Performance and Serum Enzymes of Broiler Chickens Fed Graded Levels of *Parkia biglobosa* Fruit Pulp with or without Enzymes Supplementation

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Citation: Fadipe, E., Ademola, S. G., Togun, M. E., Shittu, M. D., Akinwumi, A. O., & Arasi, K. K. (2022). Performance and Serum Enzymes of Broiler Chickens Fed Graded Levels of *Parkia biglobosa* Fruit Pulp with or without Enzymes Supplementation. *Zhivotnovadni Nauki*, *59*(5), 44-53 (Bg).

Abstract

A 6-week experiment was carried out to evaluate the performance and serum enzymes of broilers fed graded levels of *Parkia biglobosa* fruit pulp with or without enzyme supplementation. A total of 189 day old broiler chicks of Marshal strain were allotted to 7 treatments of 3 replicates each. A replicate contained 9 chicks. Diet that did not contain *Parkia biglobosa* fruit pulp served as the control. Diets containing 5, 10 and 15% *Parkia biglobosa* fruit pulp were in T1, T2 and T3, respectively. These three diets were not supplemented with exogenous enzymes. Diets T4, T5 and T6 contained 5, 10 and 15% *Parkia biglobosa* fruit pulp, respectively. These latter diets were each supplemented with 0.4 gram Polyzyme® per kg diet. The results showed that starter broilers fed control diet had the best feed conversion ratio. Starters fed enzymes supplemented 5% *Parkia biglobosa* fruit pulp diet had slightly improved feed conversion ratio than those fed unsupplemented 5% *Parkia biglobosa* fruit pulp diet. Addition of enzymes to 15% *Parkia biglobosa* fruit pulp diet elicited improved (P = 0.0002) final body weight and average daily gain (P = 0.005) of finishers relative to those fed unsupplemented 15% *Parkia biglobosa* fruit pulp. Exogenous enzymes enhanced crude fibre digestibility (P = 0.0005) for broilers fed 10% and 15% *Parkia biglobosa* fruit pulp. Feeding dietary *Parkia biglobosa* fruit pulp to broiler chickens significantly (P = 0.007) increased serum alkaline phosphatase except for those fed 15% *Parkia biglobosa* fruit pulp. Conclusively, feeding 5% *Parkia biglobosa* fruit pulp to broilers supported maximum final body weight. However, broilers fed 15% *Parkia biglobosa* fruit pulp diet required enzyme supplementation for improved final body weight and crude fibre digestibility.

Key words: *Parkia biglobosa* fruit pulp, exogenous enzymes, growth performance, nutrient digestibility, serum proteins and serum enzymes

Introduction

The rising demand for maize globally has led to increase in the price of maize and corresponding increase in cost of livestock feed and animal products (Sunmola et al., 2018). Maize is a major source of energy in poultry feeds as it constitutes about 50–60% of poultry diets Feed cost is one of the major limiting factors in poultry production as the cost of feed alone accounts for about 70–75% of the total cost of broiler production (Jurgens et al., 2009). There is therefore a need to find alternative feed resources which can be used as energy source that are readily available, cheap, non-toxic and not directly eaten by man in order to cut down the cost of poultry feed (Sekoni et al., 2018).

One of such alternatives is African locust bean, *Parkia biglobosa*, fruit pulp (PbFP). African locust bean pulp which is the yellow fruit pulp obtained from the African Locust bean tree is called ”Dorowa” in Hausa, ”Igba” in Yoruba, though it does not attract much attention like the bean. It is a potential source of energy because it is very high in energy content. Some researchers had earlier reported that the African locust bean pulp could be a good replacement for the scarce cereal grains as a source of energy in feed formulation and it is readily available at the time when maize is expensive (Afolayan et al., 2014). Research had been done on the use of African Locust bean Pulp (ALBP) in broilers production and some backwards farmers also use it in pig production and it has been reported that PbFP can replace maize in broiler diets (Kwari and Igwebuike, 2002 and Bot, 2011). According to Bot (2011), PbFP contained 11.52% crude protein (CP), 12.49% crude fibre (CF), 3.09% ether extract (EE), 4.68% ash and 68.32% nitrogen free extract (NFE). Also, Bello et al. (2008) reported that PbFP contained 5.68% crude protein, 12% crude fibre, 18% ether extract (EE), 4% ash and 68.75% nitrogen free extract (NFE). The proximate composition of PbFP revealed that it contained high fibre which may be difficult to digest by monogastric animals like broilers. The fibres are also known as non-starch polysaccharides (NSP) and they have anti-nutritional properties that depress animal performance. Non-starch polysaccharides of particular concern include: ß-glucans, pentosan, arabinogalactans, galactomannans, xylans and pectins (Jackson, 2002). There is therefore need to include exogenous enzymes in order to maximize nutrient digestibility in PbFP. Enzymes have the greatest potential use in diets that contain anti-nutritional factors that hinders nutrient availability (Ravindran and Bryden, 1997). Therefore this research work is designed to assess the growth performance, nutrient digestibility and serum enzymes of broiler chickens fed graded levels of *Parkia biglobosa* fruit pulp diets.

Materials and methods

Experimental Site

The study was carried out at the Broiler Unit, Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.

Source and processing of Test Ingredients

The pulp was sourced and harvested from scattered *Parkia biglobosa* bean trees within the university. The pulp were sorted, cleaned and manually split open. The yellow pulp with attached seeds were removed from the pods, sundried for three days and pounded lightly with pestle and mortal so that the seeds would not be broken. Thereafter, the pulp was separated from the seeds and then the pulp was thoroughly pounded and passed through a 40 mm mesh sieve. The fruit pulp was stored in airtight plastic container prior to the commencement of the experiment.

Formulation of the Experimental Diets

Seven experimental diets were formulated for the study. A corn soy based diet without PbFP served as the control. *Parkia biglobosa* pulp was included for diets in treatments T1, T2 and T3 at 5%, 10% and 15%, respectively. These diets were without exogenous enzyme supplementation. Furthermore, *Parkia biglobosa* pulp was also included for diets in treatment T4, T5 and T6 at 5%, 10% and 15% with each supplemented with 0.4 g Polyzyme® per kg diet (Table 1 and 2). The PbFP was used to replace maize on weight to weight basis.

Experimental Birds and Management

A total of 189-day old unsexed broiler of Marshal strain were randomly divided into seven treatments groups of 27 birds in each group.

Each treatment group was replicated thrice consisting of 9 birds per replicate. The birds were housed in deep litter pens. The experimental diets and clean drinking water were supplied to the birds *ad libitum* throughout the study period. Routine management practices and vaccination were undertaken during the six weeks of the experiment.

The following vitamins and trace elements were supplied per kilogramme of the premix: 12500 IU Vit A, 2500 IU Vit D3, 40 mg Vit E, 2.0 mg Vit K3, 3 mg Vit B1, 5.5 mg Vit B2, 55 mg Niacin, 11.5 mg Cal. panthotenate, 5 mg Vit B6, 0.025 mg VitB12, 500 mg choline chloride, 1 mg folic acid, 0.08 mg biotin, 120 mg manganese, 100 mg iron, 80 mg zinc, 8.5 mg copper, 1.5 mg iodine, 0.3 mg cobalt, 0.12 mg selenium, 120 mg antioxidant.

NOTE: **Metabolizable energy was calculated using Pauzenga equation, + ENZ = 40 g Polyzyme® per kg diet, PbFP = *P. biglobosa* fruit pulp, CP = Crude protein, CF = Crude fibre, EE = Ether extract, NFE = nitrogen free extract

The following vitamins and trace elements were supplied per kilogramme of the premix: 12500 IU Vit A, 2500 IU Vit D3, 40 mg Vit E, 2.0 mg Vit K3, 3 mg Vit B1, 5.5 mg Vit B2, 55 mg Niacin, 11.5 mg Cal. panthotenate, 5 mg Vit B6, 0.025 mg Vit B12, 500 mg choline chloride, 1 mg folic acid, 0.08 mg biotin, 120 mg manganese, 100 mg iron, 80 mg zinc, 8.5 mg copper, 1.5 mg iodine, 0.3 mg cobalt, 0.12 mg selenium, 120 mg antioxidant.

NOTE: **Metabolizable energy was calculated using Pauzenga equation, + ENZ = 40 g Polyzyme® per kg diet, PbFP = *Parkia biglobosa* fruit pulp, CP = Crude protein, CF = Crude fibre, EE = Ether extract, NFE = nitrogen free extract.

Experimental Design of the study

A completely randomized design was adopted for the study. The design accommodated a 3

Table 1. Ingredient composition of broiler starter diets (%)

Ingredient (%)	Control (0%)	T1 (5%)	T2 (10%)	T3 (15%)	T4 (5% + Enz)	T5 (10% + Enz)	T6 (15 + Enz)
Maize	58.50	53.50	48.50	43.50	53.50	48.50	43.50
PbFP	–	5.00	10.00	15.00	5.00	10.00	15.00
Corn bran	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Soybean meal	30.90	30.90	30.90	30.90	30.90	30.90	30.90
Fish meal (72% cp)	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Bone meal	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Enzymes	–	–	–	–	+	+	+
Total	100	100	100	100	100	100	100
Determined nutrients							
**Metabolizable Energy (Kcal/kg)	3024.39	2980.30	2936.21	2892.12	2980.30	2936.21	2892.12
CP (%)	23.98	23.10	21.00	19.25	22.75	18.55	16.45
CF (%)	4.20	11.00	10.80	7.80	6.80	11.00	14.60
EE (%)	9.00	8.40	10.40	10.20	10.50	10.20	10.90
Ash (%)	3.60	9.60	6.70	4.60	6.50	7.60	7.50
NFE (%)	47.82	36.80	40.30	47.55	41.65	42.45	36.25
Drymatter	88.60	88.90	89.20	89.40	88.20	89.80	85.70

Table 2. Ingredient composition of broiler finisher diets (%)

Ingredient (%)	Control (0%)	T1 (5%)	T2 (10%)	T3 (15%)	T4 (5% + Enz)	T5 (10% + Enz)	T6 (15 + Enz)
Maize	44.95	39.95	34.95	29.95	39.95	34.95	29.95
PbFP	–	5.00	10.00	15.00	5.00	10.00	15.00
Corn bran	20.00	20.00	20.00	20.00	20.00	20.00	20.00
SBM	28.00	28.00	28.00	28.00	28.00	28.00	28.00
Fish meal (72% cp)	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Bone meal	0.80	0.80	0.80	0.80	0.80	0.80	0.80
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Methionine	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Polyzyme®	–	–	–	–	+	+	+
Total	100	100	100	100	100	100	100
Determined Nutrients							
**Metabolizable Energy (Kcal/kg)	2893.98	2849.80	2805.80	2761.71	2849.89	2805.80	2761.71
CP (%)	21.00	19.00	17.50	17.15	18.55	16.50	16.10
CF (%)	8.00	12.20	8.40	10.10	8.40	16.40	13.00
EE (%)	9.40	10.90	8.90	10.20	9.00	10.90	9.30
Ash (%)	5.60	6.80	6.30	15.40	5.60	6.60	5.90
NFE (%)	42.20	39.00	48.50	33.15	47.65	38.10	43.00
Drymatter	86.20	87.90	89.60	86.00	89.20	88.50	87.30

x 2 factorial arrangement namely three inclusion levels of *Parkia biglobosa* fruit pulp and enzyme supplementation at two levels (0 and 0.4 g per kilograms diet).

Data collection

Growth Parameters: On the first day of the experiment, the birds were weighed for Initial Body Weight (IBW) and subsequently weighed on weekly basis. Final Body Weight (FBW) of the birds was taken on the 21st and 42nd day of the study for broiler starters and finishers, respectively. The total weight gain (TWG) was obtained as a difference between the IBW and FBW. The TWG was divided by the number of birds in each replicate and by the number of days of the study as estimate of average daily gain (ADG). The difference between feed supplied and feed left over was the total feed intake of the birds. The average daily intake was determined by dividing the total feed intake by the number of birds in each replicate. Feed Conversion Ratio (FCR) was determined by dividing the total feed intake per bird by the total weight gain per bird.

Digestibility Trial

Six birds per treatment were selected and put into metabolic cage for a 5 days nutrients digestibility trial. Two days of acclimatization was observed when faecal samples were not collected and followed by three days for the collection of faecal samples. The faecal samples were oven-dried to constant weight, ground into powdered form and representative samples were taken to the laboratory for proximate analysis.

Blood sample collection

On the 36th day of the study, 6 blood samples were collected through the jugular vein of the birds. The blood samples for serum enzymes were collected in sampled bottles free of ethylene diamine tetra acetic acid (EDTA). Serum enzymes such as Alkaline phosphatase, Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) were measured by standard scientific methods (Reitman and Frankel, 1957).

Chemical Analysis

Proximate composition: The proximate analysis of *Parkia biglobosa* fruit pulp, experimental diets and faecal samples were done according to the procedure of AOAC (1999). The metabolizable energy contents of the PbFP and experimental diets were determined using the Pauzenga equation (Pauzenga, 1985) via proximate analysis of the PbFP and diets.

Pauzenga equation: ME = 37 X % CP + 81 X % EE + 35.5 X % NFE.

Minerals analysis: The calcium, potassium, magnesium, iron and phosphorus content of PbFP were determined using Atomic Absorption Spectrophotometer (AOAC, 1990).

Anti-nutritional Factors: The tannin, phytate, saponin and oxalate of PbFP were determined by Makkar and Goodchild (1996) and Maga (1983) respectively.

Statistical Analysis of Data

Data collected were subjected to One-way and 3 x 2 Factorial ANOVA using SAS (2004). Significant means were separated by Duncan option of the same statistical software. A probability of 5% was considered significant ($P < 0.05$).

Results and Discussion

The proximate composition of *Parkia biglobosa* fruit pulp is shown in Table 3. The 14% CP content of *Parkia biglobosa* fruit pulp was higher than to 9% CP of maize (Agubosi et al., 2019). The crude protein of PbFP observed in this study was in close agreement with the findings of Bot (2011) who reported 11.52% CP. However, lower CP had been reported by other authors such as 3.19% CP (Afolayan, 2014), 5.68% CP (Bello et al., 2008), 6.7% CP (Kwari and Igwebuike, 2002) and 8.75% CP (Bayor et al., 2015). The 17.1% crude fibre in PbFP observed in this study was slightly higher than 12.49 and 12% reported by Bot (2011) and Bello et al. (2008) respectively. Lower crude fibre for PbFP had been documented by other authors such as Afolayan (2014) and Bayor et al. (2015) reported 6.03% and 8.75%, respectively. The disparity in proximate composition of PbFP may be due to the differences in geographical locations and soils in which *P. biglobosa* trees were cultivated, fertilizer treatment and differences in cultivars or different methods of processing (Bot, 2011). The mineral content in PbFP is presented in Table 4. The 2.19 mg/g calcium content recorded in PbFP in this study were inconsistent with 595.35 mg/kg (0.595 mg/g) observed by Stephen et al. (2019). However, 11650 mg/kg calcium (11.65 mg/g) was found by Bello et al. (2008) which was higher than calcium concentration in the pulp of this study. The 61.10 mg/g potassium content observed in PbFP in the present study was higher than 3945 mg/kg (3.945 mg/g) by Bello et al. (2008) but lower than 10866.40 mg/kg (108.66 mg/g) reported by Stephen et al. (2019). The 6.81 mg/g magnesium content of PbFP in the present study concurred with 7000 mg/kg (7 mg/g) reported by Bello et al. (2008). The phosphorus and iron content observed in this study are of appreciable amount. Despite variation in the mineral composition of PbFP in the present study with the observation in other studies, the pulp is a good source of important and critical minerals content. According to Olalude et al. (2021) stated calcium, magnesium and phosphorus are important for bone formation and its maintenance.

The anti-nutritional factors present in PbFP is shown in Table 5. The 0.048% tannin in *Parkia biglobosa* fruit pulp in this study varied from the findings of other authors. Malik et al. (2018), Bello et al. (2008) and Gernah et al. (2007) respectively reported 4.11 mg/100 g (0.00411%), 108 mg/100 g (0.108%) and 81 mg/100 g (0.081%) tannin content in PbFP. Variation was observed for other anti-nutrients: phytate (0.687%) differed from 215.10 mg/100 g (0.2151%) obtained by Malik et al. (2018) and 20 mg/100 g (0.02%) reported by Bello et al. (2008). The 0.398% oxalate in PbFP of this study was not consistent with the findings of Malik et al. (2018) who reported 145 mg/100 g (0.145%). It was also lower

Table 3. Proximate composition of *Parkia biglobosa* fruit pulp

Parameters (%)	PbFP
Crude protein	14.00
Crude fibre	17.10
Ash	7.00
Ether extract	10.40
Dry matter	87.70
Nitrogen free extract	39.30
Metabolizable energy (Kcal/kg)	2736.94

Note: PbFP = Parkia biglobosa fruit pulp

Table 4. Mineral elements concentration in *Parkia biglobosa* fruit pulp

Elements	Composition
Calcium (mg/g)	2.19
Magnesium (mg/g)	6.81
Potassium (mg/g)	61.10
Phosphorus (%)	1.52
Iron (mg/g)	0.53

Table 5. Anti-nutritional factors level in *Parkia biglobosa* fruit pulp

Anti-nutrients	Composition
Tannin (%)	0.048
Trypsin inhibitor unit (TIU/g)	12.67
Phytate (%)	0.687
Oxalate (%)	0.398

than 930 mg/100 g (0.93%) obtained by Bello et al. (2008). The variation in the antinutrients in PbFP may be due to the different environments in which *Parkia biglobosa* trees were planted as well as differences in soil profile and soil fertility (Malik et al., 2018).

The growth performance of broiler starters fed varying levels of *Parkia biglobosa* fruit pulp with or without enzymes supplementation from the 1st to 21st day is shown in Table 6. The addition of exogenous enzymes to the experimental diets did not significantly affect the growth performance of starter broilers except the FCR. This may be attributed to high fibre in dietary PbFP. However, the inclusion level of the pulp significantly (P = 0.028) increased FCR as the pulp level increased in the broiler starter diets. The lower the feed conversion ratio, the better it is for optimum growth performance (Bot, 2011). Broiler starters fed dietary 15% PbFP had highest feed conversion ratio, probably because they could not utilize the feed consumed as a result of high fibre. This result agrees with the observation of Bot (2011) who reported increase in feed conversion of broiler starters as the inclusion level of PbFP increases in their diet.

The growth performance of broiler finishers fed varied levels of PbFP with or without exogenous enzymes is presented in Table 7. The inclusion of the pulp and enzyme supplementation in experimental diets significantly influenced FBW

Table 6. Growth performance of broiler starters fed varying levels of *Parkia biglobosa* fruit pulp with or without Enzyme supplementation from 1st to 21st day of the study (g/bird)

Parameters	Control	T1	T2	T3	T4	T5	T6	P-value	SEM	Enz	Parkia	INT	R^2
Level of PbFP	0%	5%	10%	15%	(5% P + E)	(10% P + E)	(15% P + E)		–	–	–	–	–
IBW	50.48	51.48	48.33	50.00	50.00	50.00	50.00	0.953	1.83	0.970	0.734	0.734	0.10
FBW	670.53	641.67	608.52	540.00	598.52	569.26	569.19	0.097	26.53	0.392	0.088	0.485	0.49
ADG	29.53	28.11	26.68	23.33	26.12	24.73	24.29	0.070	1.37	0.390	0.090	0.484	0.52
ADI	49.91	51.61	50.28	48.53	45.91	47.4	49.40	0.731	2.47	0.209	0.996	0.408	0.20
FCR	1.69^{b}	1.84^{ab}	1.89^{ab}	2.10^{a}	1.76^{b}	1.91^{ab}	2.05^{a}	0.038	0.08	0.632	0.028	0.849	0.57

^{a,b,c,d} *– Means along the same row with different superscripts are significantly different (P < 0.05), Enz = Enzyme supplementation effect, Parkia = PbFP inclusion level effect, P + E = Parkia biglobosa fruit pulp plus with enzyme supplementation, INT = Interaction effect between the inclusion level of Pulp and enzyme supplementation. SEM = Standard error of mean,* R^2 *= Coefficient of determination, PBFP = Parkia biglobosa fruit pulp, IBW = Initial body weight, FBW = Final body weight, ADG = Average daily gain, ADI = Average daily intake, FCR = Feed conversion ratio*

(P = 0.0002) and average daily gain (P = 0.005) of finisher broilers. As the pulp level increased in the diets, the FBW (P = 0.002) and ADG (P = 0.030) decreased. Bot (2011) observed that as the level of *Parkia biglobosa* fruit pulp increased across the dietary treatments (from 25% to 100% replacement levels in the diet) the final weight and weight gain decreases. According to Bot (2011) as the level of the dietary fibre increase in the diet of broilers fed PbFP, the energy decreases with increase in level of PbFP thereby leading to poor growth performance of broilers. Furthermore, enzymes supplementation to 15% PbFP diet significantly improved the final body weight (P = 0.051) and average daily weight gain (P = 0.045). In addition, exogenous enzymes supplementation to 10% PbFP diet slightly enhanced FBW and ADG relative to those fed unsupplemented 10% PbFP diet. The beneficial roles of exogenous enzymes have been demonstrated in a number of tropical feedstuffs when fed to broilers. Alefzadeh et al. (2016) reported that broiler chickens fed dietary dried orange (*citrus sinensis*) peel powder supplemented with Natuzyme P50® improved weight gain. Furthermore, Sunmola et al. (2019) observed that addition of Polyzyme® to sweet orange peel meal (at 25% inclusion) in broiler diet improved the average final weight and ADG of the chickens.

The nutrient digestibility of broiler chickens fed varying levels of *Parkia biglobosa* fruit pulp with or without enzymes supplementation is presented in Table 8. The interaction effect of enzyme supplementation and PbFP strongly impacted on the digestibility of crude fibre (P = 0.0002), ether extract (P = 0.012) and ash (P = 0.002). Significant decreases were observed in the crude fibre digestibility of broilers as the level PbFP increased in the unsupplemented diets. However, exogenous enzymes supplementation significantly improved the CF digestibility relative to the unsupplemented groups. Furthermore, broiler chickens fed 10% PbFP diet supplemented with enzymes had better (P = 0.012) ether extract digestibility than their counterparts fed 10% PbFP diet without enzyme supplementation. Broilers fed 5% PbFP supplemented with enzymes had the highest (P = 0.0008) ash digestibility, however, supplementation of exogenous enzymes to higher PbFP level (10%) did not improved ash digestibility. Moreover, feeding 15% PbFP diet without enzymes to broilers significantly (P = 0.010) decreased NFE digestibility relative to those fed 10% PbFP. Furthermore, enzymes supplementation to 15% PbFP diet did not improve NFE digestibility. This indicated soluble carbohydrates are not sufficiently available for the use of broiler chickens when PbFP are fed at 15% inclusion level. The highest ash digestibility noticed in broilers fed unsupplemented 15% PbFP diet indicates that the fruit pulp is a good source of macro and micro elements. This result agrees with the report of Bello et al. (2008) who reported that *Parkia biglobosa fruit pulp* contained high amount of minerals such as calcium and magnesium, potassium, sodium, manganese, iron, zinc and copper. There were reports showing improvement on nutrient digestibility when poultry fed exogenous enzymes supplemented diets containing tropical feedstuffs. Alu (2012) reported that enzyme supplementation in laying quail fed sugarcane scrapping meal based diets improved the digestibility of crude protein, crude fibre, ether extract and nitrogen free extract. Also, Alagawany et al. (2015) reported that supplementation of commercial enzymes in poultry diets containing sunflower meal stimulates digestion of fibre. Breanna et al. (2017) stated that enzymes are expected to increase the digestion and utilization of dietary starch, protein, ß-glucan and arabinoxylan

The serum enzymes of broilers fed varying levels of *Parkia biglobosa* fruit pulp with or without enzymes supplementation is shown in Table 9. There were significant (P < 0.0001) increases in serum alkaline phosphatase (ALP) of broiler chickens fed unsupplemented PbFP diets. Additionally, there was elevated serum ALP of broilers fed enzymes supplemented PbFP diets except those fed 15% PbFP. The elevation in serum ALP of these experimental birds may indicate effective bone development for broiler chickens suggesting bioavailability of essential minerals in the pulp. Sousa et al. (2013) reported that serum ALP and bone ALP was elevated in 1 month old lambs due to high skeletal growth ve-

Table 7. Growth performance of broiler finishers fed varying levels of *Parkia biglobosa* fruit pulp with or without Enzyme supplementation from 21st to 42nd day of the study (g/bird)

Parameters	Control	T1	T2	T3	T4	T5	T6	P-value	SEM	Enz	Parkia	INT	R^2
Level of PbFP	O%	5%	10%	15%	(5% P ÷ E)	(10%% P ÷ E)	(15% P ÷ E)	–	–	–	–	–	–
IBW	642.96	641.67	608.52	540.00	598.52	569..26	569.19	0.097	26.53	0.392	0.088	0.485	0.49
FBW	1824.91^{a}	1678.89^{ab}	1502.59^{c}	1342.92^{d}	1681.30^{ab}	1588.33^{bc}	1525.93^{bc}	0.0002	47.82	0.051	0.002	0.247	0.82
ADG	54.99^{a}	49.39^{ab}	43.48.^{bc}	38.23^{c}	50.49^{ab}	48.53^{ab}	45.56^{b}	0.005	2.36	0.045	0.030	0.442	0.69
ADI	151.47	156.87	199.22	151.42	159.77	158.38	167.22	0.125	11.61	0.484	0.224	0.010	0.47
FCR	2.76^{b}	2.90^{b}	4.59^{a}	A3.98^{b}	3.22^{b}	3.28^{b}	3.67^{ab}	0.0943	0.37	0.211	0.098	0.166	0.56

^{a,b,c,d} *– Means along the same row with different superscripts are significantly different (P < 0.05), Enz = Enzyme supplementation effect, Parkia = PbFP inclusion level effect, P + E = Parkia biglobosa fruit pulp plus with enzyme supplementation, INT = Interaction effect between the inclusion level of Pulp and enzyme supplementation. SEM = Standard error of mean,* R^2 *= Coefficient of determination, PBFP = Parkia biglobosa fruit pulp, IBW = Initial body weight, FBW = Final body weight, ADG = Average daily gain, ADI = Average daily intake, FCR = Feed conversion ratio*

Table 8. Nutrient Digestibility coefficients of broiler chickens fed varying level of plastic-stored *Parkia biglobosa* fruit pulp with or without Enzymes supplementation

Parameters	Control	T1	T2	T3	T4	T5	T6	P-value	SEM	ENZ	Parkia	INT	R^2
Level of PbFP		5%	10%	15%	5% P + En	10% P + En	15% P + En	–	–	–	–	–	–
Dry matter	66.28	70.43	69.12	65.80	71.14	72.14	67.91	0.612	2.78	0.427	0.341	0.923	0.25
Crude protein	70.30	75.13	72.21	67.30	74.41	74.17	69.90	0.329	2.55	0.567	0.094	0.806	0.35
Ether extract	66.28^{b}	71.74^{ab}	63.57^{b}	63.79^{b}	65.05^{b}	77.26^{a}	63.05^{b}	0.026	2.86	0.395	0.083	0.012	0.60
Crude fibre	57.86^{cd}	62.74^{bc}	41.91^{c}	45.83^{de}	49.84^{de}	72.48^{ab}	75.81^{a}	0.0001	3.91	0.0005	0.526	0.0002	0.83
Ash	54.89^{b}	56.85^{b}	47.91^{b}	76.75^{a}	71.04^{a}	45.93^{b}	54.93^{b}	0.0008	4.10	0.382	0.002	0.005	0.77
NFE	64.45^{c}	74.80^{ab}	77.55^{a}	67.10^{bc}	74.84^{ab}	74.54^{ab}	67.24^{bc}	0.014	2.51	0.664	0.010	0.790	0.64

^{a,b} *– Means along the same row with different superscripts are significantly different (P < 0.050). Enz = Enzyme supplementation effect, P = PbFP inclusion level effect, INT = Interaction effect between the inclusion level of Pulp and enzyme supplementation. SEM = Standard error of mean,* R^2 *= Coefficient of determination, P + Enz = Parkia biglobosa fruit pulp Plus enzyme supplementation, PbFP = Parkia biglobosa fruit pulp, P + En = Parkia biglobosa fruit pulp with enzyme supplementation, NFE = nitrogen free extract*

Table 9. Serum enzymes of broiler finishers fed varying level of plastic-stored *Parkia biglobosa* fruit pulp with or without Enzyme supplementation

Parameters	Control	T1	T2	T3	T4	T5	T6	P-value	SEM	Enz	Parkia	INT	R^2
Level of PBFP	0%	5%	10%	15%	5% P ÷ En	10% P ÷En	15% P ÷ En	-	-	-	-	-	-
AST (IU/L)	45.62	49.32	28.61	51.82	38.61	58.01	48.50	0.410	9.23	0.540	0.754	0.142	0.3
ALT (IU/L)	2.89	4.64	4.32	2.83	2.51	2.56	6.60	0.489	1.55	0.976	0.691	0.162	0.2
ALP (IU/L)	23.00^{d}	29.36^{c}	36.99^{b}	44.62^{a}	48.47^{a}	45.76^{a}	22.57^{d}	< 0.0001	1.96	0.263	0.007	< 0. 0001	0.9

^{a,b,c,d} – Means along the same row with different superscripts are significantly different (P < 0.050). ALP = Alkaline phosphatase, ALT = Alanine aminotransferase, T P = Total Protein, Enz = Enzyme, supplementation effect, Parkia = PbFP inclusion level effect, INT = Interaction effect between the inclusion level of Pulp and enzyme supplementation. SEM = Standard error of mean, R^2 = Coefficient of determination, P + En = Parkia biglobosa fruit pulp with enzyme supplementation. PBFP = Parkia biglobosa fruit pulp

locity and rapid bone turnover. Serum ALP is a metalloenzyme that play an important role during mineralization (Moss, 1982).

Conclusion

It can be concluded that *P. biglobosa* fruit pulp is a rich source of nutrients particularly minerals though it contain high crude fibre. The inclusion of 5% PbFP in broiler diet supported maximum final body weight for broiler chickens. However, feeding 15% *Parkia biglobosa* pulp to broiler finishers required exogenous enzymes supplementation for improved final body weight, to maximize feed conversion ratio and enhance crude fibre digestibility.

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