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Growth performance, carcass characteristics and haemato-biochemical indices of broiler chickens fed sub-optimal protein diets with or without papaya enzyme

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Target Audience: Feed millers, Broiler farmers, Nutritionists

Abstract

Two dietary protein levels (standard and sub-optimal) were supplemented with or without papaya enzyme (PE) so as to ascertain the effect on growth performance, carcass characteristics and blood parameters of broiler chickens. Four experimental diets each were formulated during the starter (1-28d) and finisher (29-49d) phases. Starter diets A and B contained 23 and 20% CP respectively while at the finisher phase, they contained 20% and 18%CP respectively. Papaya enzyme (PE) was added as diets C and D. A total of 120 day-old Arbor Acre chicks were randomly allocated to the four dietary treatments comprising of three replicates each in a completely randomized design. Daily Feed Intake (DFI) and Daily Weight Gain (DWG) were measured while Feed to Gain Ratio (FGR) was estimated. At day 49, twelve birds per treatment were slaughtered in order to measure carcass cut-up parts (thigh, breast, neck, wing, back, drumstick and abdominal fat), and selected organs were weighed and expressed relative to live weight. Data collected were subjected to analysis of variance in a 2 × 2 factorial arrangement and treatment means separated using Duncan Multiple Range Test. Results showed that broiler chickens fed sub-optimal protein levels and supplemented with PE (20/18%CP) gave comparable response like those on standard diet (23/20%CP). Performance parameters were not significantly (P>0.05) influenced except feed intake at the starter phase. Marginal improvements were recorded for PE supplemented diets at the starter phase compared to those without PE. Carcass and organ weights were not influenced by protein or inclusion of PE. Abdominal fat pad was higher in diets with high protein. The PCV, Hb, RBC, MCHC and ALT values were higher with the use of PE while the interaction revealed that there were significant (p<0.05) differences, which did not follow any definite pattern. In conclusion, papaya enzyme improved performance of broiler chickens on the sub optimal protein diet.

Keywords*:* Carcass, Papaya enzyme, Performance, Poultry

Description of problem

The demand for protein most especially in developing countries like Nigeria is on a daily increase due to the rise in population. Since protein from the animal source is rich in the essential amino acids, minerals and vitamins that the body requires, therefore there is need to increase the production of animal products so as to bridge the animal protein gap in Nigeria. A major hindrance to successful production of quality animal products is availability of quality feeds and feed ingredients all year round. Exogenous enzymes can be used to improve the nutritional value of broiler chicken's diet, facilitate the growth of beneficial gut microflora and consequently, maximizes the conversion of dietary nutrients into quality broiler chickens meat (1, 2)

Papaya enzyme (PE) is a product of crude papain, which is obtained from an endolytic plant Pawpaw. It is a synthetic cysteine protease enzyme that is isolated from papaya (Carica papaya L.) latex. Among the major applications of pawpaw latex (papain) are their uses in the food industry (3), beer clarification (4) and preparation of protein hydrolysates (5). Pawpaw latex (papain) had also been used in the diets of broiler (6) and old laying birds (7, 8). Haruna and Odunsi (6) reported that crude pawpaw latex negatively affected the performance characteristics of broiler chickens at the starter phase, which was however slightly ameliorated during the finishing stage. Inclusion of pawpaw latex at 0.1% improved broiler immune response, sustained carcass yield and ensured better survivability of broiler chickens. Lien and Wu (7) revealed that crude papain increased feed intake, improved total serum protein, total globulin and immunoglobulin G, while the serum and liver cholesterol concentration and glutamate pyruvate transaminase were decreased in matured layer chickens. Papaya enzyme was reported to reduce the effect of heat stress in rabbits (9), expand the use of soybean meal and acted as a growth promoter in the diets of weaned piglets (10, 11). The focus of this study is to use sub-optimal protein diets with or without papaya enzyme and examined its impact on the growth performance, carcass quality and haemato-biochemical indices of broiler chickens.

Materials and methods

Experimental site

The study was carried out at the Poultry Unit of Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Ogbomoso is located in the derived savannah that lies on longitude 4^0 10^1 East of Greenwich meridian and Latitude 8^0 10^1 North of the equator. The altitude is between 300m and 600m above sea level while the mean temperature and annual rainfalls are 27^0C and 1247mm, respectively as cited by (12).

Description of papaya enzyme

The papaya enzyme (PE) used in this study was obtained from a retail store in Boston, United States of America. Papaya enzyme is a proteolytic enzyme, derived from papaya fruit. The enzyme is in a chewable tablet form with great taste. The tablet contained sucrose, dextrose, artificial colour (FD&C yellow), protease, natural and artificial flavours, and alpha-amylase. The composition includes (Carica_papaya) 45mg and papain (60,000 USP units) 6mg; sugar 1.5g; total carbohydrate 1.5g and calories 5g.

Experimental diets, birds and management

Four diets were formulated such that diet A contained 23% and 20%CP levels at the starter and finisher phases respectively. Diet B contained 20% and 18%CPlevels at starter and finisher phases respectively. Both diets did not contain papaya enzyme (PE). Diets C and D were formulated to replicate diets A and B respectively however, with the addition of 0.1%PE. The diet compositions are shown in Tables 1 and 2 respectively for starter and finisher phases. One hundred and twenty (120) day-old Arbor acre broiler chicks were randomly allotted into the four dietary treatments of 3 replicates each. Each replicate was randomly allotted 10 birds to make a total of 30 birds per treatment in a 2 × 2 factorial arrangement. On arrival, the birds were offered anti-stress and brooded for 2 weeks. Feed and fresh drinkable water were offered ad-libitum on a daily basis throughout the experiment, which lasted forty-nine (49) days. Broiler starter diets were offered from 1-21 days while broiler finisher diets were fed from 22–49 days. Routine medications and vaccinations were strictly adhered to.

Table 1: Gross composition of starter diets (day 1- 21) (dry matter %)

Ingredients (%)	A (23% CP)	B (20%CP)	C (23% CP+0.1%PE)	D (20%CP+0.1%PE)
Maize	52.1	57.0	52.1	57.0
Soya bean meal	27.0	23.0	27.0	23.0
Groundnut cake	8.00	4.00	8.00	4.00
Wheat offal	5.00	8.60	4.90	8.50
Fishmeal (72%)	3.00	2.50	3.00	2.50
Dicalcium phosphate	3.00	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00	1.00
Lysine	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25
Broiler premix*	0.25	0.25	0.25	0.25
Salt	0.20	0.20	0.20	0.20
Papaya enzyme	-	-	0.10	0.10
Total	100	100	100	100
Analyzed composition (%)				
Crude protein	22.8	20.00	22.8	20.00
Ether extract	2.87	2.87	2.87	2.87
Crude fibre	4.22	4.29	4.22	4.29
ME (kcal/kg)**	2858.00	2893.7	2858.00	2893.7

[1] Premix supplied/kg diet: Vitamin A (15,000 I.U.), Vitamin D3 (3,000 I.U), Vitamin E (20 I.U.), Vitamin K (25 mg), Thiamin (2 mg), Riboflavin (6 mg), Pyridoxine (4 mg), Niacin (40 mg), Cobalamin (0.02 mg), Pantothenic acid (910 mg), Folic acid (1.0 mg), Biotin (0.08 mg), Choline Chloride (0.05 g), Manganese (0.096 g), Zinc (0.06 g), Iron (0.024 g) PE = Papaya enzyme, **Calculated Metabolizable energy

Data measurements

Zoo technical performance: Data were collected daily on feed intake (DFI) and body weight gain (BWG) while feed to gain ratio (FGR) was calculated.

Carcass and organ evaluation:

At day 49, 4 birds per replicate of similar body weights close to the average body weight of each replicate were slaughtered, properly bled by hanging them by their legs and scalded in water at temperature of 60°C. After de-feathering, they were eviscerated and dressed to get the dressed carcass weight. The weights of the cut-up parts (thigh, breast, neck, wing, back and drumstick), organs (heart, kidney, lungs, liver, spleen and gizzard), intestines and the abdominal fat pads were recorded and expressed as a percentage of live weight.

Biochemical and Haematological analysis:

At the 49th day of the feeding trial, twelve chickens (male and female) per treatment were sacrificed for blood collection, Blood was collected into labelled sterile universal bottles containing ethylene-diamine-tetra-acetic acid (EDTA) as anticoagulant and used to determine the haematological components (packed cell volume, red blood cell, haemoglobin, white blood cell, mean cell volume, mean cell haemoglobin, and mean cell haemoglobin concentration) within an hour of sample collection following standard procedures described by (13). Blood samples were also collected into labelled sterile bottles without anticoagulant and used to determine the biochemical components (total protein, total cholesterol, albumin, globulin, urea, serum glutamate oxaloacetate transaminase (SGOT) and serum glutamate pyruvate transaminase (SGPT) as described by (13)

Table 2: Gross composition of finisher diets (day 22 – 49) (dry matter %)

Ingredients (%)	20% CP	18%CP	20% CP+0.1%PE	18%CP+0.1%PE
Maize	57.0	60.00	57.0	60.00
Soya bean meal	23.0	18.00	23.0	18.00
Groundnut cake	4.00	4.00	4.00	4.00
Wheat offal	8.60	11.10	8.50	11.00
Fishmeal (72%)	2.50	2.00	2.50	2.00
Dicalcium phosphate	3.00	3.00	3.00	3.00
Oyster shell	1.00	1.00	1.00	1.00
Lysine	0.20	0.20	0.20	0.20
Methionine	0.25	0.25	0.25	0.25
Broiler premix*	0.25	0.25	0.25	0.25
Salt	0.20	0.20	0.20	0.20
Papaya enzyme	-	-	0.10	0.10
Total	100	100	100	100
Analyzed composition (%)				
Crude protein	19.95	18.10	19.95	18.05
Ether extract	2.87	3.01	3.28	3.01
Crude fibre	4.29	4.31	3.32	4.31
ME (kcal/kg)**	2893.7	2918.77	3102.2	2918.77

[1] Premix supplied/kg diet: Vitamin A (15,000 I.U.), Vitamin D3 (3,000 I.U), Vitamin E (20 I.U.), Vitamin K (25 mg), Thiamin (2 mg), Riboflavin (6 mg), Pyridoxine (4 mg), Niacin (40 mg), Cobalamin (0.02 mg), Pantothenic acid (910 mg), Folic acid (1.0 mg), Biotin (0.08 mg), Choline Chloride (0.05 g), Manganese (0.096 g), Zinc (0.06 g), Iron (0.024 g), Copper (0.006 g), Iodine (0.004 g), Selenium (0.024 g), Cobalt (0.02 mg), Antioxidant (0.125 g), PE = Papaya enzyme, [2]Calculated Metabolizable energy

Ethical approval

This study was carried out in strict accordance with the recommendations of institutional guidelines for the care and use of laboratory animals. Chickens were humanely handled in respect of the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

Statistical analysis

The data collected were subjected to 2 × 2 factorial design using the General Linear Model procedure of (14) to determine treatment effects. Significant mean differences were determined using Duncan Multiple Range Test of the same package.

Results and Discussion

Zoo technical performance

The main effects of protein level and inclusion of papaya enzyme is presented in Table 3. The main effect of protein levels indicated that daily weight was not significantly influenced during the starter, finisher and combined starter/finisher phases. Daily feed intake was only significantly influenced at the starter phase with broilers on 23%CP consuming more than those on 20%CP. Table 3 further showed that enzyme inclusion had no effect (P>0.05) on performance indices. Interaction effects between protein level and enzyme inclusion is shown in Table 4. Only the feed intake at the starter phase showed significant changes. There were no significant interactions at the starter, finisher or combined phases for daily weight gain and feed conversion ratio. Though, there were no significant differences in the values obtained but birds on PE supplemented diets had higher values compared with non-enzyme based diets. The results of this study suggested that the inclusion of PE to high CP diet impacted positively and non-significantly on zoo technical performance response of the birds, which was in contrast to the report of (6), that dried crude pawpaw latex affected the performance of broiler negatively. This result supported the trends of previous reports in other animal models. Papaya latex (0.7%) has been reported to enhance growth performance and immune response of heat stressed growing rabbits and concluded that the latex can be used as an alternative growth promoter (9, 15). Battaa et al. (8) fed 0.01, 0.03 and 0.05% natural enzyme (plant papain) to Egyptian local layers and reported improved egg production, feed conversion ratio, nutrients digestibility, immunity and economic efficiency while feed intake was reduced at 0.05% addition of the natural enzyme. The inclusion of papain (75 mg /kg) has also been reported by (11) to significantly increase in-vitro digestibility and effectively expanded the inclusion limit of soybean meal in piglet diets. The nature of protease enzyme in pawpaw latex is to digest protein, clean up the gastrointestinal tract wall and enable efficient nutrient absorption (16). Recently, (17) found that protease enzyme supplementation enhanced performance of birds fed on low diets (17.5% CP for starter phase and 14.4 % CP for finisher phase) which make them comparable to birds fed the control diets (23% CP for starter phase and 20% CP for finisher phase). The author concluded that CP in broiler chicken diets could be reduced by about 5.6% without deleterious effect on performance.

Table 3: Main effect of protein levels and inclusion of papaya enzyme on zoo technical performance of starter, finisher and combined starter and finisher phases of broilers

TRT	Protein levels			Enzyme Inclusion		
Levels	23%/20%	20%/18%	SEM	-Enzyme	+Enzyme	SEM
Starter						
DWG, g/b	29.95	28.42	0.21	28.47	29.90	0.24
DFI, g/b	46.59[a]	44.65[b]	0.01	44.95	46.29	0.06
FCR	1.56	1.58	0.70	1.59	1.56	0.68
Finisher						
DWG, g/b	47.38	47.16	0.93	47.30	47.24	0.98
DFI, g/b	126.21	123.88	0.54	124.63	125.46	0.81
FCR	2.70	2.64	0.62	2.65	2.69	0.13
Combine						
DWG, g/b	39.88	39.07	0.61	39.20	39.75	0.74
DFI, g/b	92.09	89.92	0.36	90.48	91.53	0.66
FCR	2.33	2.31	0.80	2.32	2.32	0.97

[a,b,] Treatments on the same row with different superscripts are significantly different (P<0.05)

Table 4: Interaction effect of protein levels and inclusion of papaya enzyme on zoo technical performance of finished broiler chickens

TRT	23/20%CP	20/18%CP	-Enzyme	+Enzyme	P.value	SEM
Starter						
DWG	28.84	28.10	31.05	28.74	0.33	0.59
DFI, g/b	45.62[b]	44.28[b]	47.56[a]	45.01[b]	0.14	0.39
FCR	1.59	1.58	1.54	1.59	0.87	0.03
Finisher						
DWG	48.64	45.95	46.11	48.36	0.79	1.15
DFI, g/b	129.74	119.52	122.69	128.23	0.22	1.96
FCR	2.69	2.62	2.72	2.66	0.95	0.06
Combine						
DWG	40.16	38.25	39.61	39.88	0.84	0.76
DFI, g/b	93.69	87.27	90.49	92.57	0.25	1.19
FCR	2.35	2.29	2.30	2.33	0.95	0.04

[a,b,] Treatments on the same row with different superscripts are significantly different ($P<0.05$)

Carcass and organ measurements

The main effect of protein levels and inclusion of PE (Table 5) revealed that all parameters measured elicited no significant difference except for abdominal fat that had an elevated value (1.38%) in 23% CP compared to its counterpart 20% CP (0.74%). The interaction effect of protein levels and inclusion of PE on carcass, organs and intestinal measurements of broiler chickens fed diets containing PE at different protein levels (Table 6) revealed that there were no significant difference in live weight, dressing percentage and all cut up parts measured except wing and abdominal fat percentage, however there were reduced value in the abdominal fat of birds fed PE supplemented diets, the highest values were demonstrated in broilers fed diets without PE 1.16% and 1.61% (A and B) respectively while 0.44% and 1.03% were recorded for diets C and D respectively. The comparable values in the dressing percentage, breast, wing, back and thigh of birds fed diets with or without PE agreed with the findings of (18, 19, 20, 21, 22) that in a balanced and quality diet, enzyme might have no significant effect on carcass values.

Table 5: Main effect of protein levels and inclusion of papaya on carcass, organ and intestinal weight of broiler chickens (expressed as a percentage of live weight)

Treatment.	23%CP	20%CP	P.value	-Enzyme	+Enzyme	P.value	SEM
Live weight, g	1975.00	2016.67	0.71	2008.33	1983.33	0.81	75.00
Dressed %	67.93	71.57	0.41	95.44	90.21	0.31	2.97
Cut-up parts (%)							
Neck	5.62	5.53	0.78	5.53	5.63	0.72	0.20
Breast	21.33	24.39	0.11	23.35	22.37	0.61	1.21
Wing	7.62	7.64	0.94	7.98	7.27	0.11	0.23
Thigh	10.96	11.15	0.85	11.26	10.85	0.66	0.69
Drum stick	10.34	10.51	0.79	10.81	10.04	0.23	0.45
Back	11.09	12.37	0.18	11.81	11.65	0.88	0.61
Abdominal fat	1.38^{a}	0.74^{b}	0.00	0.80	1.32	0.04	0.05
Organs (%)							
Kidney	0.52	0.45	0.38	0.47	0.50	0.68	0.05
Lungs	0.50	0.48	0.80	0.48	0.51	0.71	0.05
Heart	0.39	0.42	0.50	0.44	0.38	0.23	0.03
Gizzard	2.60	2.32	0.15	2.57	2.36	0.39	0.13
Liver	1.87	1.99	0.30	1.85	2.02	0.23	0.07
Spleen	0.09	0.08	0.43	0.09	0.09	0.93	0.01
Bursa	0.04	0.06	0.17	0.04	0.06	0.31	0.01
Offals (cm/Kg)							
Small intestine	4.28	4.23	0.89	4.30	4.20	0.83	0.28
Large intestine	0.17	0.16	0.65	0.15	0.18	0.38	0.02
Caecum	0.66	0.68	0.73	0.62	0.67	0.61	0.07

[a and b] Treatments on the same row with different superscripts are significantly different (P<0.05)

Table 6: Interaction effect of protein levels and inclusion of papaya enzyme on carcass, organ and intestinal weight of finished broiler chickens (expressed as a percentage of live weight)

Treatment.	23%CP	20%CP	-Enzyme	+Enzyme	SEM	P.value
Live weight, g	2033.33	1916.67	1983.33	2050.00	47.9	0.81
Dressed %	73.27	62.60	69.77	73.37	2.22	0.29
Cut-up parts (%)						
Neck	5.46	5.78	5.59	5.47	0.13	0.85
Breast	22.57	20.09	24.13	24.65	0.91	0.31
Wing	8.41^{a}	6.83^{b}	7.56^{ab}	7.72^{ab}	0.22	0.05
Thigh	11.56	10.36	10.96	11.34	0.44	0.83
Drum stick	11.03	9.65	10.59	10.43	0.31	0.51
Back	11.92	10.26	11.69	13.05	0.47	0.23
Abdominal fat	1.16^{b}	1.61^{a}	0.44^{c}	1.03^{b}	0.13	0.00
Organs (%)						
Kidney	0.54	0.50	0.39	0.50	0.04	0.59
Lungs	0.52	0.49	0.45	0.52	0.03	0.85
Heart	0.43	0.35	0.44	0.41	0.23	0.55
Gizzard	2.93^{a}	2.28^{b}	2.20^{b}	2.44^{ab}	0.11	0.07
Liver	1.90^{ab}	1.85^{ab}	1.80^{b}	2.19^{a}	0.06	0.12
Spleen	0.10	0.09	0.08	0.08	0.01	0.87
Bursa	0.05^{ab}	0.02^{b}	0.02^{b}	0.09^{a}	0.01	0.02
Offals (cm/Kg)						
Small intestine	0.11	0.12	0.13	0.11	0.00	0.39
Large intestine	0.01	0.01	0.00	0.01	0.00	0.39
Caecum	0.01	0.01	0.01	0.01	0.00	0.42

[a and b] Treatments on the same row with different superscripts are significantly different (P<0.05)

Haematological and serum biochemical indices

The haematological and serum biochemistry main effect of protein levels and inclusion of PE are presented in Table 7. All parameters measured for haematology were not significantly (p>0.05) influenced except for MCH that is higher in broilers fed 20%CP (40.65) compared to those on 23%CP (38.88). The inclusion of enzyme elicited that the birds were significantly (P<0.05) influenced. Higher values of PCV, Hb, RBC and MCHC were recorded with the addition of enzyme in the diets. For serum biochemistry, the protein levels had significant (P<0.05) effect on globulin, glucose, creatinine and ALP while other parameters were not significantly (P>0.05) influenced. Broilers on 23%CP had the highest values for glucose (117.53), creatinine (1.50), and ALP (34.75) compared to its counterparts on 20%CP having (105.70, 0.85 and 27.75), respectively. The inclusion of PE only had influence on the total protein and ALT with the higher values obtained with the inclusion of PE.

The protein levels and PE inclusion interaction on haematology and serum biochemical indices are shown in Table 8. It could be deduced from this result that PE has significant (p<0.05) influence on all haematological parameters measured except MCV and WBC that were not significant (p>0.05). PCV, RBC and HB values of the birds fed diets supplemented with PE values were significantly (p<0.05) higher compared to their counterparts without PE and the highest values (30.06, 9.96 and 2.50) were recorded for PCV, HB and RBC, respectively, while the least was recorded from treatment A with values 26.50, 8.40 and 2.20 respectively. The values recorded fell within the standard ranges recommended by (23). Serum biochemical parameters were significantly (p<0.05) influenced by PE except for urea, albumin and cholesterol. Treatment C elicited the highest value for TP (4.95), ALT (33.59), ALP (34.48) and serum glucose (121.55) while treatment B had the least values for glucose (102.85) and ALT (25.77) and treatment A and D for TP (3.86) and ALP (26.38), respectively. However, the decrease in values of cholesterol of birds on PE supplemented diets conformed with the report of (23, 24) who reported a reduced cholesterol and triglycerides in broiler fed diet containing probiotics in starter, grower and finisher phase. The reduced values of AST in PE based diet agreed with the assertion that high dose of crude papain decreases the GPT and GOT activity in the liver (7) and the higher values of ALT and ALP did not conform to the assertion of (7). Some of the values obtained fell within the standard ranges recommended by (25).

Table 7: Main effect of protein levels and inclusion of papaya enzyme on haematological and serum biochemistry of finished broiler chickens

TRT	23% CP	20% CP	P.value	-Enzyme	+Enzyme	P.value	SEM
Haematology							
PCV (%)	29.00	27.00	0.16	27.00^{b}	29.00^{a}	0.03	0.54
Hb (g/dl)	9.45	8.95	0.35	8.75^{b}	9.65^{a}	0.00	0.15
RBC ($\times10^{12/l}$)	2.43	2.20	0.06	2.20^{b}	2.43^{a}	0.00	0.02
WBC ($\times10^{9/l}$)	11.30	10.60	0.11	10.95	10.95	1.00	0.31
MCV (fl)	119.65	122.68	0.30	122.73	119.6	0.29	1.99
MCH (Pg)	38.88^{b}	40.65^{a}	0.04	39.75	39.78	0.97	0.48
MCHC (g/dl)	32.53	33.18	0.13	32.45^{b}	33.25^{a}	0.01	0.15
Serum Biochemistry							
Total Protein (g/dl)	4.38	4.77	0.27	4.33^{b}	4.83^{a}	0.04	0.15
Albumin (g/dl)	2.80	2.65	0.56	2.58	2.88	0.20	0.15
Globulin (g/dl)	1.58^{b}	2.13^{a}	0.04	1.75	1.95	0.38	0.15
Glucose (mg/dl)	117.53^{a}	105.70^{b}	0.04	106.43	116.80	0.43	3.05
Creatinine (mg/dl)	1.50^{a}	0.85^{b}	0.04	1.10	1.25	0.42	0.12
Urea (mg/dl)	6.33	5.78	0.19	6.18	5.93	0.57	0.29
Cholesterol. (mg/dl)	67.15	70.07	0.68	74.80	62.39	0.06	3.96
AST (u/l)	65.50	67.75	0.74	71.00	62.25	0.08	3.08
ALT (u/l)	30.25	29.75	0.88	25.75^{b}	34.25^{a}	0.00	1.19
ALP (u/l)	34.75^{a}	27.75^{b}	0.04	32.25	30.25	0.29	1.25

$^{a\ and\ b}$ Treatments on the same row with different superscripts are significantly different ($P<0.05$)
MCHC = Mean Corpuscular Haemoglobin Concentration; MCH = Mean corpuscular Haemoglobin
MCV = Mean Corpuscular Volume ; SGOT = Serum Glutamate Oxaloacetate Transaminase
SGPT = Serum Glutamate Pyruvate Transaminase; AST = Aspartate aminotransferase
ALT= Alanine aminotransferase; ALP= Alkaline phosphatase

Table 8: Interaction effect of protein levels and inclusion of papaya enzyme on haematological and serum biochemistry of broiler chickens

Treatment.	23%CP	20%CP	-Enzyme	+Enzyme	SEM	P.value
Haematology						
PCV (%)	26.50^{b}	27.5^{b}	31.50^{a}	26.50^{b}	0.68	0.01
Hb (g/dl)	8.40^{b}	9.10^{b}	10.50^{a}	8.80^{b}	0.25	0.00
RBC ($\times10^{12/l}$)	2.20^{b}	2.20^{b}	2.65^{a}	2.20^{a}	0.05	0.00
WBC ($\times10^{9/l}$)	11.40	10.50	11.20	10.70	0.21	0.48
MCV (fl)	120.45	125	118.85	120.35	1.47	0.49
MCH (Pg)	38.15^{b}	41.35^{a}	39.60^{ab}	39.95^{ab}	0.47	0.06
MCHC (g/dl)	31.75^{b}	33.15^{a}	33.30^{a}	33.20^{a}	0.19	0.00
Serum Biochemistry						
Total Protein (g/dl)	3.75^{b}	4.90^{a}	5.00^{a}	4.65^{a}	0.17	0.01
Albumin (g/dl)	2.45	2.70	3.15	2.60	0.12	0.20
Globulin (g/dl)	1.3^{b}	2.20^{a}	1.85^{ab}	2.05^{a}	0.14	0.08
Glucose (mg/dl)	111.55^{ab}	101.30^{b}	123.50^{a}	110.10^{ab}	3.01	0.04
Creatinine (mg/dl)	1.55^{a}	0.65^{b}	1.45^{a}	1.05^{ab}	0.13	0.02
Urea (mg/dl)	6.50	5.85	6.15	5.70	0.20	0.57
Cholesterol. (mg/dl)	76.935^{a}	72.69^{ab}	57.36^{b}	67.44^{ab}	3.25	0.15
AST (u/l)	62.50^{b}	79.50^{a}	68.50^{ab}	56.00^{b}	3.20	0.03
ALT (u/l)	26.00^{b}	25.50^{b}	34.50^{a}	34.00^{a}	1.48	0.01
ALP (u/l)	34.50^{a}	30.00^{ab}	35.00^{a}	25.50^{b}	1.38	0.02

$^{a\ and\ b}$ Treatments on the same row with different superscripts are significantly different ($P<0.05$)
MCHC = Mean Corpuscular Haemoglobin Concentration ; MCH = Mean corpuscular Haemoglobin
MCV = Mean Corpuscular Volume ; SGOT = Serum Glutamate Oxaloacetate Transaminase
SGPT = Serum Glutamate Pyruvate Transaminase; AST = Aspartate aminotransferase
ALT= Alanine aminotransferase; ALP= Alkaline phosphatase

Conclusion and Applications

The findings showed that:

1. There were no significant variations in the performance of broiler chickens fed 23 or 20% crude protein during the starter phase.
2. Carcass characteristics and organ weights were maintained with or without papaya enzyme
3. Use of papaya enzyme gave a comparable response between the normal protein and suboptimal protein levels in the diet of broiler chickens.
4. Crude protein in broiler chicken diets could be reduced without deleterious effect on performance.

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