Journal of Forestry Research and Management. Vol. 20(2).59-73; 2023, ISSN 0189-8418

www.jfrm.org.ng

COMBINED EFFECT OF ENZYMES COCKTAIL AND PROBIOTIC SUPPLEMENTATION TO NOILER CHICKENS FED *CISSUS POPULNEA* Guill. & Perr. ROOT MEAL BASED DIET ON PERFORMANCE AND COST-BENEFIT ANALYSIS

[1]Aguihe P. C., [2]Alaye S. A., [2]Osaguona P.O., [3]Ilaboya I.I., [4]Uwaeziozi, U.C., [5]Wealth, A. S. and [5]Kehinde, A. S.

[1]Department of Animal Production and Health Technology, Federal College of Wildlife Management, New Bussa, Niger state.
[2]Department of Forestry Technology, Federal College of Wildlife Management, New Bussa,
[3]Department of Animal Science, Benson Idahosa University, Benin, Edo state, Nigeria.
[4]Department of Animal Science, University of Agriculture and Environmental Sciences, Umuagwo, Imo state, Nigeria.
[5]Forestry Research Institute of Nigeria, Jericho Hill, Ibadan, Oyo state.
Corresponding author's email: aguihepc@gmail.com and Tel: +2348159457940

ABSTRACT

The rising cost of conventional feedstuffs has motivated poultry scientists to explore the incorporation of tropical agroforestry plants like *Cissus populnea*; with addition of enzymes cocktail and probiotic in poultry diets to enhance feed utilization and performance at a reduced cost of production. A 35-day experiment was designed to investigate the effect of mixture of multienzymes and probiotic supplementation in the diet of growing noiler chickens containing *Cissus populnea* root meal (CPRM) on productive performance and cost-benefit analysis. A total of 120, three weeks old noiler chickens were randomly allotted to three dietary treatments with five replications of seven birds each in a completely randomized design. Three diets were formulated such that the diet 1 serving as control (T1) was a maize-soybeanbasal diet, diet 2 (T2) contain CPRM replacing 10% of maize in T1, while diet 3contained mixture of enzymes cocktail and probiotic supplementation in T2 diet at 50g/kg. Data collected were statistically analyzed in a completely randomized design by analysis of variance (ANOVA). The result showed that higher (P<0.05) final body weights were recorded in birds fed with control (1991.60g) and CPRM diets with multienzymes+probiotics supplementation (1908.40g) than those fed unsupplemented CPRM diets. Weight gain (1538.20g) of birds fed with control diet was significantly higher (P<0.05) than those on CPRM diet without multienzymes+probiotics but did not differ significantly (P>0.05) from those offered multienzymes+probiotics supplemented CPRM diets. Feed conversion ratio decreased (P<0.05) in birds offered control and CPRM diets with multienzymes+probiotics compared to unsupplemented CPRM diet group. Cost of feed/kg, cost per kg/gain and cost of production were significantly (P<0.05) lower in birds fed with CPRM diet with or without multienzymes+probiotics than the control group. Birds fed with control and multienzymes+probiotics supplemented CPRM diets had higher (P<0.05) revenue (₦1095.60 and ₦1049.40, respectively) and profit margin (₦671.24 and ₦686.93, respectively) compared to the group fed unsupplemented CPRM diet. In conclusion, incorporation of CPRM to replace 10% maize in diet of noiler growers with multienzymes+probiotics supplementation improved their performance with lower cost/kg gain and increased profit margin.

Keywords: *Cissus populnea*, feed additive, performance, cost benefit, noiler.

Journal of Forestry Research and Management. Vol. 20(2).59-73; 2023, ISSN 0189-8418

www.jfrm.org.ng

Introduction

One major factor militating against the rapid development of the poultry industry in Nigeria is the lack of adequate supply of feedstuffs at economic prices, such that the panacea for the instant provision of cheap animal protein has often been more of a burden than an asset. Feeding poultry under intensive conditions is expensive becausefeeds accounts for 65-70% of the total cost of animal production (Ekenyem and Odo, 2011; Alabi *et al.*, 2014; Oguntoye *et al.*, 2018). The upsurge in feed cost has been a major constraint in profitable poultry production in most of the developing countries and this makes animal proteins like meat, eggs and milk expensive. The competition for grains, particularly maize being the major feed component by man, animal and industry has caused severe grain supply problems in the world market, with dramatic price increases.

Hence, it makes economic sense to find cheap alternatives for maize in poultry diets. Consequently, there is increasing interest by Nigerian poultry nutritionist and farmers to harness the potentials of unconventional feed ingredients of agro-forestry origin. Besides, these agro-forestry based feed resources are readily available with little or no cost and non-competitive that can be adopted to reduce maize dependency. Amongst these plant species is *Cissus populnea* root because of its richness in essential nutrients, low amount of phytochemicals, and good source of dietary energy for growth and body maintenance (Alaye *et al.*, 2012; Adelakun *et al.*, 2014; Achikanu and Ani, 2020).

Cissus populnea is a woody climber which belongs to the family of *Vitaceae/Amplidacea* (Li, 1998; Ibrahim *et al.*, 2011), and has been linked with numerous therapeutic uses in diverse places (Olaolu and Rotimi, 2017). Extracts of *C. populnea* have been recognized for antimicrobial properties (Kone *et al.*, 2004), anti-trypanosomal activities (Atawodi *et al.*, 2002), anti-sickling properties (Moody *et al.*, 2003) and diuretic properties as well as an ethnobotanical protectant (Belmain *et al.*, 2000). It has been reported also to be used in feeding cattle by the Fulanis supposedly increasing milk production (Ojekale *et al.*, 2006). It is also used in Niger, Kogi, Plateau, Kwara and Benue states of Nigeria for making vegetable soup to stop postnatal bleeding, intestinal parasites and indigestion. The root cures arrow-poison and also serves as antidote to sore breasts experienced by women at childbearing (Burkill, 2000). According to Achikanu and Ani (2020*)*,

C. populnea contains 2.7% moisture, 4.6% ash, 13.1% crude fat, 22.1% crude fiber, 1.5% crude protein, 56.0% carbohdrates and 347.75kcal/g total energy. Despite the numerous nutritive attributes of *C. populnea*, its utilization could be limited in poultry because it is highly fibrous and contains some amounts of cell wall components such as lignin and non-starch polysaccharides (NSP) (Akomolafe *et al.*, 2013). Poultry does not produce enzymes that degrade these cell wall components, and the presence of these undigested polysaccharides in the gastro-intestinal track can result in an increase in digesta viscosity (Annison, and Choct, 1991). This can cause inefficient nutrient absorption and/or a reduction in feed intake with resultant adverse effects on growth and productivity (Jha and Mishra, 2021). Moreover, in areas with intensive poultry production, the nitrogen and phosphorus outputs are high, leading to environmental issues like eutrophication.

In order to overcome this problem, feed additives including feed enzymes, mycotoxin binders, probiotics, and prebiotics are frequently added to poultry diets to improve growth performance and gastrointestinal health through the reduction of harmful bacteria, adsorption of toxins, and increased nutrient digestibility. With a global reduction in the application of antibiotic growth promoters (AGPs), research has focused on additives that increase nutrient digestibility, encourage intestinal integrity, immunity, and reduce inflammation. In this regard, enzymes and probiotics have shown great promise (Chotinsky, 2015; Jha*et al*., 2020). Several studies demonstrated that a cocktail of enzymes improved the solubility and digestibility of protein, reduced secretions of endogenous proteins and foregut digesta viscosity as well as increased energy digestibility and availability of carbohydrates for energy utilization in birds (Morgan and Bedford, 1995; Zanella *et al*., 1999; Aguihe *et al*., 2015; Yadav and Jha, 2019). Probiotics, also known as direct fed microbials, are capable of enhancing growth performance and nutrient digestibility by improving gastrointestinal tract health via competitive exclusion of pathogenic microorganisms (Abd El-Hack *et al*., 2020; Shini and Bryden, 2022).

At present, increasing studies have suggested that probiotics, such as *Lactobacillus* and *Bacillus*, have a positive effect on the broiler growth and nutrient digestion (Fazelnia *et al*., 2021; Bhogoju *et al*., 2021). Recently, there is accumulating evidence demonstrating that there are considerable beneficial effects of enzymes and probiotics mixture in terms of efficiency to enhance poultry growth, improve intestinal health, and suppress pathogens (Jayaraman *et al*., 2017; Hussein *et al*., 2020; Luo *et al*., 2022). Obviously, there is little or no information on the effect of dietary enzymes mixture in a combination with probiotics in Noiler chickens fed diet containing an agro-forestry based ingredient.

It was hypothesized that CPRM together with supplemental exogenous enzymes cocktail and probiotic mixture can effectively be used as a feed ingredient in diets for Noiler chickens without adversely affecting performance and blood metabolites. This feeding trial is aimed at evaluating the nutritional value of CPRM based diets supplemented with mixture of enzyme cocktails and probiotics on growth performance, in grower noiler chickens with a view to ascertaining its potentials for reducing the cost of chicken production.

Materials and Methods

Description of experimental site: This study was carried out at the Federal College of Wildlife Management, New Bussa, Niger State, Nigeria. New Bussa is located at longitude 9° 81' 95″ N and 9° 49' 10″ N and latitude 4° 58' 05″ N and 4° 34' 49″ N in the Savanna Areas of Niger Basin, North Central Zone of Nigeria. It has a uniformed rainfall pattern that begins in April and end in October with the mean annual rainfall of 1043mm. Temperature generally fluctuates between 15^0C (minimum) and 35^0C (maximum) with a mean annual temperature of 28-30^0C and mean annual relative humidity of 54-55%.

Source and processing of *Cissus populnea* root meal (CPRM): The CPRM was collected from Federal College of Wildlife Management Estate, New Bussa. The authentication of the plant was carried out at the herbarium unit, Department of Forestry Technology, Federal College of Wildlife

Management, New Bussa, Niger state. The roots were cleaned, dried and hammer milled to pass through 1mm sieve to obtain *Cissus populnea* root meal (CPRM). The resulting meal was then analyzed for proximate composition using standard methods (AOAC, 2016) prior to incorporation into the formulated experimental diets.

Ethical approval: The noiler chickens in the current study were handled according to guidelines passed by the institutional ethics committee for the care of animals and were approved by the Research Animal Ethics Committee of the Federal College of Wildlife Management, New Bussa, Niger state.

Experimental Birds, Design and Management: A total of 120, three weeks old unsex noiler chickens were randomly allotted to three treatments with five replications comprising 7 birds each in a completely randomized design. The chicks were housed in an open-sided and well-ventilated facility where the floors weremade of concrete and covered with wood shavings as litter material. All diets were fed in mash form and birds were provided *ad libitum* access to feed and water throughout the study.

Experimental diets: Three isocaloric and isonitrogenous diets were formulated to meet the nutrient requirements of Noiler chickens according to NRC (1994) guidelines. Diet 1 serves as a control diet containing maize-soybean meal based while diet 2 was formulated with the *C. populnea* root meal substituting maize meal in the control diet at 10% inclusion level, and diet 3 contained a mixture of cocktail enzymes and probiotics (Fullzyme®) supplementation in diet 2 at 50g/kg.The ingredients composition of the experimental diet is shown in Table 1.

Table 1: Ingredient composition of experimental diet Noiler chickens

Ingredients	Control	CPRM	CPRM + Fullzyme*
Maize	50.55	40.55	40.05
Soybean	33.30	33.30	33.30
Fishmeal	2.50	2.50	2.50
Wheat offal	5.50	5.50	5.50
Groundnut oil	4.00	4.00	4.00
Cissus populnea root	0.00	10.00	10.00
DCP	2.00	2.00	2.00
Limestone	1.00	1.00	1.00
Salt	0.30	0.30	0.30
Methionine	0.25	0.25	0.25
Lysine	0.30	0.30	0.30
Premix	0.30	0.30	0.30
Fullzyme®	0.00	0.00	0.50
Total	100	100	100
Crude Protein %	21.29	21.53	21.49

ME Kcal/kg	3128.15	3158.53	3141.54
Analyzed composition			
Dry matter	97.72	97.66	97.07
Ash	4.64	3.77	4.42
Crude fiber	4.50	8.62	8.90
Crude protein	19.86	20.10	20.01
Crude fat	5.92	6.24	6.10
Nitrogen free extract	65.08	61.27	60.57

*Fullzyme® is acommercial product containing unique blend of concentrated exogenous enzymes and *Bacillus*-based probioticwas manufactured by Biofeed Technology Inc., Brossard, QC, Canada and composed of following active ingredientsper kilogram diet: 2,000 IU a-amylase, 2,000 IU protease, 5,000 IU ß-glucanase, 5,000 IU cellulase, 3000 IU pectinase, 20,000 IUxylanase, 2,000 IU phytase, 5,000 IU ß-mannanase, 6,500 IU lipase and 2.8 × 10^9cfu *Bacillus subtilis*.

Performance Evaluation: The initial weights of the birds were taken before the commencement of the feeding trial. The live weights of the birds as well as the feed consumption of each replicate were measured weekly. The growth performance include body weight gain which was computed as the difference between the final weight and the initial weight of the birds, feed intake was determined as the difference between the amount of feed fed offered and the leftover. The feed conversion ratio was calculated as the rate of feed intake to body weight gain.

Cost of production analysis: The market cost of the ingredients at the time of the experiment was used to calculate the cost of feed per kilogram (₦), cost of feed per 100 kilogram (₦), total cost of feed consumed (₦), cost of feed per kilogram weight gain (₦), cost of production, revenue and profit margin according the procedure as described by Medugu *et al*. (2010)

Statistical Analysis: All data collected were statistically analyzed in a completely randomized design by analysis of variance (ANOVA) (General linear model) using the procedure of SAS (2016). Differences between means were computed using Tukey test of the same software and significance was accepted at p<0.05.

Results and Discussion

Proximate Composition of CPRM and Experimental Diets: The results for the proximate composition of CPRM analysis and experimental diets are presented in Table 2. The result showed that CPRM contained 97.81% dry matter, 11.41% crude protein (CP), 7.36% crude fat, 12.01% crude fiber, 10.51% ash, 56.52% nitrogen free extract (NFE) representing the carbohydrate level, and metabolizable energy (ME) of 3025.53kcal/kg was calculated using the formula as described by Pauzenga (1985) as ME (kcal/kg) = 37x % CP x 81.1 x % EE +

35.5 x % NFE. The result of the proximate analysis shown in Table 1 revealed the compositions of the carbohydrates, crude protein, crude fat, crude fiber, ash and moisture. The compositions of the constituents are in the following order: Carbohydrates (56.52%) > Crude fiber (16.01%) > Crude protein (11.41%) > Ash (10.51%) > Crude fat (7.36%) > Moisture (2.19%). These concentrations show that the root of *C. populnea* is nutritionally rich especially in carbohydrates and crude fiber, and relatively moderate in protein, ash and crude fat. Nevertheless, the high carbohydrate and calorific value content of *C. populnea* root value can be considered as a potential dietary energy source or may be included as a part of dietary supplements (Datta *et al*., 2019). Crude fiber was the second highest in composition. Crude fiber aids digestion and absorption of glucose and fat but its presence in high level can cause gastro-intestinal disturbances and decreased nutrient usage because it is largely made up of high content of cellulose and lignin (Oladiji *et al*., 2005), which is indigestible in poultry.

The moisture content of 2.19% obtained in the present study is lower than the value of 6.50% reported by Adelakun *et al*. (2014), and is within the range of values taken as safe limit for storage of plant food materials (Umar *et al*., 2007). This low moisture content indicates that it has a long shelf life and will not be prone to microbial growth. Moisture content is a measure of the food's water activity and an indication of stability and susceptibility of a food material to microbial contamination (Olutiola *et al*., 1999; Achikanu and Ani, 2020). Ash content is an indication of the mineral content of feed and from this study, the ash content of *C.populnea* was relatively high (10.51%).

This value is higher than the reported values of 4.61% by Achikanu and Ani (2020). The crude protein level in the CPRM recorded in this study is lower than the value (32.45%) reported by Adelakun *et al*. (2014) but higher that of 1.49% observed in *C. populnea* stem as reported by Achikanu and Ani (2020). The protein content of CPRM indicates that it's relatively a good source of protein compare to the stem bark of *C. populnea* whose potential use for formation of animal feed is limited. Moreover, the CP of 11.41% in the CPRM was higher than CP in maize, a conventional energy feedstuff with CP content of 9.10% and 9.25% as reported by Aduku (2005) and Tuleun *et al*. (2005), respectively; while crude fiber of 12.01 % in the CPRM was higher than 1.30% and 2.20 % CF reported for maize by Aduku (2005) and Tuleun *et al*. (2005), respectively. This shows that CPRM has a favorable comparative protein level with maize, though high crude fiber (16.01%) in the root meal may reduce its feeding value in poultry nutrition compared to maize with 1.3 - 2.20 % crude fiber levels.

Table 2: Proximate composition of *Cissus populnea* root meal

Nutrients	CPRM
Dry matter	97.81
Ash	8.51
Crude fiber	14.01
Crude protein	11.41

Crude fat	7.36
NFE	58.71

CPRM: *Cissus populnea* root meal; NFE – Nitrogen Free Extract

Growth performance: The performance of Noiler growers fed diets containing control and CPRM diets with and without multienzymes+probiotic are shown in Table 3. Initial weights of all groups of Noiler chickens ranged between 452.20 – 459.00 g/bird and did not show any significant difference (P>0.05) among the treatments. The feed intake ranged from 2169.20 to 2228.00 g/bird and the difference between the control groups and those fed CPRM diet with or without enzymes and probiotic mixture was not significant (P > 0.05).

The final body weight and weight gain ranged from 1658.00 to 1991.60 g/bird and 1205.80 to 1538.20 g/bird, respectively. Noiler chickens fed with the control and CPRM diet with supplemental multienzymes+probiotic recorded a significantly (P<0.05) higher final body weight of 1991.60g and 1908.40g, respectively than chickens fed unsupplemented-CPRM based diet (1658.00g). Birds fed control diet had the highest (P<0.05) weight gain (1538.20g) followed by those fed multienzymes+probiotic supplemented CPRM diet (1449.40g) compared to the CPRM based diet group (1205.80g) without multienzymes+probiotic supplementation. Feed conversion ratio which ranged from 1.45 to 1.80 was significantly (P<0.05) lower in control diet group than those fed unsupplemented CPRM based diet, but did not differ significantly (P>0.05) from the group offered CPRM diet with multienzymes+probiotics supplementation.

The significantly (P<0.05) lower value of body weight and weight gain recorded in broiler chickens fed CPRM based diets may be associated with higher crude fiber content which tends to precipitate negative effects on chicken performance (Ayed *et al.*, 2011; Soltani *et al.*, 2012). The CPRM is a fibrous wild plant containing NSP (Akomolafe *et al.*, 2013) that reduces the utilization of nutrients such that the substitutions of CPRM for maize increases the viscosity of the digestive contents and interfere with digestion and absorption of nutrients. Replacement of maize with 10% CPRM without enzyme supplementation caused a reduction in weight gain and an increase in feed:gain, this resulted from the fact that the birds consumed less feed and less energy was released. High fibrous diet understandably has been reported to exhibit higher level of anti-nutritional factor in form of NSP (Yadav *et al.*, 2019), which is responsible for the significant depression of the growth as observed in chickens fed unsupplemented CPRM based diet.

However, the current experiment showed that combination of enzymes cocktail and probiotics have the potential to bring improvement in high fibrous diet and this could be linked to the availability of additional substrate for hydrolysis, thus releasing more nutrients entrapped in the matrix (Momtazan *et al.*, 2011; Wealleans *et al.*, 2017; Abdulwahid *et al.*, 2022). Supplementation of the diets with the combination of these feed additives improved digestion and gut health, making more energy to be available to the birds; resulting in an improved feed:gain in the chickens (Alabi *et al.*, 2014; Singh *et al.*, 2019). This is a reflection that enzymes cocktail and probiotic combination allow improved performance or more efficient use of cheap and low quality carbohydrate-sources like CPRM in poultry diet without adversely affecting the animal performance. The results of the current study are in agreement with the literatures, where the combination of enzymes cocktail and probiotic microbes showed an additive response for improved performance which suggests independent mechanisms involved in increasing feed efficiency and energy utilization (Dersjant-Li, 2016; Singh *et al*., 2019; Abdulwahid *et al*., 2022; Luo *et al*., 2022). Enzyme supplementations have been reported to efficiently break down or attack the arabinoxylan linkages of non-starch polysaccharide thereby breaking them into smaller units, thereby resulting in a fast decrease in intestinal viscosity and improved digestibility and availability of nutrients (Alabi *et al*., 2014; Chotinsky, 2015).

The additions of enzymes help to address the non-starch polysaccharide viscosity, which leads to improve feed efficiency and facilitate the use of lower cost feed ingredients (Lazaro *et al*., 2003; Adeola and Bedford, 2004). Moreover, several studies have suggested that carbohydrase enzymes can depolymerize NSP and starch while phytase and protease can degrade phytate and protein, respectively (Cowieson and Adeola, 2005; Adeola *et al*., 2010; Bedford and Cowieson, 2012). This would ensure prebiotic substrate for beneficial bacteria and could restrict the flow of undigested protein used by pathogenic bacteria (Bedford, 2000).

The negative impact of pathogenic bacteria on gut health and nutrient utilization can also be abated by supplying probiotics in the diet (Yadav and Jha, 2019). In addition, previous publications have shown that probiotics containing *Bacillus sp.* can interact with other gut bacteria to stabilize the gut microbial colony and improve gut health; thus, providing a conducive environment for better enzyme activity to improve digestibility and nutrient utilization (Salim *et al*., 2013; Zhang *et al*., 2014; Gao *et al*., 2017). Also, it has been suggested that the combined inclusion of multienzymes and probiotics in diet of chickens can result in a complementary improvement of nutrient utilization than those delivered by either of the supplements alone (Momtazan *et al*., 2011).

In accordance with the current result, several studies shave reported that combination of exogenous digestive enzymes and probiotic is a possible strategy to improve feed digestion and productivity of aquatic animals (Maas *et al*., 2021; Tidwell *et al*., 2021; HosseiniShekarabi *et al*., 2022) and turkey poults (Ayoola *et al*., 2013) offered unconventional feedstuffs.

Table 3: Performance of noiler birds fed CPRM based diets with FULLZYME® supplementation

Parameters	Control	CPRM	CPRM+Fullzyme	SEM	P-values
Initial body weight g/bird	453.40	452.20	459.00	5.77	0.972
Final body weight g/bird	1991.60^{a}	1658.00^{b}	1908.40^{a}	42.17	0.013
Feed intake g/bird	2228.00	2169.20	2200.80	37.48	0.206
Body weight gain g/bird	1538.20^{a}	1205.80^{c}	1449.40^{b}	27.05	0.025

Feed: gain	1.45[b]	1.80[a]	1.52[ab]	0.14	0.035

[abc]Means in the same row with different superscripts are significantly (P<0.05) different

Economics of Production: The production cost parameters of grower Noiler chickens fed diets containing CPRM with and without multienzymes+probiotic treatment are summarized in Table 4. Except for the cost of feed consumed, feed cost, operational cost and price per kg bird, the inclusion of CPRM with or without multienzymes+probiotic supplementation significantly (P< 0.05) influenced all the parameters evaluated.

The result shows that Noiler chickens fed control diet recorded a significant (P<0.05) higher cost of feed/kg (₦147.13) than those fed CPRM based diets with and without multienzymes+probiotic treatment. This observation could be attributed to low cost per unit of CPRM compared to the high cost of maize. A similar trend was observed for cost/kg gain and cost of production, where birds fed with the control diet recorded the highest (P<0.05) mean values in these cost variables than those fed CPRM with or without multienzymes+probiotic supplementation. The revenue and profit margin generated from birds fed control and multienzymes+probiotic treated CPRM diets were significantly (P<0.05) higher than those fed untreated-CPRM based diet. This result could be linked to the improved feed conversion that yielded higher weight gain in the groups fed the control and multienzymes+probiotic supplemented CPRM diets.

The outcome of our trial showed that with mixture of enzymes cocktail and probiotic supplementation, it is possible to reduce the proportion of maize in the poultry diets by up to 10% inclusion of CPRM without any detrimental effect on the performance of the birds since the amount of cost savings was associated with improve weight gain and feed/gain ratio due tocombined multienzyme+probiotic supplementation. This present finding is in accordance with the reports of Alabi*et al*. (2014) and Oguntoye*et al*. (2018).

Reductions in the cost of raising 1kg of Noiler grower on supplementation with mixture of multienzymes and probiotic were profitable. The synergistic impact of enzymes cocktail and *Bacillus*-based probiotic has made it possible to enhance the capacities of broilers to consume and utilize indigestible feed resources and also improve the utilization of the relatively digestible ones at a small cost to farmers with improved profitability (Atteh, 2013). The inclusion of CPRM with supplementation of multienzymes+probiotic in the diets reduced the cost of producing broilers and hence increased profit, one of the economic benefits of using livestock feed enzymes is the opportunity to reduce feed cost, whilst maintaining animal performance (Danisco, 2006).

Table 4: Economics of production of Noiler chickens fed CPRM based diets with multienzymes+probiotic supplementation at growth phase (21 – 56 days)

Cost indices	Control	CPRM	CPRM + Fullzyme	SEM	P-values
Cost of diet/kg(₦/bird)	147.13[a]	114.46[b]	120.83[b]	3.45	0.012
Cost of feed consumed(₦/bird)	327.81	248.29	265.92	41.06	0.442
Cost per kg/gain(₦/bird)	213.34[ab]	206.03[bc]	183.66[c]	6.98	0.023
Operational cost(₦)	96.55	96.55	96.55	0.00	ND
Cost of production(₦/bird)	424.36[a]	344.84[b]	362.47[b]	9.32	0.003
Feed cost (%)	77.25	72.00	73.36	4.77	0.652
Price/kg bird(₦/bird)	550.00	550.00	550.00	0.00	ND
Revenue(₦/bird)	1095.60[a]	911.90[b]	1049.40[a]	24.54	0.031
Profit(₦/bird)	671.24[a]	567.06[b]	686.93[a]	8.65	0.004

[a,b] Means within a row lacking a common superscript differ ($P<0.05$)

Conclusion

This study revealed that CPRM possesses good nutritive attributes to serve as a partial replacement for maize in the diet of grower Noiler chickens. Inclusion of CPRM up to 10% replacement for maize withmixture of cocktail enzymes and *Bacillus*-based probiotic in Noiler chickens diet at growth phase resulted in an improved performance with lower cost/kg gain and increased profit margin. Further studies are encourage to investigate higher inclusion levels of CPRM to reduce greater proportion of maize with addition of enzymes cocktail and probiotics in diet of grower and finisher chickens.

Acknowledgment

The authors are very grateful to the Management of the Federal College of Wildlife Management, New Bussa, Niger state for providing the facilities that helped improve the quality of this research.

References

Abd El- Hack, M. E., El- Saadony, M. T., Shafi, M. E., Qattan, S. Y. A., Batiha, G. E., Khafaga, A. F., Abdel- Moneim, A. M. E., and Alagawany, M. (2020). Probiotics in poultry feed: Acomprehensive review. *Journal of Animal Physiology and Animal Nutrition*, 104(6), 1835-1850. doi: 10.1111/jpn.13454.

Abdulwahid, A.S., Mohammed, A.B., Raouf, S.M., and Aljumaily, T.K.H. (2022): Effect of Labazyme on Growth Performance, Physiological Parameters, and Economic Efficiency of Broiler Chickens. *World Veterinary Journal*, 12 (2): 156-163.

Achikanu, C.E. and Ani, O.N. (2020): Nutritional and phytochemical content of *Cissus populnea* (Okoho) stem bark. *Asian Journal of Research in Biochemistry*, 7(3): 8-15.

Adelakun, K.M., Alaye, S.A. and Mustapha, M.K. (2014): Potential use of tropical wild plant *Cissuspopulnea* meal as alternative to soyabean meal in the diet *Clarias gariepinus* (African catfish) juvenile. *Journal of Environmental and Agricultural Sciences*, 1:12-17.

Adeola, O. and Bedford, M. R. (2004): Exogenous dietary xylanase ameliorates viscosity-induced anti-nutritional effects in wheatbased diets for white pekin ducks

(*AnasPlatyrinchosdemesticus*). *British journal of nutrition*. 92. 87- 94.

Adeola, O., J. A. Jendza, L. L. Southern, S. Powell, and A. OwusuAsiedu. (2010): Contribution of exogenous dietary carbohydrases to the metabolizable energy value of corn distillers grains for broiler chickens. *Poultry Science*. 89:1947–1954.

Aduku, A. O. (2005): Tropical Feedstuff Analysis Table. Department of Animal Science, Ahmadu Bello University, Samaru, Zaria, Nigeria.

Aguihe, P. C., Kehinde, A. S. and Iyayi, E. A. (2015): Effect of enzyme (Maxigrain) supplementation on performance characteristics and nutrient digestibility of growing Japanese quails (*Cortunixcortunix japonica*) fed diet containing yam peels meal. *Nigeria Journal of Animal Science*, 17(1): 65 – 74.

Akomolafe, S.F., Oboh, G., Akindahunsi, A.A., Akinyemi, A.J. and Tade, O.G. (2013): Inhibitory effect of aqueous extract of stem bark of *Cissus populnea* on ferrous sulphate- and sodium nitroprusside-induced oxidative stress in rat's testes In Vitro. *Pharmacology* http://dx.doi.org/10.1155/2013/130989

Alabi, O. O., Atteh, J. O., Adejumo, O. I. and Ogundele, O. O. (2014): Cost-benefit analysis of replacing maize with rice husk supplemented with Grindazyme, Nutrsea Xyla or Roxazyme-G enzyme supplementation in the diet of Arbor Acres broilers. *International Journal of Applied Agricultural and Apicultural Research*. 10 (1&2): 82-90.

Alaye, S.A., Ajagbe, S.O., Adelakun, K.M. and Adeola, A.J. (2012): Nutrient Composition of Processed root of *Cissus populnea*. *Proceeding of Forest and Forest Products Conference.*University of Ibadan, Ibadan, Nigeria. April 3rd - 6th, 2012.

Annison, G. and M. Choct. (1991): Anti-nutritive activities of cereal non-starch polysaccharides in broiler diets and strategies minimizing their effects. *World´s Poultry Science Journal,* 47: 232–242.

AOAC. (2016): Official Methods of Analysis of the Association of Official Analytical Chemists, 20th ed.; AOAC Inc. Washington, DC, USA.

Atawodi, S. E., Ameh, D. and Ibrahim, A S. (2002): Indigenous knowledge system for treatment of trypanosomiasis in Kaduna State of Nigeria. *Journal of Ethnopharmacology*, 79(2): 279 282.

Atteh, J. O. (2013): Feeding livestock for optimum profit. Keynote paper presentation at the first ASAN/NIAS (Kwara State Chapter) workshop on feeds and feeding milling held on 18th-19th June, 2013at Kwara Hotel, Ilorin, Kwara State.

Ayed, H. M., Zghal, I. and Rekik, B. (2011): Effect of sepiolite supplementation on broiler growth performance and carcass yield. *Research Open Animal Veterinary Science*, 1: 375-378.

Ayoola, A. A., R. D. Malheiros, L. V. F. M. Carvalho, S. Indrakumar, L. F. Romero, and. Ferket, P. R. (2013): The effect of supplementing corn-DDGS diet with exogenous enzymes and direct-fed microbials on nutrient digestibility in turkey poults. *Poultry Science,* 92(E-Suppl. 1): 36.

Bedford, M. R., and A. J. Cowieson. 2012. Exogenous enzymes and their effects on intestinal microbiology. *Animal Feed Science and Technology*, 173:76–85.

Belmain, S. R., Golo, P., Andan, H. F., Atarigiya., H., Chare, F. A. and Carr, P. (2000): Toxicity and repellency of ethnobotanicals used in Ghana as postharvest protectants. *Phytoparasitic*. 28 (1): 87–90.

Bhogoju, S., Khwatenge, C.N., Taylor-Bowden, T. Akerele, G., Kimathi, B.M., Donkor, J.,and Nahashon, S.N. (2021): Effects of Lactobacillus reuteri and Streptomyces coelicolor on growth performance of broiler chickens. *Microorganisms*, 9, 1341.

Burkill, H.M. (2000): The useful plant of west tropical Africa. Royal Botanic Garden Ken, 5: 296-297.

Chotinsky, D. (2015): The use of enzymes to improve utilization of nutrient in poultry diets. *Bulgarian Journal of Agricultural Science*, 21: 429–435.

Cowieson, A. J., and Adeola, O. (2005): Carbohydrases, protease, and phytase have an additive beneficial effect in nutritionally marginal diets for broiler chicks. *Poultry Science*, 84:1860–1867.

Danisco, D. (2006): Benefits of enzymes, animal nutrition U.K. info.animalnutrition@danisco.com, www.danisco.com/animalnutrition.

Datta, S., Sinha, B.K, Bhattacharjee, S. and Seal T. (2019): Nutritional composition, mineral content, antioxidant activity and quantitative estimation of water soluble vitamins and phenolics by RP-HPLC in some lesser used wild edible plants. *Heliyon*, 5(3):e01431.

Dersjant-Li, Y., van de Belt, K., van der Klis, J. D., Kettunen, H., Rinttila, T. and Awati, A. (2016): Effect of multi-enzymes in combination with a direct-fed microbial on performance and welfare parameters in broilers under commercial production settings. *Journal Applied Poultry Research*, 24:80–90 http://dx.doi.org/10.3382/japr/pfv003.

Ekenyem, B. and Odo, B. (2011): Effect of replacement of soya bean meal by Bambara nut sievate on the carcass and organ parameters of finisher broiler chicks. *Open Journal of Animal Science*, 1: 93-96.

Fazelnia, K.; Fakhraei, J.; Yarahmadi, H.M. and Amini, K. (2021): Dietary supplementation of potential probiotics Bacillus subtilis, Bacillus licheniformis, and Saccharomyces cerevisiae and synbiotic improves growth performance and immune responses by modulation in intestinal system in broiler chicks challenged with Salmonella typhimurium. *Probiotics Antimicrob. Proteins*, 13: 1081–1092.

Gao, Z., Wu, H., Shi, L., Zhang, H., Sheng, R., Yin, F. and Gooneratne, R. (2017): Study of *Bacillus subtilis* on growth performance, nutrition metabolism and intestinal microflora of 1 to 42 d broiler chickens. *Animal Nutrition*, 3: 109 – 113.

HosseiniShekarabi, S.P., Ghodrati, M., Masouleh, A.S. andRoudbarak, A.F. (2022): The multi-enzymes and probiotics mixture improves the growth performance, digestibility, intestinal health, and immune response of Siberian sturgeon (*Acipenserbaerii*). *Annals of Animal Science*, 22(3): 1063–1072.

Hussein, E.O.S., Suliman, G.M., Alowaimer, A.N., Ahmed, S.H., Abd El-Hack, M.E., Taha, A.E. and Swelum, A.A. (2020): Growth, carcass characteristics, and meat quality of broilers fed a low-energy diet supplemented with amultienzyme preparation. *Poultry Science*, 99: 1988–1994.

Ibrahim, H., Mdau, B.B., Ahmed, A. and Ilyas, M. (2011): Anthraquinones of *Cissus Populnea* Guill & Perr (Amplidaceae). *African Journal of Traditional*

Complementary and Alternative Medicines, 8(2):140-143 140.

Jayaraman, S., Das, P.P., Saini, P.C., Roy, B. and Chatterjee, P.N. (2017): Use of *Bacillus subtilis* PB6 as a potential antibiotic growth promoter replacement in improving performance of broiler birds. *Poultry Science*, 96: 2614–2622.

Jha, R., Das, R., Oak, S. and Mishra, P. (2020): Probiotics (direct-fed microbials) in poultry nutrition and their effects on nutrient utilization, growth and laying performance, and gut health: a systematic review. *Animals*. 10 (10):1863.

Jha, R. and Mishra, P. (2021): Dietary fiber in poultry nutrition and their effects on nutrient utilization, performance, gut health, and on the environment: a review. *Journal of Animal Science and Biotechnology*, 12:51-67.

Kone, W. M., Atindehou, K., Terreaux, C., Hostettmann, K., Traore, D. and Dosso, M. (2004): Traditional medicine in North Cote-d'Ivoire: screening of 50 medicinal plants for antibacterial activity. *Journal of Ethnopharmacology*. 93(1): 43–49.

Lazaro, R., Gracis, M., Medel, P. and Mateos, G. (2003): Influence of enzyme on performance and digestive parameters of broilers fed rye-based. *Poultry Science*, 82, 132-140.

Li, K. 1998. Vitaceae: In lichaonuan (ed). Fl. Republic popularis Sin. 48(2): u-vu, 1- 3, 12-208.

Luo, C. Wang, L. Chen, Y. and Yuan, J. (2022): Supplemental Enzyme and Probiotics on the Growth Performance and Nutrient Digestibility of Broilers Fed with a Newly Harvested Corn Diet. *Animals* 2022, 12, 2381. https://doi.org/ 10.3390/ani12182381.

Maas, R.M., Verdegem, M.C.J., Debnath, S., Marchal, L. and Schrama J.W. (2021): Effect of enzymes (phytase and xylanase), probiotics (*B. amyloliquefaciens*) and their combination on growth performance and nutrient utilization in Nile tilapia. *Aquaculture*, 533: 736226.

Medugu, C., IKwari, I.D., Igwebuke, J., Nkana, I., Muhammed, I.D. and Hamaker, B. (2010): Performance and economic of production of broiler chicken fed sorghum or millet as replacement for maize in the semi-arid zone of Nigeria. *Agriculture and Biology Journal of North America*, 1(3): 321-325.

Momtazan, R., H. Moravej, M. Zaghari, and H. R. Taheri. (2011): A note on the effects of a combination of an enzyme complex and probiotic in the diet on performance of broiler chickens. *Irish Journal of Agriculture and Food Research*, 50:249–254.

Moody, J. O., Ojo, O. O., Omotade, ,O. O., Adeyemo, A. A., Olumese, P. E. and Ogundipe, O. O. (2003): Anti-sickling potential of a Nigerian herbal formula (ajawaron HF) and the major plant component (*Cissus populnea* L.CPK). *Phytotherapy Research*, 17 (10): 1173–1176.

Morgan, A.J. and Bedford, M.R. (1995): Advances in the development and application of feed enzymes. *Australian Poultry Science Symposium*. 7: 109-115

Oguntoye, M. A., Maikano, Y., Samuel, T., Usman, I. and Ahmed, A. (2018): Evaluation of maize-yam peel meal based diets supplemented with exogenous cocktail enzymes on growth performance, nutrient digestibility and metabolisable energy in finisher broiler chickens. *Nigerian*

Journal of Animal Production, 45(4):125 – 134.

Ojekale, A. B., Lawal, O. A., Lasisi, A. K. and Adeleke, T. I. (2006): Phytochemisty and spermatogenic potentials of aqueous extract of *Cissus populnea* (Guill. and Perr) stem bark. *The Scientific World Journal*. 6: 2140–2146.

Oladiji, A.T. and Mih, F.O. (2005): Proximate composition mineral and phytochemical constituents of *Eleusinecoracana* (finger millet). *African Journal of Biotechnology*, 4 (12): 1440-1441.

Olaolu, T. D. and Rotimi, D. E. (2017): Evaluation of the effect of *Cissuspopulnea* aqueous root infusion on some testicular function indices and serum hormones of male rats. *Nigerian Journal of Biotechnology*, 34: 105-116.

Olutiola, P.O., Famurewa, O. and Sonntag, H.G. (1999): An Introduction to General Microbiology, a Practical Approach. Germany: Heidelberger Verlagasanstalt and Druckerei GmbH Heidelberg.

Pauzenga, U. (1985): Feeding parent stock. *Zootechnia International*, 4 (5): 22-24.

Salim, H. M., H. K. Kang, N. Akter, D. W. Kim, J. H. Kim, M. J. Kim, J. C. Na, H. B. Jong, H. C. Choi, O. S. Suh, and W. K. Kim. (2013): Supplementation of direct-fed microbial as an alternative to antibiotic on growth performance, immune response, cecal microbial population, and ileal morphology of broiler chickens. *Poultry Science*. 92:2084–2090.

SAS. (2016): Statistical Analysis Software (SAS) Users Guide Statistics, SAS Inc. Cary, North California, 2016 edition.

Shini, S. and Bryden, W. L. (2022): Probiotics and gut health: linking intestinal homeostasis to poultry productivity. *Animal Production Science*, 62: 1090-1112.

Singh, A. K., Tiwari, U. P., Berrocoso, J. D., Dersjant-Li, Y., Awati, A. and Jha, R. (2019): Effects of a combination of xylanase, amylase and protease, and probiotics on major nutrients including amino acids and non-starch polysaccharides utilization in broilers fed different level of fibers. *Poultry Science.* 0:1–11 http://dx.doi.org/10.3382/ps/pez310.

Soltani, A., Pourreza, J., Kheiri, F. and Faghani, M. (2012): Effect of partially substituted barley malt on performance, bone ash, calcium and phosphorus of broiler chickens. *Research of Animal Veterinary Science*, 2: 133-135.

Tidwell J.H., Coyle S.D., Rossi W. and Rucker K. (2021): Evaluation of brewers spent grains with different levels of exogenous enzymes on the production performance and body composition of Nile tilapia (*Oreochromisniloticus*) and channel catfish (*Ictalurus punctatus*). *J. Appl. Aquac*. 1–16.

Tuleun, C. D., Njike, M. C., Ikurior, S. A. and Ehiobu, N. G. (2005): Laying performance and egg quality of hens fed cassava root meal/brewer's yeast slurry based diets. *Production Animal Techniques*, 1: 148-152.

Umar, K.S., Hassan, L.G. and Ado, Y. (2007): Mineral composition of *DetariummicrocarpumGrown* in Kwatarkwashi, Zamfara State, Nigeria. *International Journal of Pure Applied Science*, 1(2): 43-48.

Wealleans, A. L., M. C. Walsh, L. F. Romero, and Ravindran, V. (2017): Comparative effects of two multi-enzyme combinations and a *Bacillus* probiotic on growth performance, digestibility of energy and nutrients, disappearance of non-starch polysaccharides, and gut microflora in broiler chickens. *Poultry Science,* 96: 4287–4297.

Yadav, S. and Jha, R. (2019): Strategies to modulate the intestinal microbiota and their effects on nutrient utilization, performance, and health of poultry. *Journal of Animal Science and Biotechnology*. 10:2.

Yadav, S., B. Mishra, and R. Jha. (2019): Cassava (*Manihot esculenta*) root chips inclusion in the diets of broiler chickens: effects on growth performance, ileal histomorphology, and cecal volatile fatty acid production. *Poultry Science,* doi: 10.3382/ps/pez143.

Zanella, I., Sakomura, N.K., Silversides, F.G., Fiqueirdo, A. and Pack, M. (1999): Effect of enzyme supplementation of broiler diets based on maize and soybeans. *Poultry Science.* 78: 561-568.

Zhang, S.C., Gao, Z.H. and He, H. (2014): Preliminary observation of the effect of endophytic marine bacterium from mangrove on growth performance and immunologic function of yellow feather broilers. *Journal of Henan Agricultural Science,* 43(2):119e22.