Growth performances of broiler chickens fed on molasses enriched cassava fibre based-diet supplemented with enzymes

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1 ABSTRACT

This study was designed to evaluate the effects of molasses enriched cassava fibre based-diet supplemented with fibrolytic enzymes on growth performances of broilers. Chicks were fed for 07 weeks on feed in which 50% of maize was substituted with cassava fibre enriched with molasses and supplemented with enzyme. These chicks were, compared to chicks fed on the control ration without cassava fibre and any supplement. From day 49, faeces were collected for 3 consecutive days to evaluate the digestibility of feed components. The results showed that the ration supplemented with enzyme ($R_{50}E$) induced the highest digestibility of organic matter, nitrogen, NDF and crude fibre. The highest ($p<0.05$) live weight and weight gain was recorded with the same ration. While, the inclusion of 2% molasses ($R_{50}M_2$) decreased ($p<0.05$) weight gain and live weight. No significant effect was observed between treatment groups for feed intake and feed conversion ratio. The cost of production of live weight decreased significantly ($p<0.05$) with cassava fibre in the ration compared to the control treatment. No significant ($p>0.05$) difference was recorded between treatment groups for carcass characteristics, digestive organs and hematological parameters, except for the length of the intestine and blood platelets that increased ($p<0.05$) with enzyme ($R_{50}E$) and molasses supplemented with enzyme ($R_{50}M_2E$) respectively. The serum content in ALT, urea, total cholesterol and LDL-cholesterol decreased while total protein and HDL-cholesterol increased with the inclusion of enzyme in the ration. The ration enriched with molasses increased LDL-cholesterol and decreased serum content in creatinine and total protein. It was concluded that fibrolytic enzymes improve digestion of cassava fibre based-feed, growth performance and reduce the cost of production of broilers.

2 INTRODUCTION

Maize does not contain any specific anti-nutritional factors and is generally incorporated in poultry diet at the rate of 60 to 70%. This cereal is generally expensive and its production is still very low in Africa where it is one of the most important staple food for humans (Kana et *al*., 2015; Durume et *al*., 2015; Nortey et *al*., 2015). This justifies the interest in the search for other energy sources that can partially or totally replace maize in animal feed in order to reduce the cost of production and avoid competition between human and animals for maize. Tropical countries produce large quantities of alternative products, including cassava tubers, with world production estimated at 277 million tons in 2018 and 40 million tons in sub-Saharan Africa (FAO, 2020). Cassava production is steadily growing, easy to cultivate and resistant to harsh environmental conditions (Ukechukwu, 2008). It has an energy value (3154-3488 Kcal of metabolic energy/Kg MS) comparable to that of maize and may be used as a substitute for maize in the diet of broiler chickens. Studies revealed that 75% maize can be substituted with cassava flour (Mafouo et *al*., 2011) and 50% maize with cassava fibre in broiler diet without any negative effect on production performances (Kana et *al*., 2014; 2015). The incorporation of cassava flour and its by-products in animal feed is limited due to it powdery nature after grinding, low protein (2 - 2.5%), lipid (0.4 - 0.7%) and cyanide (ANF) contents (IFAD, 2008; Mafouo et *al*., 2011; Kana et *al*., 2015). These factors sufficiently justify the search for ingredients with agglomerating properties such as molasses, which some studies have demonstrated its use in poultry rations at a level less than 5% (Anaïs et *al*., 2013). Le Dividich et *al*. (1975) reported that molasses could be included in monogastric rations as a palatability factor at a level between 2 and 3%. Due to its viscous nature, it could reduce the powdery appearance of the cassava meal in the rations. Cassava and its by-products are very rich in fibre as compared to maize. Fibrolytic enzymes are capable of degrading these fibres and making the nutrients contain available to monogastric animals for better growth. This study was designed with general objective to promote the use of locally, available and less expensive feed resources like cassava by-product in animal nutrition in order to avoid competition between human and animal for maize.

3 MATERIALS AND METHODS

3.1 Area of study: The experiment was conducted at the poultry unit of the Teaching and Research Farm of the University of Dschang (UDs), Cameroon. This farm is located at latitude 05°25 North and longitude 10°25 East in the western highland of Cameroon. The climate of the study area is characterized by average daily temperature of 21°C. The annual rainfall is between 1500 mm and 2000 mm with the average relative humidity of 76%.

3.2 Cassava fibre and enzyme: Cassava fibre used as source of energy was provided by the Pilot Incubation Center (CIP), Douala Cameroon. The enzyme (EnziBlend plus®) was bought at the local market. EnziBlend Plus® includes a wide range of specific enzyme activities that specifically targets non-starch polysaccharides and non-digestible protein fractions of feed.

3.3 Animals: A total of 280 day-old chicks of Cobb 500 strain were randomly assigned to 20 experimental units of 14 chicks per unit and replicated 4 times for a duration of 49 days. The density on litter was 20 chicks per m² at the starter phase and 10 chickens per m² at the finisher phase. Vaccines were administered to the birds in drinking water against the Newcastle disease (HitchnerB1®) and Infectious Bronchitis (H120®) on the 7th day and recalled on the 18th day of age. Vaccine against the Gumboro disease (IBAGumboro®) was administered to the birds on the 11th day of age. Coccidiosis prevention was done using an anticoccidian (Vetacox®) and vitamin (Amintotal®) was administered three days per week in drinking water. An anti-infectious (Nephroseptic®) and an antibacterial (Enrofloxacyn® and Trisulfin®) was administered for infectious prevention during the first week of study.

3.4 Experimental diets and design: Both at the starter and the finisher phase, a control diet was formulated (Tables 1 and 2) with maize as the main energy source (R0). Four other diets were formulated by substituting 50% maize with cassava fibre (R_{50}), enriched with 2% molasses

($R_{50}M_2$), supplemented with 0.1% of enzyme ($R_{50}E$) and the combination of molasses and enzyme ($R_{50}M_2E$). Each of the 5 experimental diets was fed to 56 birds in a completely randomized design with 4 replicates per treatment. Birds were fed *ad libitum* throughout the trial.

Table 1: Composition of the experimental rations at the starter phase

Ingredients	**R_0**	**R_{50}**	**$R_{50}M_2$**	**$R_{50}E$**	**$R_{50}M_2E$**
Maize	50	25	24	25	24
Wheat bran	13.5	9	9	9	9
Cassava fibre	0	25	24	25	24
Cotton seed meal	4.5	7	7	7	7
Soybean meal	21	23	23	23	23
Oyster shell	1	1	1	1	1
Fish meal	5	5	5	5	5
Premix 5%*	5	5	5	5	5
Molasses	0	0	2	0	2
Total	100	100	100	100	100
Calculated chemical composition and Cost of feed					
Metabolisable energy (kcal /kg)	2955.15	2867.03	2870.10	2867.03	2870.10
Crude Proteins (%)	23.39	22.64	22.65	22.64	22.65
Energy/Protein	126.37	126.64	126.72	126.64	126.72
Lysine (%)	1.41	1.41	1.40	1.41	1.40
Methionine (%)	0.49	0.46	0.46	0.46	0.46
Calcium (%)	1.17	1.18	1.22	1.18	1.22
Non-phytate phosphorous (%)	0.56	0.53	0.60	0.53	0.60
Fat (%)	2.01	1.86	1.83	1.86	1.83
Cost per kg of feed (FCFA)	258.88	222.80	221.30	227.80	226.30

*Premix 5%: Crude protein = 40%, Lysine = 3.3%, Methionine = 2.40%, Calcium = 8%, Phosphorous = 2.05%, Metabolisable energy = 2078Kcal/Kg.
R_0 = 100% of maize, R_{50} = maize + cassava fibre (1/1), $R_{50}M_2$= R_{50} + 2% molasses, $R_{50}E$ = R_{50} + Enzyme, $R_{50}M_2E$ = $R_{50}M_2$+Enzyme.

Table 2: Composition of the experimental rations at the finisher phase

Ingredients	R_0	R_{50}	$R_{50}M_2$	$R_{50}E$	$R_{50}M_2E$
Maize	60	30	29	30	29
Wheat bran	12	3	3	3	3
Cassava fibre	0	30	29	30	29
Cotton seed meal	1	5	5	5	5
Soybean meal	16	21	21	21	21
Oyster shell	1	1	1	1	1
Fish meal	5	5	5	5	5
Premix 5%*	5	5	5	5	5
Molasses	0	0	2	2	0

Total	100	100	100	100	100
Calculated chemical composition and Cost of feed					
Metabolisable energy (kcal /kg)	3000.90	3031.34	3034.40	3031.34	3034.40
Crude Proteins (%)	20.15	20.44	20.45	20.44	20.45
Energy/Protein	148.93	148.33	148.42	148.33	148.42
Lysine (%)	1.21	1.29	1.28	1.29	1.28
Methionine (%)	0.45	0.43	0.43	0.43	0.43
Calcium (%)	1.16	1.16	1.21	1.16	1.21
Non-phytate phosphorous (%)	0.53	0.45	0.51	0.45	0.51
Fat (%)	3.18	1.78	1.74	1.78	1.74
Cost per of feed (FCFA)	256.40	223.10	221.60	228.10	226.60

*Premix 5%: Crude protein = 40%, Lysine = 3.3%, Methionine = 2.40%, Calcium = 8%, Phosphorous = 2.05%, Metabolisable energy = 2078Kcal/Kg.
R_0 = 100% of maize, R_{50} = maize + cassava fibre (1/1), $R_{50}M_2$= R_{50} + 2% molasses, $R_{50}E$ = R_{50} + Enzyme, $R_{50}M_2E$ = $R_{50}M_2$+Enzyme.

3.5 Data collection: Data on feed intake and weight gain were collected weekly. Weight gain was obtained by the difference between two consecutive weekly weights. Feed conversion ratio was obtained by dividing the total feed intake per bird by total weight gain. The cost of production of kilogram of weight gain was obtained by multiplying the cost of kilogram of feed by the feed conversion ratio. At 49 days of age, 10 birds per treatment were randomly selected for carcass evaluation. The birds were fasted for 24 hours, weighed and slaughtered to evaluate carcass yield, relative weight of liver, heart, pancreas, gizzard, head and legs as proceeded by Kana et *al.* (2015). The intestine was measured with the cut done from the start of the duodenal loop to the end of the cloaca. The density of the intestine was calculated as the ratio of the weight/length of the intestine. During the carcass characteristics evaluation, blood was collected in 02 test tubes, one of which contained an anticoagulant was used for quantification of red and white blood cells, haemoglobin, haematocrit and platelets using Genus automatic haematometer, model K-T 6180. Blood without anticoagulant was used for the analysis of aspartate aminotransferase, alanine aminotransferase, total cholesterol, HDL-cholesterol, creatinine, urea, triglycerides, total protein and albumin as indicated in the Chronolab® Kits package. Globulins were calculated as recommended by Abdel-Fattah et *al.* (2008): Globulins = serum total protein - albumin.

3.6 Digestibility of feed components: At 49 days of age, two broiler chickens per replicate were selected and transferred in the cages. A 3-days acclimatization was allowed before a 3-day collection of faeces. Faecal dropping were collected between 8:00 and 8:30 am for a periods of 3 days. Daily droppings from each cage were weighed fresh and oven dried at 60°C until constant weight. The faeces from each replicate were pooled together, ground and use for the determination of dry matter (DM) and organic matter (OM) according to the procedure of A.O.A.C (1990), crude cellulose (CC) by the Scheerer method, crude protein by the Kjedhal method and neutral detergent fibre (NDF) by the Van Soest et *al.* (1991) method. The apparent digestibility (aDC) of nitrogen, NDF, OM and CC were calculated according to the following formula:

$$aDC= (\text{Feed intake (g)}-\text{Faeces (g)})/(\text{Feed intake (g)})\times 100$$

3.7 Statistical analysis: Data on feed intake, live weight, weight gain, feed conversion ratio, carcass characteristics, nutrient digestibility, cost of production, hematological and biochemical parameters were summited to one-way analysis of variance (ANOVA). In case of statistical difference, means were compared by the Duncan's multiple range test at 0.05 threshold (Vilain, 1999). Statistical Package for Social Sciences (SPSS 21.0) software was used for the statistical analysis.

4 RESULTS

4.1 Digestibility of feed components: Table 3 shows that the apparent digestibility of OM (66.43%), nitrogen (58.05%) and crude fibre (59.73%) were improved in the cassava fibre based-diet supplemented with enzyme ($R_{50}E$) compared to all other treatments. The apparent digestibility of NDF decreased with molasses free enzyme ($R_{50}M_2$) compared to all other rations while the incorporation of enzyme in feed substantially improved the digestibility of NDF in molasses-enriched feed ($R_{50}M_2E$) for about 35.5% compared to the molasses free enzyme feed.

Table 3: Variation in feed components digestibility with respect to treatments

Parameters	Treatments				
	R_0	R_{50}	$R_{50}M_2$	$R_{50}E$	$R_{50}M_2E$
DM ingested (g)	163.21	182.26	186.73	178.66	167.98
DM excreted (g)	76.35	89.77	89.29	81.82	91.07
aDC DM (%)	53.22	50.75	52.18	54.20	51.73
OM ingested (g)	146.13	157.40	158.59	154.29	142.66
OM excreted (g)	54.45	58.06	58.67	50.05	58.37
aDC OM (%)	62.74	63.11	63.00	67.56	59.09
CC ingested (g)	5.70	8.63	5.14	8.46	4.62
CC excreted (g)	3.34	7.04	5.11	3.41	3.57
aDC CC (%)	41.44	18.42	0.64	59.73	22.83
N ingested (g)	3.62	3.40	3.30	3.33	2.97
N excreted (g)	0.84	0.76	0.72	0.70	0.73
aDC N (%)	76.90	77.54	78.07	79.05	75.22
NDF ingested (g)	81.98	113.66	71.84	111.41	64.62
NDF excreted (g)	36.42	60.08	52.29	52.33	37.46
aDC NDF (%)	55.57	47.14	27.20	53.03	42.03

R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme ; DM= dry matter ; OM= organic matter; CC= Crude cellulose ; N= Nitrogen ; NDF= Neutral detergent fibre ; aDC = apparent digestibility coefficient.

4.2 Growth performances: Table 4 shows that, enzyme had no significant ($p > 0.05$) effect on growth parameters at the starter phase. The same observation was noticed for feed intake and feed conversion ratio at the finisher phase and throughout the trial. However, although not significant, feed conversion ratio tends to decrease with molasses-free diet supplemented with enzyme ($R_{50}E$). The supplementation of the cassava fibre based-diet with enzyme induced a significantly higher live body weight and weight gain ($p < 0.05$) at the finisher phase and throughout the study period compared to the molasses-enriched rations supplemented or not with enzyme. However, molasses-enriched ration without enzyme (R50M2) induced a significant ($p < 0.05$) decrease in body weight and weight gain compared to the same ration supplemented with enzyme and the rations without enzyme and molasses (R0 and R_{50}).

Table 4: Growth performances of broiler chickens as affected by molasses and fibrolytic enzymes

Period (Days)			Treatments			*p*
	R_0	R_{50}	$R_{50}M_2$	$R_{50}E$	$R_{50}M_2E$	
			Feed intake (g)			
1-21	1173.27±121.38	1246.98±150.49	1149.18± 84.57	1114.64± 53.54	1162.95± 96.34	*0.523*
22-49	3759.24±334.94	3853.08±137.85	3640.12±108.26	3805.61±152.75	3890.76±130.88	*0.424*
1-49	4932.51±317.18	5100.06±265.50	4789.31±169.50	4920.25±202.80	5053.71±137.89	*0.371*
			Live weight (g)			
1-21	476.84 ± 27.43	480.19± 50.20	455.64 ± 45.09	487.63± 14.79	472.91 ± 26.69	*0.767*
1-49	1899.08± 74.76 ^{ab}	1895.60± 48.71 ^{ab}	1786.60±56.11^{c}	1980.10±50.67^{a}	1877.60± 59.42^{b}	*0.006*
			weight gain (g)			
1-21	433.15 ± 27.43	436.50± 50.20	411.95± 45.09	443.94 ± 14,79	429.22 ± 26.69	*0.767*
22-49	1425.49 ± 77.04 ^{ab}	1425.64± 29.95 ^{ab}	1327.14±43.66^{c}	1496.20±48,28^{a}	1402.35±60.41^{bc}	*0.009*
1-49	1855.39 ± 74.76 ^{ab}	1851.91±48.71 ^{ab}	1742.91±56.11 ^{c}	1936.41±50,67 ^{a}	1833.91±59.42 ^{b}	*0.006*
			Feed conversion ratio			
1-21	2.70 ± 0.16	2.88 ± 0.41	2.80± 0.15	2.51± 0.09	2.71 ± 0.11	*0.222*
22-49	2.65 ± 0.35	2.70 ± 0.06	2.75± 0.13	2.54± 0.10	2.78 ± 0.06	*0.406*
1-49	2.66 ± 0.25	2.74 ± 0.07	2.75± 0.17	2.54± 0.07	2.76 ± 0.10	*0.227*

a, b,c: means with the same letters on the same row are not significantly different ($p > 0.05$)
R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme

4.3 Carcass characteristics: Carcass yield and relative weight of organs of broiler chickens were not significantly ($p > 0.05$) affected irrespective of the treatment. However, there was an upward trend in carcass yield, relative weight of organs and abdominal fat with 50% maize substituted with cassava fibre enriched or not with molasses and supplemented or not with the enzyme compared to the control ration (Table 5).

Table 5: Variation in carcass yield and relative weight of organs of broilers as affected by differents treatments

Carcass Characteristics (%LW)			Treatments			*p*
	R0	R_{50}	$R_{50}M_2$	$R_{50}E$	$R_{50}M_2E$	
Carcass yield	67.94±6.94	72.89±2.70	71.38± 1.38	72.50±1.95	70.96±4.37	*0.720*
Head	2.20± 0.22	2.29± 0.34	2.49 ± 0.22	2.29±0.25	2.40± 0.33	*0.209*
Legs	3.58± 0.55	4.08± 0.34	3.82 ± 1.17	3.67±1.02	4.03±0.64	*0.620*
Heart	0.44± 0.08	0.48± 0.05	0.48 ± 0.05	0.46±0.11	0.45± 0.09	*0.717*
Liver	1.56± 0.28	1.99± 0.38	1.95 ± 0.39	1.93±0.11	1.81± 0.22	*0.230*
Pancreas	0.18± 0.07	0.18 ±0.07	0.24 ± 0.04	0.19±0.05	0.20± 0.04	*0.156*
Abdominal fat	1.57 ±0.45	1.91± 0.79	1.85 ± 0.65	2.39±0.82	1.78± 0.70	*0,144*

R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme

4.4 Development of digestive organs: No significant ($p > 0.05$) difference was recorded between treatment groups for the relative weight of gizzard, gut weight and gut density as summarized in Table 6. Analysis of variance revealed a significant increased ($P < 0.05$) in gut length with the enzyme supplemented ration ($R_{50}E$) compared to those of broilers fed on cassava based diet without enzyme and molasses (R_{50}) and the ration enriched with 2% molasses supplemented with enzyme ($R_{50}M_2E$).

Table 6: Variation in digestive organs weight of broilers fed on molasses enriched cassava fibre based diet supplemented with enzymes

Parameters	Treatments					*p*
	R0	**R_{50}**	**$R_{50}M_2$**	**$R_{50}E$**	**$R_{50}M_2E$**	
Gizzard (%)	1.63± 0.20	1.51± 0.25	1.65 ± 0.21	1.50±0.14	1.35±0.19	*0.180*
Intestine length (cm)	199.11±19.03 [a]	188.40±17.61 [b]	197.30±14.93 [a]	206.20±13.99 [a]	180.63±19.86 [b]	*0.022*
Intestine weight (g)	2.98 ± 0.37	3.00 ± 0.96	3.69 ± 0.36	3.49 ± 0.44	3.14 ± 0.55	*0.370*
Intestine density (g /cm)	0.34 ± 0.05	0.30 ± 0.10	0.32 ± 0.03	0.33 ± 0.04	0.33 ± 0.03	*0.571*

a, b,c: means with the same letters on the same row are not significantly different (p > 0.05)
R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme

4.5 Cost of production: At the starter phase, no significant (p > 0.05) difference was recorded between treatments for the cost of feed intake. The supplementation of cassava fibre based-diets enriched or not with molasses and supplemented or not with enzyme induced a significant decrease(p < 0.05) in the cost of feed intake and the cost of production of kilogram of live weight (Table 7).

Table 7: Variation in cost of production of broilers as affected by the molasses enriched cassava fibre based diet supplemented with enzyme

Periods (Days)	Treatments					*p*
	R0	R_{50}	$R_{50}M_2$	$R_{50}E$	$R_{50}M_2E$	
Feed intake cost (Fcfa)						
1-21	303.88± 31.44	278.08 ± 33.56	253.97± 18.69	254.14± 12.21	262.83 ± 21.77	*0.060*
22-49	962.37± 85.74 [a]	859.24 ±30.74 [b]	808.11±24.03 [b]	867.68 ± 34.83 [b]	883.20±29.71 [b]	*0.005*
1-49	1266.24±81.21 [a]	1137.31±59.21 [b]	1062.08±37.56 [b]	1121.82±46.24 [b]	1146.03± 31.26 [b]	*0.002*
Production cost (Fcfa)						
1-21	700.29±40.13 [a]	640.90±90.65 [ab]	619.44±32.53 [b]	572.00 ± 20.94 [b]	612.81 ± 24.87 [b]	*0.028*
22-49	679.52±89.32	602.88±12.53	608.40±29.63	580.35 ± 21.96	631.75 ± 13.38	*0.056*
1-49	686.60±63.77 [a]	613.69±16.66 [b]	609.33±37.27 [b]	579.15± 16.45 [b]	625.78 ± 22.21 [b]	*0.011*

a, b: means with the same letters on the same row are not significantly different (p > 0.05)
R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme

4.6 Blood parameters: The supplementation of the cassava fibre based diet enriched or not with molasses with enzyme had no marked effect (p > 0.05) on blood parameters of broilers, except for platelets that increased significantly (p < 0.05) with 2% molasses and the enzyme ($R_{50}M_2E$) compared to the other rations including the control (Table 8).

Table 8: Variation in blood constituents of broiler chickens as affected by molasses enriched cassava fibre based diet supplemented with enzyme

Blood parameters	Treatments					
	R_0	**R_{50}**	**$R_{50}M_2$**	**$R_{50}E$**	**$R_{50}M_2E$**	***P***
WBC (10^3/µL)	86.22±8.54	78.73±6.73	77.17±1.69	79.05±4.90	77.73 ±8.07	*0.250*
RBC (10^6/µL)	2.66±0.47	2.21±0.56	1.92±0.44	2.42±0.42	2.05±0.34	*0.163*
HGB (g/dL)	13.03±1.74	11.10±2.18	10.60±0.40	10.35±3.10	10.40±2.03	*0.265*
HCT (%)	35.97±3.24	33.30±7.19	35.20±5.14	36.33±4.41	31.47±6.13	*0.704*
MCH (pg)	49.50±5.90	50.82±4.10	50.23±3.20	51.78±6.95	50.47±3.50	*0.969*
MCHC (g/dL)	36.18±3.56	33.52±2.54	31.93±4.78	33.30±3.07	33.10±2.39	*0.375*
PLT (fL)	55.33 ± 14.61^b	63.40 ± 23.29^b	73.00 ± 6.08^b	56.00 ± 19.13^b	118.67 ± 44.75^a	*0.013*
PCT (%)	0.08±0.02	0.11 ± 0.05	0.11 ± 0.02	0.09 ± 0.03	0.15 ± 0.05	*0.140*

a, b: means with the same letters on the same row are not significantly different (P > 0.05)
R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme ; P=Probability; MCHC= Mean corpuscular hemoglobin concentration; MCH= corpuscular mean hemoglobin; WBC= white blood cells; RBC= red blood cells; HGB= hemoglobin; HCT= hematocrit; PLT= platelets

4.7 Biochemical parameters: Results in table 9 revealed that the incorporation of molasses in cassava fibre based feed ($R_{50}M_2$) significantly ($p<0.05$) decreased serum content in total protein compared to the same ration without molasses supplemented with enzyme ($R_{50}E$) which induced the highest total protein level. The cassava fibre based diet enriched with molasses and supplemented ($R_{50}M_2E$) or not ($R_{50}M_2$) with enzyme significantly ($p<0.05$) decreased serum content in creatinine as compared to all the rations free from molasses. However, Molasses-free rations were comparables to the control ration which recorded the highest level of creatinine. The serum content in urea decreased significantly ($p<0.05$) with the substitution of 50% maize with cassava fibre enriched or not with molasses; and supplemented or not with the enzyme compared to the control ration. No significant ($p>0.05$) difference was observed between treatments for the serum content in AST. However, there was a significant ($p<0.05$) decreased in serum content in ALT with 50% substitution of maize with cassava fibre enriched or not with molasses and supplemented or not with enzyme compared to the control ration. The serum content in triglyceride increased significantly ($p<0.05$) with the incorporation of the enzyme in the ration enriched with molasses compared to all other rations. There was a significant ($p<0.05$) decreased in total cholesterol level with the substitution of 50% maize by cassava fibre supplemented ($R_{50}E$) or not (R_{50}) with enzyme compared to all other rations. HDL-cholesterol level increased significantly ($p<0.05$) with the substitution of 50% maize with cassava fibre (R_{50}) compared to bird fed on the control ration and the ration enriched with molasses without enzyme ($R_{50}M_2$). The incorporation of molasses and enzyme in feed ($R_{50}M_2E$) significantly ($p<0.05$) increase the serum content in LDL-cholesterol compared to birds fed on cassava fibre free molasses diets (R_{50}). No significant ($p>0.05$) difference was recorded between rations for serum content in albumin, globulin and albumin / globulin ratio.

Table 9: Variation in serum biochemical profile of broilers as affected by cassava fibre enriched molasses based diet supplemented with enzyme

	Treatments					
Parameters	**R0**	**R50**	**R50M2**	**R50E**	**R50M2E**	***p***
AST (IU/L)	101.06±22.54	111.13±15.82	102.03± 24.94	140.70±49.54	131.75±32.48	*0.104*
ALT (IU/L)	476.73±177.16[a]	305.41±142.92[b]	17.50±8.11[c]	25.50±9.62[c]	47.95±24.59[c]	*0.000*
Creatinine (mg/dL)	0.04±0.02[a]	0.04 ±0.02[a]	0.02 ±0.01[b]	0.04±0.02[a]	0.02 ±0.01[b]	*0.027*
Urea (mg/dL)	7.59±2.93[a]	5.93 ±1.53 [ab]	4.56±0.44[b]	5.00±2.09[b]	4.79 ±1.30[b]	*0.036*
Total Proteins (g/dL)	2.99±0.25[abc]	2.87±0.31[bc]	2.82±0.20[c]	3.26 ±0.47[a]	3.20 ±0.32[ab]	*0.043*
Albumin (g/dL)	1.44 ± 0.14	1.31±0.04	1.37±0.08	1.47±0.32	1.37±0.22	*0.527*
Globulin (g/dL)	1.55±0.17	1.57±0.29	1.45±0.25	1.79±0.35	1.83±0.43	*0.095*
A/G ratio	0.94± 0.12	0.86±0.16	0.98±0.23	0.85 ± 0.24	0.80±0.28	*0.486*
Triglycerides (mg/dL)	59.01± 7.38[b]	50.34±7.06[b]	62.53±7.44[b]	49.38±13.51[b]	103.44±27.94[a]	*0.000*
Total Cholesterol (mg/dL)	118.03±12.18[ab]	104.62±13.54[b]	118.60±17.71[ab]	104.51±17.53[b]	134.70±9.68[a]	*0.003*
HDL- Cholesterol (mg/dL)	13.96± 2.99[b]	21.92±2.85[a]	16.51±5.65[b]	17.62±5.13[ab]	17.80±3.33[ab]	*0.035*
LDL- Cholesterol (mg/dL)	114.21±8.25 [ab]	89.19±12.66 [b]	115.12±13.05[ab]	105.92±26.2[ab]	127.92±29.31[a]	*0.034*

a, b, c: means with the same letters on the same row are not significantly different (P > 0.05)
R_0 = 100% Maize ; R_{50} = Maize + cassava fibre (1/1) ; $R_{50}M_2$= R_{50} + 2% molasses ; $R_{50}E$ = R_{50} + Enzyme ; $R_{50}M_2E$ = $R_{50}M_2$+Enzyme ; P=Probability; A= albumin, G= globulin, HDL= high density lipoprotein, LDL= low density lipoprotein.

5 DISCUSSION

Supplementing rations in which maize is partially replaced by cassava fibre, with enzyme induced an increase in the digestibility of organic matter, nitrogen and crude cellulose. This result is similar to the findings of Oliaei et *al.* (2016) who fed broilers with rations containing 0, 6 and 12% of canola supplemented with 350 g of enzyme per ton of feed and concluded that the inclusion of the enzyme in the rations increased the digestibility of feed components. The apparent digestibility of NDF decreased with the molasses enrichment of the ration. The low values recorded with the molasses could be due to the laxative effect of molasses, which accelerate the digestive transit. Cassava fibre enriched with molasses induced a non-significant (p> 0.05) decrease in feed intake. This result is in contradiction with the findings of Kana et *al.* (2015) who, supplemented the ration containing cassava fibre with spirulina and recorded a non-significant increase in feed intake. The partial replacement of maize by cassava fibre in the broilers ration induced a non-significant increase in cumulative feed intake thus corroborating the results of Kana et *al.* (2014) who reported similar results by incorporating palm oil (which reduced the powdery of feed) in cassava fibres based diet. The tendency to consume less feed with enzyme could be due to the enzymatic action that facilitated the digestion of feed constituents and makes nutrients available, thus satisfying the animals' energy requirements quickly. There was a significant increase in live weight of broilers with the ration supplemented with enzyme compared to the enzyme-free molasses-enriched ration. This result is in agreement with the findings of Ehebha and Eguaoje (2018) who reported a significant increase in body weight and weight gain with the substitution of 20% maize with cassava peels meal in broilers ration. Esiegwu (2017) recorded the same trend with the substitution of 30% maize with garri (fermented and cooked cassava) in broilers ration. Kana et *al.* (2014) recorded a decrease in live weight and weight gain with the increasing level of cassava fibre in the rations of broilers supplemented with palm oil. Whereas, Kreman et *al.* (2012) found no significant effects respectively on body weight and weight gain when local hens were fed on cassava-based rations instead of maize. The decrease in weight with feed enriched with molasses can be due to the laxative effect of molasses, which accelerated the digestive transit of feed, leading to poor feed conversion ratio. No significant difference was recorded between treatments for feed conversion ratio. This result is in agreement with the findings of Essien (2017) and Ehebha and Eguaoje (2018) who recorded the same results with increasing level of full fat palm kernel in the ration and with the substitution of 20% maize with cassava peels meal in broilers ration respectively. In contrast, Kreman et *al.* (2012) recorded higher feed conversion ratio values with the substitution of maize with cassava in local chicken feed. The non-significant lower feed conversion efficiency recorded with enzyme was thought to be related to the effects of the enzyme in making the nutrients in the ration more accessible. No significant difference was recorded between treatments with respect to carcass characteristics. Esiegwu (2017) and Essien (2017) observed the same trend respectively with the substitution of 30% maize with garri (fermented and cooked cassava) and the incorporation of increasing levels of full fat palm kernel in broiler ration. With the exception of the length of the intestine that significantly increased with the enzyme compared to other treatments, no significant difference was observed between treatments with respect to the digestive organs development. This increase in the length of the intestine with the enzyme reflects an increased in the absorption area of the animal intestine, hence a better valorisation of feed due to the enzyme. The enzyme induced a significant decrease in the average cost required to produce one kilogram of live weight compared to the control ration. This result corroborates those of Mafouo et *al.* (2011) and Kana et *al.* (2014) who recorded similar trends respectively, with increasing level of substitution of maize by cassava meal and with an increasing level of substitution of maize by cassava fibres. However, Bot et *al.* (2013) recorded an increase in production cost with the substitution of 75 and 100% maize by *Parikia biglobosa* in the starter phase for about 40 and 72% respectively. The present decrease in production cost could be due to the better valorisation of the feed due to the enzyme that induced a lower feed conversion ratio. Blood is an important reflector of physiological, pathological and nutritional status of an organism (Olafedehan et *al.*, 2010; Etim et *al.*, 2014), and animals with good blood composition are likely to perform better (Etim et *al.*, 2014). With the exception of blood platelets, which increased significantly with the inclusion of molasses and enzyme in the ration, the enzyme had no effect on haematological parameters. This result contradicts the findings of Kana et *al.* (2014) who reported a decreased in haemoglobin content with the substitution of 50, 75 and 100% maize with cassava fibres enriched or not with 3% palm oil. Adeyemi et *al.* (2008) reported that the incorporation of fermented cassava by rumen filtrate in broiler chickens feed resulted in a decrease in white blood cell count. The present results corroborates the results of Akinfala and Tewe (2001) who recorded no significant effect with the incorporation of whole cassava tuber plant up to 60% in the diet of pigs. This consistency of haematological parameters could be due to the high availability of nutrients in feed related to the effect of the enzyme. Incorporation of the enzyme into the diet resulted in a decrease in serum content in ALT with no effect on serum content in AST. This result is in contradiction with that of Uchegbu et *al*. (2010) who reported no significant effect on serum content in ALT with the substitution of 20% maize with yam peel meal in broilers diet. The incorporation of the enzyme in the diet had no significant effects on serum content in albumin, globulin, albumin / globulin ratio and resulted in a significant increase in the total protein level. The present result contradicts the finding of Abdel-Fattah et *al*. (2008) who reported that the serum concentration of globulins increased significantly while A/G ratio dropped in the same way with rations containing organic acids compared to the control. Similarly, Adeyemi et *al*. (2008) reported that the incorporation of fermented cassava by rumen filtrate in broiler feed resulted in a decrease in total protein and globulin levels without significantly altering albumin levels. Kana et *al*. (2014) reported that the substitution of maize by cassava fibres did not affect the albumin/globulin ratio. Likewise, Esiegwu (2017) reported that serum protein concentration in broilers is not significantly affected when 10, 20 and 30% maize is substituted with garri in broiler feed. The present result suggest that the enzyme helped to maintain the immune response by influencing the quality and digestibility of the rations, resulting in improved protein biosynthesis in the chickens' bodies. According to Griminger (1986) and Abdel-Fattah et *al*. (2008), high globulin levels and low A/G ratio reflect better disease resistance and immune response. This study revealed a decrease in serum content in creatinine with the inclusion of molasses and a decrease in serum urea with the incorporation of enzyme in the rations. This result contradict the findings of Uchegbu et *al*. (2017) who recorded no significant effect on serum content in creatinine an urea with increasing level of plantain peelings up to 20% in broiler diets. The present results is in agreement with those of Esiegwu (2017) who reported that urea and creatinine content decreased significantly with the incorporation of garri at 10 to 30% and cassava flour in the ration. This could be attributed to poor deamination of dietary proteins. The decrease in serum content of cholesterol and LDL-cholesterol; and the increase in HDL-cholesterol recorded in this study with the incorporation of enzyme in cassava fibre based diet, contradicted the findings of Uchegbu et *al*. (2010) who reported an increase in serum content in total cholesterol with the incorporation of 10% yam peel meal in broilers ration. The results obtained could be due to the low fat content of cassava fibre and an improved nutrient bioavailability due to the effect of the enzyme.

6 CONCLUSION

The supplementation of diet in which 50% maize is replaced with cassava fibre with enzyme improve feed digestibility, growth performance and reduced the cost of production without negative effects on haemato-biochemical profile of broiler chickens. Maize can then be partially replace by cassava fibre in broilers diet supplemented with enzyme to improve growth performances and reduce the cost of production.

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