retention, carcass characteristics.

1.0 Introduction

The shortage of good quality feeds needed to sustain livestock growth has being a major challenge to the poultry farmers in the developing countries. Thus crop residues, agro-industrial by- products and the kernel of some unconventional fruits of tropical trees are being evaluated to assess their nutritive potential to support livestock productivity. Several factors have been limiting the utilization or increased levels of incorporation of unconventional feedstuffs in livestock feed. These factors include low protein content (Gohl, 1981), high fibre (Cho and Smith, 1988), amino acid imbalance and presence of anti-nutritional factors (Tacon and Jackson, 1985). Anti-nutritional factors have significant negative effects on livestock production. These include reduction in palatability, utilization of ration, digestibility and intoxication of different classes of livestock, resulting in mortality or decreased animal production (Amuchie, 2001). The effects of dietary levels of raw mango seeds (*Mangifera indica*) on the performance and carcass quality of broiler chickens. The effects of using cooked Nigerian mango – seed kernels (*Mangifera indica*) on the performance, carcass yield and meat quality of broiler chickens was examined by Joseph, and Abolaji (1997). The findings of the authors suggested the need of using other more effective methodologies to process mango seed kernel, in order to enhance its utilization by broiler chickens. This study investigated the replacement of maize with different values of the mixed-culture of *Aspergillus niger* and *Penicillium chrysogenum* fermented “Oori” mango kernel cake on the performance and carcass characteristics of broiler chickens.

2.0 Materials and Methods

2.1 *Source of fungi and preparation of mango kernel cake (MKC)*

Aspergillus niger and *Penicillium chrysogenum* were isolated from decomposed kernels of “Oori” mango cultivar commonly referred to as “Ogbomoso mango” in the western parts of Nigeria. Fungal isolation was carried out using potato dextrose agar and identification was performed according to Samson and Van Reen-Hoekstra (1988), while MKC was prepared as described by Kayode and Sani (2008).

2.2 *Preparation of mixed-culture inoculum*

A mixture of 50ml of *Aspergillus niger* suspension ($5x10^4$ spores/ml) and 50ml of P*enicillum chrysogenum* suspension ($5x10^4$ spores/ml) was prepared as fermentation starter inoculum.

2.3 *Mixed-culture fermentation of the MKC used for feeding experiment*

One-kilogramme of autoclaved mango kernel cake was mixed with 1litre of sterile distilled water in a fermenter and stirred properly to obtain a uniform mash as described by Kayode and Sani (2008). Twenty millilitres of the mixed-culture starter suspension ($5x10^4$spore/ml) was added, mixed and incubated at ambient temperature (27 ± 5^0C) for 168 h (Lawal *et al*., 2005). Fermentation process was terminated by autoclaving at 121^0C for 30 minutes.

2.4 *Experimental site for feeding broiler chickens*

The eight (8) weeks feeding experiment using broiler chickens was conducted in the poultry section of the Faculty of Agriculture, University of Ilorin, Nigeria.

2.5 *Graded level of mixed-culture fermented MKC diets for the feeding experiment*

The mixed-culture of *Penicillium chrysogenum* and *Aspergillus niger* fermented MKC with other ingredients (Table 1 and 2) were used to formulate diets at graded level of replacement for maize to reach the NRC (1984) nutrient requirement of broilers.

2.6 *Management of the broilers during feeding experiment (starter and finisher phases)*

One hundred and forty four day-old broiler chickens were used for the study. The birds were divided into six groups of 24 chickens each, which were allocated randomly to six dietary treatments using a Completely Randomized Design (CRD). Each treatment was replicated thrice and each replicate contained 8 broiler chicks. The chicks were reared in an electrically heated metabolic cage at 37 ± 2^0C with feed and water supplied *ad-libitum*. The management of the birds was done as outlined by Oluyemi and Robert (1979).

Six dietary treatments (Tables 1 and 2) were formulated. The control of the experimental diets was 0% fermented MKC and different levels of fermented MKC replacement for maize at 20%, 40%, 60%, 80% and 100%. The diets were made iso-nitrogenous (23% and 20% crude protein for starter and finisher phases respectively) with the provision of at least the minimum calorie (2700kcal/kg) requirement for chickens as recommended by Oluyemi and Robert (1979). Routine vaccine was administered as when due. The birds were weighed and allocated to their respective treatment diets. The starter phase lasted for 4weeks before a switch to the finisher diet which also lasted for another 4weeks. Records of feed consumption and body weight were taken weekly. Body weight gain and feed to gain ratio (Feed Conversion Ratio) were estimated from the data collected.

Table 1: Composition of the experimental broiler starter diets (g/100g)

Ingredient	**Diet/Composition (g/100g)**					
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)
Maize	45.00	36.00	27.00	18.00	9.00	-
Mango kernel cake	-	9.00	18.00	27.00	36.00	45.00
Soya bean meal	15.00	15.00	15.00	15.00	15.00	15.00
Groundnut cake	20.00	20.00	20.00	20.00	20.00	20.00
Brewers dried grain	10.00	10.00	10.00	10.00	10.00	10.00
Wheat offal	4.95	4.95	4.95	4.95	4.95	4.95
Fish meal (72%)	1.50	1.50	1.50	1.50	1.50	1.50
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell	0.30	0.30	0.30	0.30	0.30	0.30
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.10	0.10	0.10	0.10	0.10	0.20
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25

Table 2: Composition of the experimental broiler finisher diets (g/100g)

Ingredient	**Diet/Composition (g/100g)**					
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)
Maize	45.00	36.00	27.00	18.00	9.00	-
Mango kernel cake	-	9.00	18.00	27.00	36.00	45.00
Soya bean meal	15.00	15.00	15.00	15.00	15.00	15.00
Groundnut cake	15.00	15.00	15.00	15.00	15.00	15.00
Brewers dried grain	10.00	10.00	10.00	10.00	10.00	10.00
Wheat offal	9.95	9.95	9.95	9.95	9.95	9.95
Fish meal (72%)	1.50	1.50	1.50	1.50	1.50	1.50
Bone meal	2.50	2.50	2.50	2.50	2.50	2.50
Oyster shell	0.30	0.30	0.30	0.30	0.30	0.30
Salt (NaCl)	0.30	0.30	0.30	0.30	0.30	0.30
Methionine	0.10	0.10	0.10	0.10	0.10	0.20
Lysine	0.10	0.10	0.10	0.10	0.10	0.10
Vitamin premix	0.25	0.25	0.25	0.25	0.25	0.25

2.7 *Metabolic trial*

Apparent nutrient retention study was carried out for three consecutive days during the fourth and eighth week of the experiment respectively. The amount of feed consumed and the orts were taken and total collection was made of the feaces voided. The feaces were later separated from feathers and spillover feed particles and then oven dried at 60^0C for 48hrs. The dried samples were milled prior to analysis for dry matter, fat, fibre, protein, ash and carbohydrate in both the diets and feaces before computing the apparent nutrient retention (Krishna and Ranjhan, 1982).

2.8 *Internal organs and carcass quality evaluation*

At the end of the eight weeks experiment of feeding the broilers with graded levels of fermented MKC, two birds per replicate were starved overnight, euthanized by cervical dislocation and decapitated (Rowsell, 1990). The body weight of the birds was recorded before they were euthanized, bled weight was taken after anchoring them to bleed properly on fixed nails to which the legs were attached. Evisceration was accomplished by the removal of the internal organs (liver, lung, heart, kidney, spleen, digestive tract, bile, gizzard and pancreas) which were individually weighed and calculated as percentage of carcass weight. The eviscerated carcass was cut into prime cuts (head, shanks, thighs, wings, back, breast and drumsticks) and calculated as percentage of live weight. Each eviscerated carcass was dissected into fat, muscle (lean meat) and bone before they were calculated as percentage of carcass weight.

2.9 *Proximate Analysis*

Dry matter, crude protein, ether extract, crude fibre and total ash were parameters analyzed on the feed samples. The analysis was carried out according to the procedure of Association of Official Analytical Chemist (AOAC, 2000).

2.10 *Experimental design and Statistical analysis*

Completely Randomized Design was used, while data obtained was analyzed by one-way ANOVA. Significant differences among the means were determined by using Duncan's New Multiple Range Test as outlined by Obi (2002).

3.0 Results and Discussion

3.1 *Proximate composition of the diets (starter and finisher)*

The results of proximate composition of the experimental diets (starter and finisher) are shown in Tables 3 and 4 respectively. During the two feeding regimes (starter and finisher phases), the crude protein contents were 23.48 – 24.15% and 19.47 – 20.09% and the calculated amounts of energy provided were 3065.2 – 3228.5 kcal/kg DM and 3080.8 – 3254.8 kcal/kg DM.

Table 3: Proximate composition of starter broiler diets containing graded levels of mixed-culture (*A. niger* and *P. chrysogenum*) fermented "Oori" MKC

Proximate Composition (g/100gDM)	**Dietary Treatments**					
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)
Crude protein	23.92	24.15	24.03	23.95	23.70	23.48
Crude fat	5.28	5.57	5.92	6.45	6.72	7.03
Crude fibre	4.37	3.54	3.60	3.55	3.10	2.95
Total ash	7.20	7.14	6.43	6.09	6.05	5.68
Nitrogen free extract	59.23	59.60	60.02	59.96	60.43	60.86
ME (kcal/kg DM)	3065.2	3090.8	3158.0	3172.1	3203.2	3228.5

Key:

ME = Calculated Metabolisable energy (Janssen *et al*. 1979)
A = Diet A (0% Replacement for maize; Control)
B = Diet B (20% Replacement for maize)
C = Diet C (40% Replacement for maize)
D = Diet D (60% Replacement for maize)
E = Diet E (80% Replacement for maize)
F = Diet F (100% Replacement for maize)

Table 4: Proximate composition of finisher broiler diets containing graded levels of mixed-culture (*A. niger* and *P. chrysogenum*) fermented "Oori" MKC

Proximate Composition (g/100gDM)	**Dietary Treatments**					
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)
Crude protein	19.52	19.65	19.77	19.94	20.09	19.47
Crude fat	4.52	4.98	5.29	6.05	6.15	6.32
Crude fibre	5.20	4.58	4.15	3.85	3.62	3.25
Total ash	6.61	6.56	5.87	5.60	5.55	5.35
Nitrogen free extract	64.15	64.23	65.02	64.41	65.19	65.61
ME (kcal/kg DM)	3080.8	3113.2	3186.9	3197.5	3227.4	3254.8

ME = Calculated Metabolisable energy (Janssen *et al.* 1979)

3.2 *Performance characteristics (starter and finisher phases)*

The performance characteristics of the starter and finisher broilers are shown in Tables 5 and 6 respectively. The final weight (183.28g/bird) of birds fed on diet F during the starter phase and the mean value (968g/bird) obtained for the same birds during the finisher phase was significantly lower ($p < 0.05$) than other diets. Total weight gain and feed intake of the birds decreased ($p < 0.05$) with the increment of fermented MKC percentage in the diets, except for birds on treatment B whose weight gain during the starter phase (123.90g/bird/week) was higher than all other treatment diets, but not statistically different ($p < 0.05$) from the value (123.16g/bird/week) of the control diet. The weight gain (123.61, 123.90 and 112.54 g/bird/week) and feed intake (302.85, 301.29 and 284.83 g/bird/week) of birds fed on diets A, B, and C (0, 20, and 40% replacement value for maize) respectively were significantly higher ($p < 0.05$) than other diet treatments at the end of the 4th week (starter phase). While, at the end of the 8th week (finisher phase) of the experiment, the weight gain of broilers fed on diets A (444 g/bird/week) and B (442 g/bird/week) were significantly higher ($p < 0.05$) than that obtained for birds fed on diet C (396 g/bird/week) and diet D (374 g/bird/week). The values (196 g/bird/week) obtained for the weight gain of birds fed on diet F was significantly lower ($p < 0.05$) than all other treatments. The reduction in feed intake of the broilers may be associated with the residual anti-nutrients; particularly tannins which are inherent in mango kernel and give it a dry, pickery and astringent sensation in the mouth (Joslyn, 1970; Joseph and Abolaji, 1997). Apata (1990) reported that plants rich in tannins and oxalates are poisonous to humans and animals.

Table 5: Performance characteristics of starter broiler chickens fed on diets containing graded levels of mixed-culture (*A. niger* and *P. chrysogenum*) fermented "Oori" MKC

Parameters	**Dietary Treatments**						
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)	SEM
Initial weight (g/bird)	31.84	30.54	41.97	41.62	37.70	42.00	0.94
Final weight (g/bird)	526.28	526.14	498.13	485.42	389.41	183.28	0.04
Total weight gain (g/bird)	494.45^{d}	495.60^{d}	456.16^{cd}	443.80^{c}	351.44^{b}	141.28^{a}	0.12
Weight gain (g/bird/week)	123.61^{d}	123.90^{d}	112.54^{cd}	104.55^{c}	87.86^{b}	35.32^{a}	0.07
Feed intake (g/bird/week)	302.85^{c}	301.29^{c}	284.83^{bc}	269.80^{b}	166.98^{a}	144.70^{a}	0.34
Feed conversion ratio (FCR)	2.45^{a}	2.43^{a}	2.53^{a}	2.58^{a}	2.66^{ab}	3.82^{b}	0.08
Mortality (%)	-	-	-	-	-	4.16	-

abc…. means on the same row with different superscript are significantly different ($p < 0.05$)
Values are means of three replicates determinations; SEM = Standard error of mean

The feed conversion ratio ranged between 2.45 (diet A) and 3.82 (diet F) during the starter phase, while during the finisher phase of the feeding experiment it ranged between 2.36 (diet A) and 3.79 (diet F). These results showed that the performance of the birds was better ($p < 0.05$) during the finisher phase than at the starter phase. The values of feed conversion ratio obtained for treatment F were statistically higher ($p < 0.05$) in both phases of the experiment than in the control and other treatments. The only mortality (4.16%) recorded during feeding of graded levels of the mixed-culture fermented MKC, occurred among the birds fed on diet F (100% replacement value for maize) which happened to be during the first week of the starter phase.

Table 6: Performance characteristics of finisher broiler chickens fed on diets containing graded levels of mixed-culture (A. niger and P. chrysogenum) fermented “Oori” MKC

Parameters	**Dietary Treatments**						
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)	SEM
Initial weight (g/bird)	526	526	498	485	389	183	3.29
Final weight (g/bird)	2302	2294	2082	1981	1397	968	0.09
Total weight gain (g/bird)	1776^{d}	1768^{d}	1584^{c}	1496^{c}	1008^{b}	784^{a}	2.05
Weight gain (g/bird/week)	444^{c}	442^{c}	396^{bc}	374^{bc}	252^{b}	196^{a}	1.92
Feed intake (g/bird/week)	1048^{c}	1052^{c}	967^{b}	947^{b}	802^{a}	743^{a}	0.67
Feed conversion ratio (FCR)	2.36^{a}	2.38^{a}	2.44^{a}	2.53^{a}	3.18^{ab}	3.79^{b}	0.04
Mortality (%)	-	-	-	-	-	-	-

abc…. means on the same row with different superscript are significantly different ($p< 0.05$)
Values are means of three replicates determinations; SEM = Standard error of mean

Table 7: Nutrient retention of starter broiler chickens fed on diets containing graded levels of mixed-culture (*A. niger* and *P. chrysogenum*) fermented “Oori” MKC

Parameters (%)	**Dietary Treatments**						
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)	SEM
Dry matter	77.01^{b}	73.02^{b}	70.71^{b}	69.78^{ab}	58.65^{a}	52.51^{a}	1.12
Crude protein	84.71^{c}	80.94^{c}	74.25^{bc}	69.27^{b}	58.35^{a}	54.79^{a}	0.71
Crude fat	87.47^{c}	89.23^{c}	80.56^{bc}	75.09^{b}	73.58^{b}	64.45^{a}	0.56
Crude fibre	61.27^{b}	61.89^{b}	60.05^{b}	59.93^{b}	55.60^{a}	53.78^{a}	0.30
Total ash	71.96^{b}	71.55^{b}	65.44^{ab}	65.03^{ab}	62.82^{a}	60.67^{a}	0.02

abc…. means on the same row with different superscript are significantly different ($p< 0.05$)
Values are means of three replicates determinations; SEM = Standard error of mean

3.3 *Nutrient retention (starter and finisher phases)*

The nutrient utilization by broilers fed with graded levels of mixed-culture fermented MKC during the starter and finisher phases are shown in Tables 7 and 8 respectively. Crude protein retention during the starter phase was significantly higher ($p < 0.05$) in birds fed on diets A (84.71%), B (80.94%) and C (74.25%) than other treatments. Crude protein retention was increased to 86.77% (diet A), 83.29% (diet B) and 77.29% (diet C) during the finisher phase. The results of the two retention trials at 4th and 8th weeks showed that birds on treatment F gave the least values of nutrient retention for all the parameters measured. The birds fed on diets E and F showed no significant difference ($p < 0.05$) in the retention of protein, fat, fibre and ash during the two phases of the retention trials, while the values obtained for all the nutrient parameters measured generally decreased ($p < 0.05$) with the increment of fermented MKC in the diet, irrespective of the phase. The progressive decrease in nutrient retention and increase in feed conversion ratio with the increment of fermented MKC in the diet may be attributed to the fact that the residual anti-nutrient (tannins) are probably complexing some nutrients thereby obstructing their absorption and the complete utilization of the diets. There could be de-conjugation of bile salts that resulted in poor feed conversion ratio observed in the diets containing higher inclusion levels of the fermented MKC (Table 5). An improvement in the bird's nutrient retention (p < 0.05) was observed during the finisher phase (Table 8) compared with what is obtained during the starter phase (Table 7) of the experiment. The range of values obtained during the finisher phase were dry matter (55.36 – 81.05%), crude protein (56.90 – 86.77%), crude fat (66.71 – 89.76%), crude fibre (58.77 – 63.65) and total ash (60.67 – 79.24%). The performance of the birds was better at the finisher phase than at the starter phase probably due to a better utilization of the nutrients with increase in the age of the birds, as reported by Onilude and Osho (1999). Oldale (1996) reported that the inclusion level of raw materials in animal's diet is restricted by many factors including the quality and digestibility of the materials, the species concerned and the age of the animals. Amuchie (2001) also reported that anti-nutritional factors in the diet of any livestock specie have significant negative effects on livestock production such as reduction in palatability, digestibility and utilization of ration. There could be intoxication of different classes of livestock, resulting in mortality or decreased production of animal and reduction in the quality of meat, egg and milk products due to the presence of hazardous residues. Nevertheless, there was noticeable improvement in feed intake, weight gain and feed conversion ratio reported in the present work compared to the results obtained in previous works using raw mango seed kernels (Joseph *et al*., 1995) and cooked mango seed kernels (Joseph and Abolaji, 1997) in broilers rations.

Table 8: Nutrient retention of finisher broiler chickens fed on diets containing graded levels of mixed-culture (*A. niger* and *P. chrysogenum*) fermented "Oori" MKC

Parametes (%)	**Dietary Treatments**						
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)	SEM
Dry matter	81.05^{c}	80.86^{c}	78.93^{c}	75.52^{bc}	62.43^{b}	55.36^{a}	2.09
Crude protein	86.77^{c}	83.29^{c}	77.29^{bc}	71.36^{b}	59.27^{a}	56.90^{a}	0.05
Crude fat	89.76^{c}	88.90^{c}	83.33^{bc}	82.15^{b}	73.05^{ab}	66.71^{a}	0.08
Crude fibre	63.65^{b}	61.45^{ab}	63.60^{b}	63.21^{b}	60.84^{ab}	58.77^{a}	0.97
Total ash	77.02^{c}	79.24^{c}	72.44^{ab}	68.03^{b}	62.82^{a}	60.67^{a}	1.07

abc…. means on the same row with different superscript are significantly different (p< 0.05) Values are means of three replicates determinations; SEM = Standard error of mean

The improvement in the bird's general performance may be attributed to the fermentation process. Possibly, the synergistic activities of the myriad of enzymes produced by *Aspergillus niger* and *Penicillium chrysogenum* during the mixed-culture fermentation caused alterations in the chemical composition of the MKC; which had in turn interfere positively with the development of the birds (Table 9). Zyla *et al*., (1999) reported that enzymes produced during fermentation gave a synergistic effect leading to better utilization of nutrients.

3.4 *Carcass characteristics (finisher phase)*

The carcass characteristics of broilers fed on diets containing graded levels of fermented MKC are shown in Table 9. The carcass weight was significantly higher (p < 0.05) in birds fed on diets A (1.74kg) and B (1.61kg), while, the value obtained for birds fed on diet F (0.51kg) was significantly lower (p < 0.05) than other treatments except diet E. No significant differences (p < 0.05) were observed in percentage bled weight, head, neck, wing, shank, lung, spleen, bile, proventiculus, pancrease, bone, muscle and abdominal fat. Most of the carcass parameters measured decreased progressively with increase in inclusion level of the fermented MKC. The dressed carcass percentage of birds fed on diet F differ significantly (p < 0.05) from others, The gizzard**,** thigh and drum stick were significantly lower (p < 0.05) in birds fed on diets E and F while, the empty crop, liver, heart and kidney of the same birds on diets E and F increased significantly (p < 0.05) at higher levels of fermented MKC inclusion (Table 9).

Rexen (1981) reiterated in his findings that biodegradation brings about changes in carcass parameters as observed in this study. The differences observed in the weights of some internal organs and carcass parameters (Table 9) may be associated with the levels of feed intake, the residual anti-nutrients in the fermented MKC, and the chemical composition (including the metabolic products of fermentation) of the diets available to the birds. Low gizzard weight had been associated with high tannin consumption in broilers (Mustapha and Oguntona, 1990). Although, the abdominal fat of the treatment diets were not significantly different from the control diet, the range of values (1.17-1.89%) obtained show that the rate of absorption of dietary fat through binding of fibre and other nutrients to bile in the small intestine had lead to a mop-up of bile in the enterohepatic system (Peterson and Aman, 1991). The sprawl and bow-legs abnormalities that manifested during the finisher phase in treatments E and F (Plate 1e and f) may be associated with insufficiency of some vitamins like biotin, cobalamin (B12), panthotenic acid and others which at the highest levels of replacement (45%) with the fermented MKC may be deficient (Saif, 2003). The interaction among these vitamins or their unbalanced combination with minerals may be responsible for metabolic abnormalities and leg deformation. The residual phytate in the fermented MKC may also have contributed to the legs abnormalities (Plate 1f). Phytate had been reported to complex with dietary essential minerals in legumes and cereals, thus rendering them poorly available to monogastric animals (Oluremi *et al*., 2007).

Table 9: Carcass characteristic of the broiler chickens fed on diets containing graded levels of mixed-culture (*A. niger* and *P. chrysogenum*) fermented "Oori" MKC (finisher phase)

Carcass Parameters	**Dietary Treatments**						
	A (0%)	B (20%)	C (40%)	D (60%)	E (80%)	F (100%)	SEM
Carcass weight (kg)	1.74^{c}	1.61^{c}	1.47^{b}	1.34^{b}	0.78^{ab}	0.51^{a}	1.20
Bled weight percentage *	98.13^{a}	98.02^{a}	98.84^{a}	97.52^{a}	97.60^{a}	97.25^{a}	0.95
Dressed percentage *	66.25^{bc}	68.04^{c}	67.15^{bc}	65.43^{b}	66.29^{bc}	60.34^{a}	0.46
Head *	2.75^{a}	2.71^{a}	2.73^{a}	2.70^{a}	2.60^{a}	2.53^{a}	0.02
Neck *	2.56^{a}	2.64^{a}	2.57^{a}	2.49^{a}	2.11^{a}	2.11^{a}	0.09
Breast *	8.61^{b}	8.75^{b}	9.07^{b}	6.93^{ab}	6.62^{a}	6.16^{a}	1.34
Thigh *	6.71^{b}	7.15^{b}	6.71^{b}	6.48^{b}	4.09^{a}	3.75^{a}	0.26
Drum stick *	7.71^{b}	6.48^{b}	6.84^{b}	6.75^{b}	5.00^{a}	4.49^{a}	0.06
Wing *	5.50^{a}	5.12^{a}	5.06^{a}	5.01^{a}	4.65^{a}	4.36^{a}	0.02
Shank *	3.87^{a}	3.31^{a}	3.16^{a}	3.08^{a}	3.29^{a}	3.06^{a}	0.08
Liver *	2.10^{a}	2.43^{a}	2.46^{a}	2.80^{a}	3.92^{b}	4.45^{b}	0.04
Lung *	0.79^{a}	0.81^{a}	0.80^{a}	0.87^{a}	0.72^{a}	0.89^{a}	0.02
Heart *	0.48^{a}	0.50^{a}	0.54^{a}	0.71^{b}	0.71^{b}	0.78^{b}	0.00
Kidney *	0.35^{a}	0.43^{a}	0.77^{b}	0.81^{b}	0.96^{bc}	1.46^{c}	0.05
Spleen *	0.16^{a}	0.16^{a}	0.14^{a}	0.14^{a}	0.13^{a}	0.10^{a}	0.21
Pancrease *	0.39^{a}	0.39^{a}	0.36^{a}	0.36^{a}	0.37^{a}	0.35^{a}	0.06
Proventiculus *	0.78^{a}	0.72^{a}	0.79^{a}	0.74^{a}	0.70^{a}	0.70^{a}	0.03
Bile *	0.09^{a}	0.08^{a}	0.08^{a}	0.07^{a}	0.07^{a}	0.06^{a}	0.02
Empty gizzard *	3.91^{a}	3.91^{a}	3.89^{a}	3.86^{a}	3.77^{b}	3.75^{b}	0.04
Empty Crop *	0.30^{a}	0.49^{ab}	0.45^{ab}	0.50^{ab}	0.64^{b}	0.64^{b}	1.09
Small intestine *	2.89^{a}	3.48^{a}	3.75^{ab}	4.23^{ab}	5.02^{ab}	8.48^{b}	0.32
Abdominal fat**	1.89^{a}	1.82^{a}	1.74^{a}	1.20^{a}	1.17^{a}	1.25^{a}	0.23
Bone**	29.75^{a}	29.34^{a}	30.12^{a}	30.05^{a}	30.07^{a}	30.94^{a}	0.10
Muscle (Lean meat)**	68.36^{a}	68.84^{a}	68.14^{a}	68.75^{a}	68.76^{a}	67.81^{a}	2.07

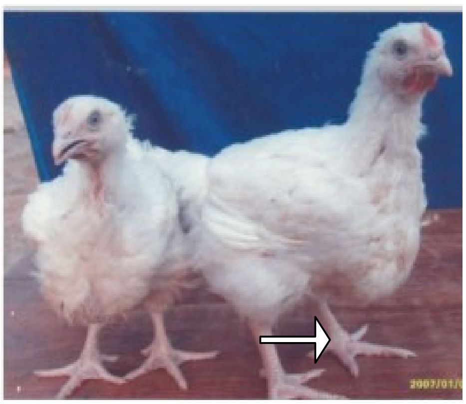
* = Percentage computed as a ratio of live weight; ** = Percentage computed as a ratio of carcass weight
abc…. means on the same row with different superscript are significantly different ($p < 0.05$)
Values are means of two replicates determinations; SEM = Standard error of mean

a) **0% MKC Replacement for maize (Diet A)**

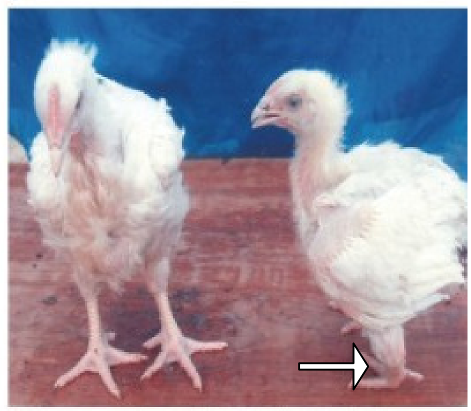
b) 20% MKC Replacement for maize (Diet B)

c) 40% MKC Replacement for maize (Diet C)

d) 60% MKC Replacement for maize (Diet D)



e) 80% MKC Replacement for maize (Diet E)



f) 100% MKC Replacement for maize (Diet F)

Plate 1(a-f): Photographs of the broilers after feeding with graded level of mixed-culture (*A. niger* and *P. chrysogenum*) fermented MKC for eight weeks.

⇨ = sprawl and bow-legs (leg deformation)

3.0 Conclusion

The bird's performance and carcass characteristics observed in this study that up to 60% of *Aspergillus niger and Penicillium chrysogenum* (mixed-culture) fermented "Oori" mango kernel cake could be used to replace maize in broiler's diet without deleterious effect.

Acknowledgements

The authors express their sincere appreciation to the University of Ilorin Authority for the Staff Development Award granted for this research work.

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