

Implications of Feeding Cassoya Diets Supplemented with Protease Enzyme on Carcass Characteristics, Gut Morphology and Ileal Viscosity of Broiler Chickens

¹Olanloye*, S. A.,¹Apata, E. S.,²Oguntoye, M. A.,³Orimogunje, A. A.,¹Mufutau, R.A. and ⁴Fafiolu, O. A.

¹Department of Animal Production, Olabisi Onabanjo University, Ayetoro Campus, PMB 0012, Ayetoro, Ogun State, Nigeria.

²Department of Animal Science, Taraba State University, Jalingo.

³Department of Animal Health Technology, Federal College of Animal Health and Production Technology, Moore Plantation, Apata, Ibadan, Oyo State, Nigeria.

⁴Department of Animal Nutrition, Centre of Excellence in Agricultural Development and Sustainable Environment (CEADESE), Federal University of Agriculture, Abeokuta, Ogun State, Nigeria.

*Corresponding author: silifat.olanloye@oouagoiwoye.edu.ng; +234-08137779130

Target Audience: Animal Scientists, Researchers, Farmers and Policy Makers

Abstract

This study evaluated the implications of cassoya based diets (mixture of cassava root meal and full-fat soybean in ratio 40:60) supplemented with protease enzyme on carcass parameters, morphometric analysis and ileal viscosity of broiler chickens. Three hundred day-old ROSS 308 broiler chickens were placed on 6 dietary treatments for 6 weeks; in 5 replicates of 10 birds each. The first, second and third treatments had cassoya inclusion levels of 0, 50 and 100 % respectively without enzyme while treatments 4, 5 and 6 had protease enzyme supplementation at 10 g/tonne. Data collected were analyzed using Analysis of Variance in a Completely Randomized Design. The result showed that final live weight, plucked weight, eviscerated weight were significantly ($p < 0.05$) higher in 0% (1736.80, 1384.00, 1280.00 and 1112.00) g and 50% (1738.60, 1386.00, 1280.00 and 1076.00)g respectively by the interaction of and enzyme supplementation). Morphometric results showed that villus height to creph depth ratio ranged from (5.00 to 5.86), (4.11 to 5.65), and (2.96 to 4.61) for duodenum, jejunum and ileum. Highest villus heights were obtained with the interaction of enzyme and cassoya diets at 0% and 50% compared to those without enzyme. Interaction effect of cassoya inclusion and enzyme supplementation significantly influenced ($p < 0.05$) the gut viscosity at 100rpm. Cassoya diet at 50 % level of inclusion with enzyme supplementation in broiler finisher diet is recommended for improvement on carcass and development of intestinal organ structure.

Keywords: Chickens, Cassava, Carcass, Gut-morphology, Viscosity, Protease enzyme

Description of Problem

Most nutrients needed for the nourishment of poultry birds for sustainability of life, growth, health and reproduction are contained in feed-stuffs the animal consumed. It has been established that feeding constitutes over 70% of the total cost of production [1] which implies that efforts to increase poultry industry productivity should be directed towards improved feed resources particularly energy sources that could replace maize during period of scarcity to ensure optimum performance of the birds. As a result of increased demand from flour millers and breweries, the price of maize has soared, resulting in a proportionate increase in feed costs. Consequently, many feed mills and poultry projects have closed down, and those remaining are operating at excess capacity. Maize accounts for about 45 to 55% of poultry feed [2]. The recent trend in the feeding of poultry is the utilization of locally available, cheap feed resources such as cassava which can comfortably replace the conventional feed ingredients when properly supplemented. Thus, to achieve maximal benefits from enzyme addition, it is necessary to ensure that the enzymes are chosen on the basis of substrates in the ingredients used in feed formulations. It was reported by [3] that efficient carcass parameters were recorded with enzyme supplementation. Also, [4] reported that enzyme supplemented diet reduced viscosity of gastro intestinal tract content and improve absorption of nutrient is linked to bile salt concentration which result in beneficial

effect in poultry [5]. This study focused on efficient supplementation of cassava to meet the nutritional needs to improve broiler chickens feed intake.

Materials and Methods

Experimental Site

The studies were carried out at the Poultry Unit of the Directorate of University Farms (DUFARMS), College of Animal Science and Livestock Production, Federal University of Agriculture, Abeokuta, Ogun-State, Nigeria. The farm is located on latitude 7°13'35.48"N and Longitude 3°26'12.38"E with an elevation of 415 feet and eye altitude of 700 feet (9). This area lies in the rainforest vegetation zone which has humid climatic condition with an average rainfall of 1,037 mm, a mean ambient temperature of about 34.7°C and yearly average relative humidity of 83%.

Experimental Materials

Cassava tubers were purchased from a private farm in Odeda Local Government while full-fat soybean grains were purchased commercially and other feed ingredients were purchased from a reputable feed mill in Abeokuta. Cassava tubers were washed in clean water, grated, screw pressed and dried with solar drier. Cassava and full-fat soya were mixed manually in ratio 40:60 respectively. Enzyme was sourced from Nutrivitas limited Ikeja, Lagos state.

The singled enzyme used was Ronoxyme^(R) proACT enzyme.

Management of Experimental Animals

A total of three hundred day-old ROSS 308 broiler chickens were purchased from AGRITED Nigeria limited. The poultry pen and the equipment were thoroughly washed and disinfected before the arrival of the chicks. The birds were raised on battery cage system. They were reared to the finisher phase (4 – 6 weeks). Routine management and medication (drug and vaccines) were observed. Feed and water were supplied to the birds *ad libitum*.

were randomly allotted to six dietary treatments. Each treatment group was further divided into five replicate groups of ten birds each in a 3x2 factorial arrangement, using Complete Randomized Design.

Experimental Diets

The experimental diets consist of six dietary *Cassoya* inclusion levels replacing 0 %, 50 %, and 100 % maize with full-fat soya with and without protease enzyme supplementation at 10 kg/tonne. Table 2 shows the six experimental diets formulated.

Experimental Design

The three hundred day-old broiler chicks

Table 1: Percentage composition of experimental diets during the starter phase (0-3weeks)

	-Enzyme			+Enzyme		
	0%	50%	100%	0%	50%	100%
Ingredients	D1	D2	D3	D4	D5	D6
Maize	41.2	20.6	-	41.2	20.6	-
FFSB	49.0	24.5	-	49.0	24.5	-
Cassoya	-	45.1	90.2	-	45.1	90.2
W/offal	5.8	5.8	5.8	5.8	5.8	5.8
Bone meal	1.0	1.0	1.0	1.0	1.0	1.0
Oyster shell	2.0	2.0	2.0	2.0	2.0	2.0
Lysine	0.1	0.1	0.1	0.1	0.1	0.1
Methionine	0.3	0.3	0.3	0.3	0.3	0.3
Premix	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
Crude protein (%)	23.26	22.66	21.23	23.26	22.66	21.23
Fat (%)	8.50	8.42	7.90	8.50	8.42	7.90
Fibre (%)	6.50	6.71	7.54	6.50	6.71	7.54
Ash (%)	8.60	8.42	8.36	8.60	8.42	8.36
NFE (%)	50.74	51.35	52.98	50.74	51.35	52.98

FFSB – full-fat soya bean. Premix composition per 2.5kg feed the following; Vitamin A (I.U.) 12,000,000, Vit. D₃ (I.U.) 2,500,000, Vit. E(mg) 40,000, Vit. K (mg) 2,000, Vit. B₁(mg) 3,000, Vit.B₂(mg)4,000, Biotin (mg) 75, Folic Acid (mg) 1,000, Niacin (mg) 50,000, D Caal.Pn (mp) 11,000, Co.(mg) 300, Cu(mg) 8,000, I (mg) 1,500 Se (mg) 120, Zn (mg) 60,000, Fe (mg) 40,000, Mn (mg) 100,000, Cl (mg) 300,000. NFE - Nitrogen free extract.

Table 2: Percentage composition of experimental diets during the finisher phase (4 – 6weeks)

	-Enzyme			+Enzyme		
	0%	50%	100%	0%	50%	100%
Ingredients	D1	D2	D3	D4	D5	D6
Maize	48.0	25.96	-	48.0	25.96	-
FFSB	36	18	-	36	18	-
Cassoya	-	42.9	85.8	-	42.9	85.8
W/offal	12	12	11	12	12	11
Bone meal	0.7	0.7	0.7	0.7	1.0	0.7
Oyster shell	2.0	2.0	2.0	2.0	2.0	2.0
Lysine	0.5	0.1	0.5	0.5	0.1	0.5
Methionine	0.2	0.3	0.2	0.2	0.3	0.2
Premix	0.3	0.3	0.3	0.3	0.3	0.3
Salt	0.3	0.3	0.3	0.3	0.3	0.3
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Analysis						
Crude protein (%)	20.34	20.01	19.57	20.34	20.01	19.57
Fat (%)	9.00	8.51	8.50	9.00	8.51	8.50
Fibre (%)	6.50	6.71	7.54	6.50	6.71	7.54
Ash (%)	8.60	8.60	10.00	8.60	8.60	10.00
NFE (%)	56.83	55.08	53.62	56.83	55.08	53.62

FFSB - full-fat soya bean. Premix composition per 2.5kg feed the following; Vitamin A (I.U.) 12,000,000, Vit. D₃ (I.U.) 2,500,000, Vit. E(mg) 40,000, Vit. K (mg) 2,000, Vit. B₁(mg) 3,000, Vit.B₂(mg)4,000, Biotin (mg) 75, Folic Acid (mg) 1,000, Niacin (mg) 50,000, D Caal.Pn (mp) 11,000, Co.(mg) 300, Cu(mg) 8,000, I (mg) 1,500 Se (mg) 120, Zn (mg) 60,000, Fe (mg) 40,000, Mn (mg) 100,000, Cl (mg) 300,000. NFE - Nitrogen free extract.

Data collection

Gut morphometry

0.5 cm portion was taken at the medium part of each of the three intestinal segments (duodenum, jejunum and ileum) and used for histological measurements. The samples were opened longitudinally, rinsed with cold saline and fixed in a buffered formalin solution. Histological analysis was done according to the procedures of [6]. The preparations were mounted between slide and strip. Intestinal villi with their crypts were, individually, separated under a dissecting microscope while the length and width of the villi were measured according to the procedures described by [7].

Gut viscosity

At the end of the experiment, the intestinal content of one birds from each replicate were exposed, collected and emptied into a sample bottle and labeled. Approximately 2 g of fresh digesta were taken from each sample using sensitive scale and diluted to a volume of 400ml pure water. Viscosity BROOKFIELD DV-E UK was used to centrifuged and determined the viscosity of the digesta following manufacturers’ calibration of 50 rpm, 60 rpm and 100 rpm respectively.

Carcass Evaluation

At the end of the feeding trial, two birds per replicate were randomly selected, weighed and slaughtered for carcass evaluation. Prior

to slaughtering the sampled birds were fasted overnight. Live weight, dressed weight, dressing percentage, cut up parts (thigh, drumstick, breast, back, wings, head, neck and shanks) and organs (gizzard, liver, lungs, kidney and abdominal fat) were excised and weighed. The weight was expressed as a percentage of the live weight as describe by [8].

Statistical Analysis

All data generated were subjected to Analysis of Variance (ANOVA) Using SAS, statistical package, [9]. Significant means were separated using Duncan' Multiple Range Test of the software package. The experimental layout was 3x2 factorial arrangements in a randomized complete design.

Results and Discussion

Proximate Analysis of Cassava and Full-fat Soya

The proximate analysis of cassava and full-fat soya used in *cassoya* diet formulation as seen in Table 3 shows that they contained 94.0% and 84.50% dry matter, 1.75 % and 34.74 % crude protein, 5.0% and 16.5% ether extract, 13% and 8% crude fibre and 1.5 % and 6.5 % ash respectively. Neutral detergent fibre, Acid detergent fibre and Acid detergent lignin for cassava were 26%, 7% and 0.59% while that of full-fat soya were 44%, 29% and 3.0% respectively.

Table 3: Proximate composition of cassava root and full-fat soybeans

Parameter	Cassava	Full-fat soybeans
Moisture (%)	6.00	15.50
Ash (%)	1.50	6.50
Ether Extract (%)	5.00	16.50
Crude fibre (%)	13.00	8.00
Dry matter (%)	94.00	84.50
NFE (%)	78.75	34.26
Crude protein (%)	1.75	34.74
ADL(%)	0.50	3.00
NDF (%)	26.00	44.00
ADF (%)	7.00	29.00
Calculated		
Metabolisable energy (kcal/kg)	3265.88	3839.76

NFE: Nitrogen free extract, ME: metabolisable energy, NDF: neutral detergent fibre, ADF: acid detergent fibre, ADL:acid detergent lignin.

Main effect of *Cassoya* inclusion and enzyme supplementation on carcass characteristics and internal organs of finishing broiler chickens

Result of carcass characteristics and internal organs are presented in Table 4. The final live weight, plucked weight, eviscerated weight and the head were significantly ($p < 0.05$) affected by *Cassoya* inclusion. Decreased in final live weight, plucked weight, dressed weight, and eviscerated weight as inclusion of *Cassoya* level increased showed the response of birds to different *Cassoya* proportion. On the other hand, head weight increased as inclusion increases which indicated that carcass weight are not directly related to cut part. Hence higher value observed in birds fed 0% and 50 % *Cassoya* revealed feed efficiency because the feed is balance for amino acid, with the use of full-fat soya which is high in lysine. According to [10], lysine plays a prominent role in meat quality by enhancing muscle pH, increasing protein deposition, and reducing the water-holding capacity. Increased in liver weight observed in birds fed diet without enzyme supplementation may be due to the fact that they were the part responsible for detoxification. The insignificant value of heart obtained in this study attests to the low cholesterol level revealed in the experimental birds.

Table 5, shows the interaction effect of *Cassoya* inclusion and enzyme supplementation on carcass characteristics of finishing broiler chicken. Final live weight, plucked weight, dressing weight, eviscerating weight, neck, shank, thigh,

breast, gizzard and abdominal fat were significantly affected ($p < 0.05$) by the interaction of *Cassoya* inclusion and enzyme supplementation. Enzyme supplementation improved carcass traits efficiently. Birds fed enzyme supplemented diet had higher values for final live weight, plucked weight, dress weight, and eviscerated weight. This result agrees with the findings of [3] who reported efficient carcass parameters with enzyme supplementation. It also supports the report of [11] that enzyme utilization improved dressing weight of poultry birds. Decrease value observed in final live weight, plucked weight and eviscerated weight of birds fed 100% *Cassoya* without enzyme supplementation could be linked to the resultant effect of higher fibre content and anti-nutritional factor in the feed as observed in performances characteristic. Higher similar value observed for thigh and breast in birds fed 0% and 50% *Cassoya* with enzyme compare to other dietary treatment is an index of superiority of broiler chickens on the diet, this could be attributed to the effect of enzyme. This present study agreed with findings of [12] and [13] that increased carcass yield by addition of enzyme in diets directly increased breast meat yield. Different opine was reported by [14] that addition of multi enzyme had no significant effect on breast, thigh and wing component increase in gizzard weight in birds fed experimental diet could be attributed to transit time used in digestion and toxin reduction in nutrient which agrees with the report of [15]. According to [16] and [17], diet with high fiber such as cassava peel has

been demonstrated to increase gizzard weight of broiler. Similarly Increased gizzard volume with increasing structural components in the diet has also been reported by [18]. The abdominal fat was higher in birds fed 0% *Cassoya* without enzyme compare to other treatments. This might be due to the presence of full fat soya in the diet and greater retention of fat. Suggesting that the main factor affecting fat deposition is diet composition. Birds on *Cassoya* diet had reduce abdominal fat which is better for human consumption as a result of it reduced fat content because everybody is after low cholesterol food, this could be due to presence of arginine in cassava root. Arginine is an essential amino acid that helps in reduced carcass fat deposition [19]. Dressing percentage (%) value obtained were higher compare to values (60-72.3%) observed by [20], but the proportion of abdominal fat (0.27-1.4%) reported is in line with this study. [21] reported a reduce range of (67-68%) dressing percentage for six weeks broiler. [22] also reported that the lower fat content of the carcass of birds fed the fibrous test diet suggests that these birds fed to meet their energy requirement with no extra energy for fat deposition.

Table 6, shows the main effects of *Cassoya* inclusion on morphology indices of finishing broiler chickens. *Cassoya* inclusion significantly ($p < 0.05$) influenced the duodenum villus height and ileum villus height to crepth ratio. Duodenum villus height values ranged from 897.50 to 1083.00 (μm). Birds fed 0% and 50% *Cassoya*

inclusion recorded the higher values for duodenum villus height while the least was obtained in 100% *Cassoya* inclusion. Morphometric analysis shows no indication of abnormality on the treatments group. The study revealed increase intestinal villi height and width in birds fed diet containing 50% *Cassoya*. This suggests efficient adaptation to high fibre diet by the experimental birds. This is in line with the report of earlier researcher [23] that diets containing high fibre were associated with enlargement of the intestinal villi in rats. Thus the increase in villi height suggests an increase in the absorptive surface area of the intestine. On the other hand, the reduction observed in birds fed 100% *Cassoya* diet may be as result of reduced feed intake and associated stress, which correlate with the findings of [24] that the villi height and crepth depth of the small intestine were decreased with a reduce feed intake. According to [25] stress can affect the physiological function of bird which may result in delayed intestinal growth.

Table 7 showed that the interaction between *Cassoya* inclusion and enzyme supplementation significantly influenced all measured morphological parameters. Birds fed diets with lower *Cassoya* inclusion supplemented with enzymes had the greatest villus height and villus height to crepth ratio in the duodenum and jejunum. Conversely, birds fed a diet with the highest *Cassoya* inclusion without enzyme supplementation had the lowest values for these measurements. Ileum villus height was highest in birds fed diets with lower cassava

inclusion supplemented with enzymes. The significant increased effect obtained on intestinal morphology of duodenum villus height and illium crepth ratio in birds fed enzyme supplemented diet could be due to complementary effect of exogenous enzyme on endogenous enzyme which directly affect the gut content and could be the major reason behind better digestibility performance in those fed enzyme supplemented diets. According to [26] supplementation of enzymes improves morphology status in gut and immunological status in broiler chickens.

Table 4: Main effect of *Cassoya* inclusion and enzyme supplementation on carcass characteristics of finishing broiler chickens (4-6 weeks)

supplementation Parameters	<i>Cassoya</i> inclusion				Enzyme		
	0%	50%	100%	SEM	- Enzyme	+Enzyme	SEM
Final live weight(g/bird)	1666.40 ^a	1642.30 _a	1226.10 _b	19.28	1418.07 _b	1605.15 ^a	43.21
Plucked weight(g/bird)	1346.00 ^a	1289.10 _a	1003.20 _b	31.75	1123.40 _b	1302.00 ^a	25.93
Dressing weight(g/bird)	1227.00	1166.10	906.00	27.32	1029.89 _b	1198.70 ^a	22.31
Eviscerated weight(g/bird)	1013.00 ^a	949.10 ^a	728.00 ^b	22.84	782.12 ^b	1011.40 ^a	18.64
Dressing percentage	73.62	71.00	73.89	3.09	75.57	74.94	2.70
Cut part (%live weight)							
Neck	3.13	2.98	2.94	0.211	2.73 ^b	3.30 ^a	0.17
Shank	4.04	4.41	4.29	0.12	4.23	4.27	0.09
Head	2.47 ^b	2.83 ^a	3.06 ^a	0.10	2.90	2.68	0.08
Drumstick	9.12	9.18	8.70	0.27	8.89	9.11	0.22
Thigh	9.85	9.21	8.76	0.31	8.42	9.82	0.32
Breast	16.33	15.03	14.70	0.78	14.29	15.72	0.64
Back	13.95	14.79	13.26	0.74	13.99	14.01	0.60
Wing	7.89	7.34	7.74	0.24	7.68	7.63	0.19
Organs weight (%live weight)							
Gizzard	1.77	1.60	1.57	0.08	1.47	1.55	0.07
Liver	1.91	1.82	1.92	0.08	1.98 ^a	1.78 ^b	0.06
Heart	0.46	0.46	0.45	0.02	0.46	0.45	0.02
Lung	0.42	0.40	0.46	0.03	0.43	0.43	0.02
Intestinal weight	6.49	7.32	7.63	0.47	7.56	6.73	0.38
Spleen	0.14	0.12	0.12	0.01	0.12	0.13	0.01
Abdominal fat	1.87	0.88	0.96	0.36	1.47	1.01	0.21
Proventriculus	0.52	0.49	0.53	0.03	0.52	0.50	0.03

^{abc} Means on the same row having different superscripts are significantly different (P<0.05)

Table 5: Interaction effect of *Cassoya* inclusion and enzyme supplementation on carcass characteristics of finishing broiler chickens (4-6 weeks)

Parameters	-Enzyme			+Enzyme			SEM
	0%	50%	100%	0%	50%	100%	
Final live weight (g/bird)	1596.00 ^b	1546.00 ^c	1112.10 ^d	1736.80 ^a	1738.60 ^a	1340.00 ^c	27.27
Plucked weight (g/bird)	1308.00 ^a _b	1192.20 ^b _c	870.00 ^d	1384.00 ^a	1386.00 ^a	1136.00 ^c	44.91
Dressed weight (g/bird)	1099.70 ^c	1194.00 ^b	796.00 ^d	1260.00 ^a	1280.00 ^a	1054.00 ^c	38.64
Eviscerated weight (g/bird)	914.00 ^b	822.00 ^b	610.00 ^c	1112.00 ^a	1076.00 ^a	846.00 ^b	32.29
Dressing percentage	69.90	77.23	71.58	72.55	73.63	78.66	2.75
Cut part (% liveweight)							
Neck	3.17 ^{ab}	2.40 ^b	2.61 ^{ab}	3.09 ^{ab}	3.57 ^a	3.27 ^{ab}	0.21
Shank	4.00 ^b	4.18 ^{ab}	4.42 ^{ab}	3.99 ^b	4.64 ^a	4.17 ^{ab}	0.17
Head	2.56	3.07	3.08	2.39	2.61	3.05	0.14
Drumstick	8.86	9.12	8.70	9.37	9.24	8.71	0.39
Thigh	9.28 ^{ab}	8.22 ^b	8.75 ^{ab}	10.42 ^a	10.20 ^a	8.78 ^{ab}	0.56
Breast	15.03 ^{ab}	14.37 ^{ab}	13.55 ^{ab}	17.28 ^a	15.37 ^{ab}	16.51 ^{ab}	1.02
Back	13.80	15.34	12.83	14.10	14.24	13.69	1.04
Wing	7.77	7.57	7.70	8.01	7.11	7.77	0.33
Organs (%liveweight)							
Gizzard	1.93 ^a	1.64 ^{ab}	1.65 ^{ab}	1.62 ^{ab}	1.56 ^{ab}	1.48 ^b	0.12
Liver	1.99	1.93	2.01	1.82	1.70	1.82	0.11
Heart	0.49	0.44	0.44	0.43	0.48	0.46	0.03
Lung	0.45	0.38	0.46	0.40	0.42	0.46	0.04
Intestinal weight	6.84	7.69	8.14	6.13	6.95	7.12	0.66
Spleen	0.13	0.12	0.12	0.16	0.12	0.12	0.16
Abdomial fat	2.53 ^a	0.97 ^{ab}	0.90 ^{ab}	1.23 ^{ab}	0.79 ^b	1.03 ^{ab}	0.51
Proventriculus	0.53	0.51	0.52	0.52	0.49	0.53	0.47

^{abcde} Means on the same row having different superscripts are significantly different (P<0.5)

Table 8 shows that *Cassoya* inclusion had no significant ($p>0.05$) effect on gut viscosity of birds fed the experimental diet at 50rpm, 60rpm, and 100rpm. Enzyme supplementation significantly ($p<0.05$) affected the gut viscosity at 100rpm, birds fed enzyme supplemented diet had the least value of 4.33 cp compared to 6.27 cp obtained in birds fed diet without enzyme. The interaction between *Cassoya* inclusion and enzyme supplementation only affected gut viscosity significantly ($p<0.05$) at 100 rpm as seen in Table 9. Birds fed a diet with moderate *Cassoya* inclusion (50%) supplemented with enzymes had the lowest

gut viscosity. Conversely, birds fed a diet with the highest *Cassoya* inclusion (100%) without enzyme supplementation had the highest gut viscosity. Reduced value observed in ileal digesta viscosity of broilers on *Cassoya* diets with enzyme was due to enzyme activities. This corroborate the findings of [4] that enzyme supplemented diet reduced viscosity of gastro intestinal tract content, improved nutrient uptake and performance. Improve absorption of nutrient observed could also be linked to bile salt concentration effect which had beneficial result on poultry birds [5].

Table 6: Main effect of *Cassoya* inclusion and enzyme supplementation on morphology and morphometric indices of finishing broiler chickens

<i>Cassoya</i> inclusion		Enzyme supplementation							
		0	50	100	SEM	-Enzyme	+Enzyme	SEM	
Duodenum	Villus height	1083.00 ^a	1011.00 ^{ab}	897.50	30.70	901.00 ^b	1093.33 ^a	31.2	
	Crepth depth	196.00	194.00	186.00	4.20	183.33 ^b	200.67 ^a	4.70	
	Villus /crepth ratio	5.49	5.27	4.91	0.14	4.95	5.50	0.64	
Jejunum	Villus height	809.10	813.00	862.10	20.20	759.50 ^b	896.67 ^a	20.70	
	Crepth depth	190.00	168.50	178.20	4.40	168.46 ^b	189.33 ^a	4.90	
	Villus /crepth ratio	4.38	5.16	4.60	0.10	4.61	4.80	0.60	
Ileum	Villus height	682.90	716.50	638.00	21.90	601.60 ^b	756.67 ^a	22.40	
	Crepth depth	198.50	172.1	140.9	5.40	167.33	173.67	5.90	
	Villus /crepth ratio	3.44 ^b	4.17 ^{ab}	4.64 ^a	0.17	3.72 ^b	4.40 ^a	0.67	

^{ab} Means on the same row having different superscripts are significantly different ($P<0.05$)

Table 7: Interaction effect of *Cassoya* inclusion and enzyme supplementation on morphology and morphometric indices of finishing broiler chickens

		-Enzyme			+Enzyme			
Parameter	(μm)	0	50	100	0	50%	100	SEM
Duodenum	Villus height	898.00 ^c	926.00 ^c	879.00 ^c	1268.00 ^a	1096.0 ^b	916.00 ^c	31.4
	Crept h depth	176.00 ^b	184.00 ^b	190.00 ^b	216.00 ^a	204.00 ^a	182.00 ^a	4.90
	Villus /crept h ratio	5.10 ^{ab}	5.00 ^{ab}	4.68 ^b	5.86 ^a	5.48 ^{ab}	5.15 ^{ab}	0.84
Jejunum	Villus height	772.20 ^b	762.20 ^b	744.00 ^c	846.00 ^{ab}	968.00 ^a	882.00 ^a	20.9
	Crept h depth	174.00 ^b	165.00 ^b	166.40 ^b	206.00 ^a	172.00 ^b	190.00 ^a	5.10
	Villus /crept h ratio	4.63 ^{ab}	4.66 ^{ab}	4.53 ^{ab}	4.11 ^b	5.65 ^a	4.66 ^{ab}	0.80
Ileum	Villus height	581.80 ^b	647.00 ^b	576.00 ^b	784.00 ^a	786.00 ^a	700.00 ^a	22.6
	Crept h depth	200.00 ^a	172.00 ^b	130.00 ^b	197.00 ^a	172.20 ^b	151.80 ^c	6.10

Table 8: Main effect of *Cassoya* inclusion and enzyme supplementation on gut viscosity of finishing broiler chickens

Parameter	<i>Cassoya</i> inclusion			enzyme supplementation			SEM
	0%	50%	100%	-enzyme	+enzyme	SEM	
50 rpm	1.05	1.13	1.13	0.06	1.22	0.96	0.04
60 rpm	1.55	1.49	1.47	0.06	1.59	1.42	0.05
100 rpm	5.50	5.14	5.26	0.19	6.27 ^a	4.33 ^b	0.59

^{ab} Means on the same row having different superscripts are significantly different(P<0.05)

Table 9: Interaction effect of *Cassoya* inclusion and enzyme supplementation on gut viscosity of finishing broiler chickens

Parameter	-enzyme			+enzyme			SEM
	0%	50%	100%	0%	50%	100%	
50rpm	1.20	1.14	1.33	0.89	1.13	0.87	0.12
60rpm	1.72	1.57	1.50	1.38	1.43	1.44	0.10
100rpm	6.20 ^a	6.19 ^a	6.35 ^a	4.74 ^b	4.09 ^b	4.18 ^b	0.89

^{ab} Means on the same row having different superscripts are significantly different(P<0.05)

Conclusion and Application

These findings highlight the importance of enzyme supplementation in mitigating the negative effects of high fibre diets on broiler performance.

- (a) Enzymes improve nutrient utilization from *Cassoya*-based diets, resulting in better carcass characteristics and meat yield.
- (b) *Cassoya* inclusion level and enzyme supplementation independently affected the morphology of the small intestine in broiler chickens. Birds fed diets with lower cassava inclusion (0% and 50%) had greater duodenum villus height compared to those fed a diet with higher *Cassoya* inclusion (100%). Conversely, birds fed a diet with the highest *Cassoya*

inclusion had a higher ileum villus height to crepth ratio compared to those with lower inclusion.

- (c) Enzyme supplementation generally improved villus height in all intestinal segments (duodenum, jejunum, and ileum).
- (d) Enzyme supplementation can mitigate these negative effects, particularly for birds fed diets with higher *Cassoya* inclusion levels. Enzyme supplementation can lead to better overall broiler performance by improving gut health and nutrient absorption.
- (e) These findings suggest that *Cassoya* itself may not directly influence gut viscosity in broilers. However, enzyme supplementation can be

beneficial in reducing gut viscosity, particularly at higher shear rates, potentially improving nutrient passage and gut health.

References

1. Afolayan, M. O. and Afolayan, M. (2008). Nigeria Oriented Poultry Feed Formulation Software Requirements. *Journal of Applied Sciences Research* 4(11): 1596-1602.
2. Bamgbose, A. M., Ogungbenro, S. D., Obasohan, E. E., Aruna, M. B., Oteku, L. E., Ighene, U. R., Otoikhian, C. S. O. and Imasuen, J. A. (2004). Replacement value of value of maize offal /cashew nut for maize in broiler diet. *Proceedings of the 29th Annual Conference of Nigerian Society Of Animal Production(NSAP)*.219-221
3. Bharathidhasan, A. C. H., Andrasekaran, D., Natarajan, A., Ravi, R. and Ezhilvalavan, S. (2009). Effect of enzyme supplementation on carcass quality, intestinal viscosity and ilealdigestibilities of broilers to nutrient reduced diet Tamilnadu. *Journal of Veterinary and Animal Sciences* 5 (6): 239-245.
4. Maisonnier, S., Gomez, J., Chagneau, A. M. and Carre, B. (2001). Analysis of Variability in Nutrient Digestibilities in Broiler Chickens. *British Poultry Science Journal* 42:70:76.
5. Danicke, S. (2001). Interaction between cereal identity and fat quality and content in response to feed enzymes in broilers. In *Farm Animal Nutrition* (Bedford, M.R. and Partridge, G.G., Eds), CABI, Wallingford, pp.199-236.
6. Goodlad, R. A. S., Levi Lee, C. Y., Mandir, N., Hodgson, H. and Wright, N. A. (1991). Morphometry and cell proliferation in endoscopic biopsies. *Gastroenterology* 101: 1235-1241.
7. Hampson, D. J. (1986). Alteration in piglet small intestine structure at weaning. *Research in Veterinary Science* 40: 32-40.
8. BROOKFIELD DV-E UK BY AMETEK Brookfield Engineering Team, UK
9. Shahin K.A and Elazeem, F.A (2005). Effects of breed, sex and diet and their interactions on carcass composition and tissue weight distribution of broiler chickens. *Arch. Tierz., Dummerstorf* 48; (6), 612-626
10. Statistical Analysis System Institute Inc. (1999). SAS STAT Programmecary, NC: SAS institute Inc.
11. Tesseraud, S., Bouvarel, I., Collin, A., Audouin, E., Crochet, S., Seiliez, I. and Leterrier, C. 2009. Daily variations in dietary lysine content alter the expression of genes related

- to proteolysis in chicken pectoralis major muscle. *Journal of Nutrition* 139:38–43.
12. Eruvbentine, D., Dipeolu, M. A. and Oguntana, E. B. (2002). Composition of enzyme and antibiotic inclusion in diet for laying hen. *Proceedings 27th Conference of Nigeria Society for Animal Production*. March 17th, Federal University of Technology Akure, Nigeria. Pp.101-104
 13. Wang, Z. R., Qiao, S.Y., Lu, W. Q. and Li, D. F. (2005). Effects of Enzyme Supplementation on Performance, Nutrient Digestibility, Gastrointestinal Morphology, and Volatile Fatty Acid Profiles in the Hindgut of Broilers Fed Wheat-based Diets. *Journal of Poultry Sciences*. 84:875–881
 14. Alam, M. J., Howlider, M. A. R., Pramanik M. A. H. and Haque, M. A. (2003). Effect of exogenous enzyme in diet on broiler performance. *International Journal of Poultry Science* 2: 168-173.
 15. Café, M. B., Borges, C. A., Fritts, C. A. and Waldroup, P. W. (2002). Avizyme improves performance of broilers fed corn-soybean meal-based diets. *Journal of Applied Poultry Research* 11:29–33.
 16. Khempaka, S., Thongkratok, R., Okrathok, S. and Molee, W. (2014). An evaluation of cassava pulp feedstuff fermented with *A. oryzae*, on growth performance, nutrient digestibility and carcass quality of broilers. *Journal of Poultry Science* 51:71-79.
 17. Svihus, B. (2011). The gizzard function influence of diet structure and effects on nutrient availability. *World's Poultry Science Journal* 67:207-224.
 18. Meremikwu, V. N., Ibekwe, H. A. and Essien, A. (2013). Improving broiler performance in the tropics using quantitative nutrition. *World's Poultry Science Journal* 169:633 - 638.
 19. Amerah, A. M., Ravindran, V. and Lentle, R. G. (2009). Influence of insoluble fibre and wholemeal wheat inclusion on the performance, digestive tract development and ileal microbiota profile of broiler chickens. *British Poultry Science* 50:366-375.
 20. Fouad, A. M., El-Senousey, H. K., Yang, X. J. and Yao, J. H. (2012). Role of dietary L-arginine in poultry production. *International Journal of Poultry Science* 11:718–729.
 21. Havenstein, G. B., Ferket, P. R. and Qureshi, M. A. (2003). Growth, livability and feed conversion of 1957 versus 2001 broilers when fed representative 1957 and 2001 broiler diets. *Poultry Science*. 92:1500–1508.
 22. Patra, B.N., Bais, R.K.S., Prasad, R. B. and Singh, B. P. (2002).

- Performance of necked neck versus normally feathered coloured broilers for growth, carcass traits and blood biochemical parameters in tropical climate. *Asian-Australian Journal of Animal Science* 15:1776–1783.
23. Corzo, A. and Kidd, M. T. (2003). Arginine needs for chick and growing broiler. *International Journal of Poultry Science* 2:379-382.
 24. Yu, B., Tsai, C. C., Hsu, J. C., and Chiou, P.W.S. (1998). Effect of different sources of dietary fibre on growth performance, intestinal morphology and caecal carbohydrases of domestic geese. *British Poultry Science*. 39:560-567.
 25. Hu, X. F. and Guo Y. M. (2008). Corticosterone administration alters small intestinal morphology and function of broiler chickens. *Asian-australia Journal of Animal. Science* 2:1773–177
 26. Hensel, M. (2000). *Salmonella* pathogenicity island 2. *Molecular Microbiology*, 36: 1015–1023.
 27. Yaghobfar, A., Boldage, F., and Sharifi, S. D., (2007). Effects of enzyme supplement on nutrient digestibility, metabolisable energy, egg production, egg quality, and intestinal morphology of the broiler chicks and layer hens fed hull-less barley based diets. *Pakistan Journal Biotechnology Sciences*. 10:2257–2266.