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Effects of Dietary Rice Offal Inclusion Level and Enzyme (Natuzyme) Supplementation on the Performance and Nutrient Digestibility of Finisher Broiler Chicken

Patience Belikisu Egbunu[1*], Comfort Doshima Tuleun[1], Kanan Tyohemba Orayaga[1] and Sylvester Eke Adejoh[2]

[1]Department of Animal Nutrition, Federal University of Agriculture, Makurdi, Benue, Nigeria.
[2]Department of Animal Production, Federal University of Agriculture, Makurdi, Benue, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An eight-week study was carried out to determine the effect of dietary rice offal inclusion levels and Natuzyme® enzyme supplementation on performance of broiler chicken. Two hundred and ten 7-day old broiler chicks of *Arbor Acre* strain were randomly allocated to seven dietary treatments groups with each treatment having thirty birds. The experiment had two phases; starter (28 days) and finisher phase (28 days). The seven dietary treatments were 0% (T1) without enzyme and without rice offal, 5% (T2 and T3) with and without enzyme, 10% (T4 and T5) with and without enzyme, and 15% (T6 and T7) with and without enzyme supplementation at 250 mg per kg diet. The experiment was a 2 x 3 factorial in a completely randomized design having treatment groups replicated three times, and each replicate had 10 birds, which were randomly allocated to the experimental diets. Performance at the starter phase showed no significant differences (P>0.05)

**Corresponding author: E-mail: ademupatienceb@gmail.com;*

across the treatment groups for the main effect, interaction and treatment combination. There was non-significant difference (P>0.05) for rice offal level main effect. At finisher level, significant differences (P<0.05) occurred in the enzyme level and all were significantly higher at 0.025%. No statistical differences (P>0.05) for interaction. Results of the nutrient digestibility showed significant differences (P<0.05) in the rice offal level for ash and NFE, but no difference in the enzyme levels for main effect and interaction. Significant (P<0.05) differences occurred in the treatments combination for dry matter and crude protein. Broiler starter and finisher performed better at 0.025% enzyme supplementation of rice offal.
It was recommended that 0.025% enzyme should be included in rice offal and 15% of the enzyme treated rice offal should be used in finisher broiler diets.

Keywords: Dietary rice offal; enzyme (Natuzyme®); broiler chicken; performance and nutrient digestibility.

1. INTRODUCTION

Broiler chicken is important source of table meat in Nigeria. They are fast growing and are efficient converters of feeds. According to Oluyemi and Roberts [1], they can attain a market weight between 1.6 to 2 kg at 8 weeks with a feed conversion ratio of 2:1. Urdaneta and Leeson [2] also asserted that broiler birds are fast growing birds and are described as one of the most efficient converters of feed to animal protein and it is generally assumed that when birds eat more, they attain higher body weight at market age from eight to twelve weeks. Broiler birds are birds that have high feed consumption and conversion of non-conventional feed ingredients that cannot be directly consumed by man into high quality meat [3]. However, the production of broiler birds as meat bird cannot be effective in the absence of adequate feed and feed ingredients in right proportion.

It has been estimated that 70-80% of poultry production inputs is been attributed to feed cost, hence making it imperative that good quality feed be available at reasonable price to make poultry production more profitable [4]. For this to happen, there is need to explore the use of alternative and non-conventional feed ingredients that are cheaper and locally available [5]. One of such alternative feed ingredients is rice offal.

The use of rice offal to replace cereal grains in poultry diets have been studied [6,7]. Rice offal has been successfully fed to broiler chickens at lower levels of inclusion in order to reduce feed costs and increase the profit margin [8,9,10,11]. It is an agro-industrial by product that could contribute to poultry feeding and is available in large quantities all year round in many towns in rice growing areas. Nigeria has the potential to produce about 200,000 metric tonnes of rice offal from the 500,000 metric tonnes of rice produced annually [12]. The offal, therefore, makes up about 40% of the parboiled rice and contains husk, bran polishing and small quantities of broken grains. In spite of its abundance, it has been neglected as animal feeds because it contains high level of fibre and low protein and energy [13]. Maikano [10] reported the proximate composition of rice offal thus; 94.42% dry matter, 5.09% crude protein, 30.39% crude fibre, 3.40% ether extract, 16.67% ash and 46.10% nitrogen free-extract.

In broilers, high fibre tends to limit the amount of intake of the available energy by the birds and it also results to the secretion of excessive nutrients [14]. Agbede et al. [15] had shown that high fibre and lignin contents of rice offal are capable of reducing nutrient utilization and also precipitate metabolic dysfunction when digested by non-ruminants. Considering the fact that poultry cannot fully utilize high fibre diets because of the lack of the digestive framework that can elaborately digest large amount of fibre, it becomes necessary, therefore, to incorporate exogenous enzymes into diets containing high fibre in order to enhance the breakdown of the non-starch polysaccharides (NSPs) present in fibre.

Enzymes are organic catalyst which hasten the break down and digestion of food substances and thereafter remain unchanged. The breakthrough in feed enzyme products has provided a quantum leap in animal nutrition. Feed enzymes enhance digestibility and availability of dietary nutrients and subsequent animal performance to sustain livestock production. The inclusion of enzymes in poultry feed brings about higher utilization of nutrients trapped in the vegetable feed ingredient. Enzymes enable the nutritionist to lower the cost

of production and improve performance of birds [16].

In view of the importance of fibre and its utilization by poultry (broiler) and the benefits of the use of enzymes to increase digestion and utilization of fibrous feedstuff, the need for this study becomes imperative.

The present study was therefore designed to investigate the effect of dietary rice offal inclusion level and enzyme supplementation on growth performance of broiler.

2. MATERIALS AND METHODS

The study was conducted at Livestock Unit, Teaching and Research Farm, Kogi State College of Education Ankpa. Ankpa is located on latitude 7.4053° N, and Longitude 7.6223° E in the southern guinea savanna ecological zone of West Africa, with a climate that has two distinct seasons (wet and dry season). The wet season starts in April and ends in October while the dry season spans November through March. High temperature is experienced between February and April, while the harmattan with cool chilly weather is experienced from December to early February. The area has annual rainfall ranging from 500 to 1000 mm with a minimum temperature range of 23.10°C to 26.09°C and maximum temperature range of 34.50°C to 37.60°C, respectively. The relative humidity ranges between 38.50% and 62% according to a website address [17].

2.1 Source and Preparation of Test Ingredient

Rice offal was sourced from local rice mill in Ankpa, Ankpa Local Government Area of Kogi State, cleaned of foreign materials, separated into two lots and bagged to the time it was incorporated in the diets. Before incorporation into the diets, one of the lots was treated with Natuzyme$^{(R)}$ at 250 mg/kg, while the other remained untreated. All the conventional ingredients were obtained from the open market. The micro ingredients namely bone ash, vitamin/mineral premix, methionine, lysine and common salt were obtained from a reputable livestock store.

2.2 Dietary Preparation

Experimental diets were compounded such that maize based broiler starter chick diets were formulated according to the National Resource Council (NRC) [18] recommendation of 23% CP and 2800 kcal/kg as the control (T_1) (NRC, 1994). Rice offal was included at Three levels; 5%, 10% and 15% respectively, while Natuzyme® was included at 250 mg/kg. This generated six diets; three with rice offal without Natuzyme® and three with rice offal and Natuzyme® with a separate control, which contained neither rice offal nor Natuzyme® making a total of seven diets, for both starter and finisher broiler chickens (Tables 1 and 2). The diets were coded thus: T1 (control, 0% rice offal, 0% Natuzyme®), T2 (5% rice offal with 0.025% Natuzyme®), T3 (5% rice offal without Natuzyme®), T4 (10% rice offal with 0.025 Natuzyme®), T5 (10% rice offal without Natuzyme®), T6 (15% rice offal with 0.025 Natuzyme®) and T7 (15% rice offal without Natuzyme®).

Composition of Natuzyme®

Cellulase 6,000,000 u/kg
Gluconase 7,000,000 u/kg
a-mylase 7,000,000 u/kg
pectinase 70,000 u/kg
Phytase 500,000 u/kg
Protease 500,00 u/kg and
Lipase 30,000 u/kg

2.3 Experimental Design

The feeding trial involved a 2 x3 factorial arrangement in a completely randomized design with three replicate per treatment and ten bird per replicate; the total number of birds per treatment been thirty. The chicks were weighed and balanced at the beginning of the experiment and randomly allocated to the various treatment groups and replicates.

2.4 Experimental Animals and Management

Two hundred and ten (210) Arbor acre strain broiler chicks were purchased from Vertex farm in Ibadan and used in the feeding trial. The birds were reared on deep litter system, in an open sided wire mesh screened poultry house and were covered with polyethylene sheets to conserve heat. Heat (38°C-27°C i.e from starter to finisher stage) was supplied by using kerosene stoves, electric bulbs, and lanterns during brooding for the first 3 weeks of age. Feed and clean water were supplied *ad libitum* throughout the feeding trial, which lasted for starter and for

finisher. Vaccines like Newcastle (i/o) vaccine was administered at day-old, Gumboro vaccine was administered at 7th and 14th days, while the Newcastle vaccine lasota was given at 21st day into drinking water as recommended by National Veterinary Research Institute, Vom, Jos, Nigeria. Vitalyte-electrolyte and energy replacement formulation, containing trace elements and some amino acids were given via drinking water before and after vaccination and handling of the birds. Dewormer, zolex, was given via drinking water at the end of the fourth and fifth weeks to deworm them. Antibiotics were also given along with the anti-coccidiosis occasionally. The litter materials were kept dried throughout the period of the experiment bdased on the management practice. Camry Table Scale; max. = 50 kg, min. = 4 kg, e = 200 g and Camry Digital Scale measuring from 0.00 g to 2 kg were used for measuring feed and birds.

2.5 Growth Performance

Initial weight: The birds were weighed at the beginning of the experiment and recorded against each replicate of treatment groups.

Feed Intake: The birds were served weighed amount of feed weekly and the corresponding leftover feed weighed and recorded in each of the replicate. Feed intake were determined by difference.

Table 1. Percentage composition of Broiler chick diets containing different inclusion level of rice offal supplemented with enzyme (Natuzyme®) (%)

	Experimental diets						
Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**
Rice offal levels	-	5	5	10	10	15	15
Natuzyme® level	-	+	-	+	-	+	-
Maize	50.00	49.35	49.35	41.70	41.70	34.35	34.35
Soybean Meal	26.71	27.00	27.00	28.00	28.00	27.00	27.00
Groundnut Cake	13.44	14.00	14.00	14.35	14.35	16.00	16.00
Maize offal	6.00	-	-	-	-	-	-
Rice offal	-	5.00	5.00	10.00	10.00	15.00	15.00
Bone meal	3.00	3.00	3.00	2.80	2.80	2.80	2.80
Palm oil	-	0.80	0.80	2.25	2.25	4.00	4.00
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	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
Total	100	100	100	100	100	100	100
Calculated analysis							
Crude Protein	23.29	23.15	23.15	23.26	23.26	23.11	23.11
ME (Kcal/kg)	2848.18	2848.83	2848.83	2825.91	2825.91	2813.19	2813.19
Crude Fibre	4.10	5.46	5.46	7.33	7.33	9.13	9.13
Ether Extract	2.23	3.95	3.95	5.28	5.28	6.81	6.81
Calcium	1.22	1.30	1.30	1.33	1.33	1.43	1.43
Phoshorus	0.86	0.89	0.89	0.89	0.89	0.92	0.92
Methionine	0.57	0.57	0.57	0.58	0.58	0.56	0.56
Lysine	1.22	1.21	1.21	1.18	1.18	1.23	1.23

Vitamin-mineral premix (animal care®) supplies the following additional nutrients per kg of feed. Vitamins D (1,200,000 I. U), D3 (300,000 I.U), E (3,000 mg), K3 (250 mg), folic acid (10 mg), Niacin (4,000 mg), Calpan (1,000 mg), B2 (500 mg), B12 (2 mg), B1 9200 mg), B6 (350 mg), Biotin (8 mg), Antioxidant (12,500 mg), Minerals. Cobalt (25 mg), Selenium (25 mg), iodine (120 mg), iron, (4000 mg), Manganese (700 mg), Copper (800 mg), Zinc (6,000 mg) and Chlorine Chloride (20,000 mg). T_1 = control diet, T_2 = 5% Rice offal with enzyme, T_3 = 5% Rice offal without enzyme, T_4 = 10% Rice offal with enzyme, T_5 = 10% Rice offal with enzyme, T_6 = 15% Rice offal with enzyme, T_7 = 15% Rice offal without enzyme*

Table 2. Percentage composition of broiler finisher diets containing different inclusion level of rice offal supplemented with enzyme (Natuzyme®) (%)

	Experimental diets						
Ingredients	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**
Rice offal levels	-	5	5	10	10	15	15
Natuzyme® level	-	+	-	+	-	+	-
Maize	50.15	49.15	49.15	46.45	46.45	40.55	40.55
Fulfat Soybean	24.00	24.50	24.50	29.50	29.50	40.60	40.60
Groundnut Cake	11.00	11.50	11.50	8.70	8.70	-	-
Maize offal	11.00	6.00	6.00	2.00	2.00	-	-
Rice offal	0.00	5.00	5.00	10.00	10.00	15.00	15.00
Bone meal	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Premix	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Methionine	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
Total	100	100	100	100	100	100	100
Calculated analysis							
Crude Protein	20.12	20.10	20.10	20.03	20.03	20.01	20.01
ME (Kcal/kg)	3062.15	3022.11	3022.11	3001.21	3001.21	2998.11	2998.11
Crude Fibre	4.04	5.51	5.51	7.15	7.15	9.08	9.08
Ether Extract	7.30	6.63	6.63	7.25	7.25	8.67	8.67
Calcium	1.24	1.33	1.33	1.43	1.43	1.54	1.54
Phosphorus	0.85	0.89	0.89	0.94	0.94	1.02	1.02
Methionine	0.57	0.54	0.54	0.54	0.54	0.56	0.56
Lysine	1.02	1.02	1.02	1.09	1.09	1.19	1.19

Vitamin-mineral premix (animal care®) supplies the following additional nutrients per kg of feed. Vitamins D (1,200,000 I. U), D3 (300,000 I.U), E (3,000 mg), K3 (250 mg), folic acid (10 mg), Niacin (4,000 mg), (1,000 mg), B2 (500 mg), B12 (2 mg), B1 9200 mg), B6 (350 mg), Biotin (8 mg), Antioxidant (12,500 mg), Minerals. Cobalt (25 mg), Selenium (25 mg), iodine (120 mg), iron, (4000 mg), Manganese (700 mg), Copper (800 mg), Zinc (6,000 mg) and Chlorine Chloride (20,000 mg). T_1 = control diet, T_2 = 5% Rice offal with enzyme, T_3 = 5% Rice offal without enzyme, T_4 = 10% Rice offal with enzyme, T_5 = 10% Rice offal with enzyme, T_6 = 15% Rice offal with enzyme, T_7 = 15% Rice offal without enzyme*

Final body weight of birds in treatments replicates were measured at the end of the respective phases; starter and finisher. Final weight for starter was weighed at week four while that of the finisher was weighed at week eight.

Table 3. Proximate composition of test ingredients (rice offal) on dry matter basis

Nutrient (%)	Composition
Dry matter	89.31
Crude protein	4.38
Ether extract	5.85
Crude fibre	28.40
Ash	16.95
Nitrogen free extract	33.73

Proximate composition of rice offal meal as well as feacal sample collected during digestibility trial were analyzed using a standard method [19], at animal Nutrition Laboratory Department of Animal Nutrition, Federal University of Agriculture Makurdi

Weight gain: It was determined as the difference between initial and final weights.

Feed Conversion ratio: This was calculated using the formula:

$$FCR = \frac{Feed\ consumed\ (g)}{Weight\ gain\ (g)}$$

Protein intake: This was calculated by multiplying total feed consumed by the amount of crude protein in the diet.

Protein efficiency ratio: This was determined by finding the ratio of gain in body weight (g) to protein intake (g) i.e.

$$PER = \frac{Gain\ in\ body\ weight\ (g)}{Protein\ intake\ (g)}$$

Mortality rate: Mortality were recorded if and when it occurs and was calculated as the ratio of

the number of dead birds to the total number of birds per treatment, expressed as percentage.

$$Mortality\ Rate\ = \frac{Number\ of\ dead\ birds\ \times\ 100}{Total\ number\ of\ birds}$$

At the finisher phase, two hundred and ten (210), four weeks-old broiler starter chicks used at the starter phase of the experiment were pooled together, weighed and randomly allocated to the described diets (Table 4). The feeding trial involved seven treatments with three replicate per treatment and 10 birds per replicate as in the starter phase. The experiment lasted for 48 days. Birds and left over feed were weighed weekly and recorded. Performance parameters were measured as in experiment 1.

The seven diets were formulated to meet standard nutrient requirements of broilers according to Aduku [20] from day old to 28 (starter phase) and from 29-42 (finisher phase).

2.6 Digestibility Study

At the end of the 7th week in the study, two birds were selected from each replicate, such that their average weights were similar to the average weights of the whole replicate, transferred into metabolic cages and allowed an adjustment period of three days. The birds were there after fed weighed amounts of feed daily for four days. Left over feed for each day was weighed to determine feed intake by difference, fecal droppings were collected weighed and oven dried to a constant weight. Collected fecal samples from each replicate were thoroughly mixed and milled to obtain a homogenous mixture, which were analyzed for proximate composition according to standard methods [21]. The percentage total digestible nutrient (TDN) and apparent digestibility coefficient were then calculated using the following formulae below as outlined by McDonald et al. [22].

Digestibility coefficient was calculated using the formula;

$$Apparent\ Digestibility\ =$$

$$\frac{Nutrient\ Intake\ -\ Nutrient\ in\ Faeces\ \times\ 100}{Nutrient\ intake\ (g)}$$

2.7 Data Analysis

Data generated were subjected to Analysis of Variance (ANOVA) using the general linear models procedures SPSS software version 16.0 [23] and Significant differences between means were separated using Duncan's Multiple Range Test, of the same package relation weighs were transformed using arcsin transformation before subjecting such data to analysis at variance.

3. RESULTS AND DISCUSSION

3.1 Main Effect of Dietary Rice Offal or Enzyme (Nutuzyme®) Supplementation on Performance of Starter Broiler Chickens

Result of the main effect of rice offal or enzyme (Natuzyme®) supplementation on the growth performance of broiler starter chickens is presented in Table 4. Broiler chicks fed 5, 10 and 15% rice offal had similar average final weight (AFW) which ranged from 622.50 to 642.50, average daily weight gain (ADWG), from 17.38 to 18.06, daily feed intake (DFI) ranged from 41.67 -90.83, feed conversion ratio (FCR) ranged from 2.29 to 2.35, daily protein intake (DPI) ranged from 9.13 to 9.67 and protein efficiency ratio (PER) ranged from 0.53 to 0.54. There were no significant differences (P > 0.05) across the treatment group in all the measured parameters.

Table 4. Main effect of dietary rice offal or enzyme (Natuzyme®) supplementation on performance of starter broiler chickens

Parameters	Rice offal level					Enzyme level			
	5%	10%	15%	SEM	P	0%	0.025%	SEM	P
Initial weight (g)	136.67	135.83	136.67	1.08	0.82	136.11	136.67	0.88	0.66
Final weight (g)	642.50	622.50	633.33	1.08	0.74	636.67	628.89	14.84	0.72
Daily weight gain (g)	18.06	17.38	17.74	0.65	0.77	17.88	17.50	0.53	0.70
Daily feed intake (g)	42.05	90.83	41.67	28.93	0.41	74.31	42.06	23.62	0.35
Feed conversion ratio	2.35	2.29	2.35	0.07	0.80	2.25	2.41	0.06	0.09
Daily protein intake (g)	9.67	9.13	9.59	0.23	0.23	9.25	9.68	0.18	0.13
Protein efficiency ratio	0.54	0.53	0.54	0.02	0.77	0.52	0.56	0.01	0.08

SEM= Standard error of mean, P = Probability value for rice offal main effect. p = probability value for enzyme main effect

Table 5. Interaction effect of dietary rice offal by enzyme (Natuyme®) supplementation on performance of starter broiler chicken

Rice offal X enzyme		Parameters						
		IW	FW	DWG	DFI	FC R	DPI	PER
5% RO	0%	136.662	666.667	18.93	42.03	2.22	9.67	0.51
	0.025%	136.662	618.33	17.20	42.08	2.41	9.68	0.57
10% RO	0%	135.00	623.33	17.44	40.71	2.21	8.83	0.51
	0.025%	136.662	621.667	17.23	40.95	2.38	9.43	0.55
15% RO	0%	136.662	620.00	17.26	40.18	2.32	9.24	0.53
	0.025%	136.662	646.667	18.22	43.16	2.37	9.93	0.55
SEM		1.41	24.09	0.87	37.89	0.11	0.35	0.03
P		0.82	0.37	0.37	0.39	0.61	0.54	0.64
LS		NS	NS	NS	NS	NS	NS	NS

SEM = Standard error of mean, P = Probability value, LS = level of significance, NS = Not significant (P<0.05), RO = Rice Offal, IW = Initial Weight, FW = Final Weight, DWG = Daily Weight Gain,DFI=Daily feed intake, DPI = Daily Protein Intake, FCR = Feed Conversion Ratio, PER = Protein Efficiency Ratio

Table 6. Treatment combination effect of dietary rice offal and enzyme (Natuzyme) supplementation on performance of starter broiler chicken

Parameters	Experimental diets								
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	SEM	P
	C	ER5	NER5	ER10	NER10	ER15	NER15		
Initial weight (g)	135.00	136.67	136.67	135.00	136.67	136.67	136.67	1.41	0.9^{ns}
Final weight (g)	650.00	666.67	618.33	623.33	621.67	620.00	646.67	24.09	0.7^{ns}
Daily weight gain (g)	18.40	18.93	17.20	17.44	17.33	17.26	18.23	0.87	0.7^{ns}
Daily feed intake (g)	40.66	42.03	43.16	38.40	40.95	40.18	43.16	37.89	0.47^{ns}
Feed conversion ratio	2.21	2.22	2.48	2.21	2.37	2.32	2.37	0.11	0.52^{ns}
Daily protein intake (g)	9.35	9.67	9.68	8.83	9.43	9.24	9.93	0.35	0.44^{ns}
Protein efficiency ratio	0.51	0.51	0.57	0.51	0.55	0.53	0.55	0.03	0.50^{ns}

T_1 = Control diet, T_2 = 5% rice offal with enzyme T_3 = 5% Rice offal without enzyme, T_4= 10% Rice offal with enzyme, T_5 = 10% rice offal without enzyme, T_6 = 15% Rice offal with enzyme, T_7 = 15% rice offal without enzyme. NER = No enzyme rice offal, ERO = Enzyme rice offal, P = probability value for main effect, SEM= Standard error of mean

The non-significant differences observed on the growth performance showed that the levels of rice offal or enzyme supplementation had no adverse effect on the growth performance of starter broiler chickens. This could be attributed to the balanced nature of the diet, though the fibre was high, the birds may have all gotten their requirement and such making any effect the enzyme may have created.

This result is also in agreement with the finding of Darwang and Damang [24]; Oyawoye and Nelson [12] and Maikano [25], who stated that rice offal can be added at levels of 10% in broiler starter feed without any adverse effect on growth performance.

3.2 Interaction Effect of Dietary Rice Offal by Enzyme (Natuzymes®) Supplement on Performance of Starter Broiler Chickens

Result of the interaction effect of dietary rice offal and enzyme (Natuzyme®) supplementation on the performance of broiler starter is presented in Table 5. There were no significant interaction (P>0.05) between levels of rice offal and enzyme supplementation in all the growth performance parameter measured. The Non significant interaction between rice offal and enzyme (Natuzyme) supplementation agreed with the report of Daffwang and Shwarmen [26] and Maikano [10] that broilers chickens can tolerate

up to 15% rice offal dietary levels at the starter phase (0-4 weeks) with no adverse effect on growth performance.

3.3 Treatment Combination Effect of Dietary Rice Offal and Enzyme (Natuzyme®) Supplementation on the Performance of Starter Broiler Chicken

Result of treatments combination effects of dietary rice offal and enzyme (Natuzyme) on the performance of broiler starter chicken is presented in Table 6. There were no significant differences (P>0.05) across the measured parameter. Ranges in performance indices were; initial weight 620.00 – 666.67 g; daily weight gain 17.20-18.73 g; daily feed intake 38.40-43.16 g; feed conversion ratdio 2.21-2.48 g; daily protein intake 8.83 - 9.93 and protein efficiency ratio which ranged from 0.51 to 0.57.

The result showed no significant effect on all the parameter of growth performance namely final body weight, daily weight gain, daily feed intake, feed conversion ratio, daily protein intake and protein efficiency ratio. The chicks fed 5% rice offal with enzyme supplementation had higher value of final body weight and the least value among birds fed 5% rice offal without enzyme supplementation. The final weight of birds obtained in this study ranged from 618.33 g to 666.69 g which was similar to the average weight of 692 g reported by Aduku et al. [27] for broiler chicks. Obun et al. [28] reported a final weight of chicks which ranged 480 to 649 g for starter broiler chicks. The fast growth rate recorded in this study could be attributed to the quality of experimental feed in terms of palatability and acceptability. The daily weight gain followed similar pattern. The daily feed intake of birds fed 5% and 15% rice offal without enzyme supplementation have higher value compare to birds in the other treatments. This observation could be attributed to the fact that birds on higher level of dietary rice offal consumed more feed in an attempt to satisfy their energy requirement [29]. The feed conversion ratio of 2.21 to 2.48 is within the acceptable range of 2.0 to 5.0 as reported by Oluyemi and Roberts [1]. The low value of feed conversion ratio observed in this study across the treatment showed that birds were able to eat less and convert the feed into muscle or tissue which had led to increase value of final weight gain. The daily protein intake and protein efficiency ratio had similar value across the treatment which range from 9.24 to 9.93 and 0.51 to 0.57 respectively.

3.4 Main Effect of Dietary Rice Offal or Enzymes (Natuzyme®) Supplementation on Performance of Broiler Finisher Chicken

Results of the performance of broiler finisher chickens fed rice offal or enzyme supplementation is presented in Table 7. Effect of rice offal on growth performance parameters

Table 7. Main effect of dietary rice offal or enzyme (Natuzyme®) supplementation on growth performance of finisher broiler chicken

	Rice offal level (%)					Enzyme level (%)			
Parameters	**5**	**10**	**15**	**SEM**	**P**	**0**	**0.025**	**SEM**	**P**
Initial weight (g)	136.67	135.83	136.67	1.08	0.82	136.11	136.67	0.88	0.66 ^{ns}
Final weight (g)	1651.53	1706.09	1641.57	50.27	0.63	1577.55^{b}	1755.25 ^{a}	41.04	0.01*
Daily weight gain (g)	27.06	28.04	26.88	0.89	0.62	25.74 ^{b}	28.90 ^{a}	0.73	0.01*
Daily feed intake (g)	68.35	69.23	69.30	1.57	0.89	68.16	69.76	1.28	0.39 ^{ns}
Feed conversion ratio	2.53	2.49	2.60	0.08	0.63	2.66 ^{b}	2.42 ^{a}	4.33	0.03*
Daily protein intake (g)	15.04	15.23	15.25	0.34	0.89	14.99	15.35	0.28	0.39 ^{ns}
Protein efficiency ratio(g)	0.56	0.55	0.57	0.02	0.70	0.58 ^{b}	0.53 ^{a}	0.01	0.02*

Ab means with different superscripts are significantly different (P<0.05), SEM = Standard error of mean, P = Probability value, 0% = no enzyme, 0.025% = enzyme, p = probability value for main effect

Table 8. Interaction effect of dietary rice offal by enzyme (Natuzyme®) supplement on growth performance of finisher broiler chicken

Rice Offal X Enzyme		IW	FW	DFI	FPI	FCR	DPI	PER
5% RO	0%	136.667	1640.093	26.853	70.240	2.623	15.450	.573
	0.025%	136.667	1662.963	27.257	66.460	2.440	14.623	.537
10% RO	0%	135.000	1559.583	25.440	66.340	2.610	14.593	.573
	0.025%	136.667	1852.593	30.640	72.117	2.367	15.863	.517
15% RO	0%	136.667	1532.960	24.933	67.887	2.747	14.933	.603
	0.025%	136.667	1750.187	28.817	70.713	2.453	15.557	.530
SEM		1.41	74.25	1.32	2.17	0.11	0.48	0.03
P		0.821	0.189	0.189	0.129	0.892	0.131	0.774
LS		NS	NS	NS	NS	NS	NS	NS

SEM= Standard error of mean, P = Probability value, LS = level of significance, NS = Not significant (P<0.05), RO = Rice Offal, IW = Initial Weight, FW = Final Weight, DWG = Daily Weight Gain, DFI = Daily feed Intake, DPI= Daily protein intake, FCR = Feed Conversion Ratio, PER = Protein Efficiency Ratio

was not significantly different (P>0.05). However, enzyme supplementation significantly improved the final body weight, daily weight gain, protein efficiency ratio and feed conversion ratio of broiler finisher chickens. The final weight of birds supplemented with enzyme was higher (1755.25 g) compared to birds on diet without enzyme (1577.55 g) supplementation. The daily weight gain follow similar pattern. The value of feed conversion ratio of birds on enzyme supplementation was lower to birds on un-supplemented diet which led to the higher final weight of birds on enzyme supplementation. This showed that the enzyme was able to influence digestion of rice offal positively resulting to better utilization observed in daily weight gain which also led to the higher value observed in final body weight gain. The feed conversion ratio were similar to the range reported by Jain [30].

3.5 Interaction Effect of Dietary Rice Offal and Enzymes (Natuzyme®) Supplementation on Performance of Finisher Broiler Chicken

Result of the interaction effect of dietary rice offal and enzyme (Natuzyme®) supplementation on performance of finisher broiler chicken is presented in Table 8. Enzymes by rice offal interaction had no significant effect (P>0.05) on any of the performance parameters. The non significant interaction between levels of rice offal by enzyme supplementation on performance of broiler chicken showed that the level of rice offal and the quantity of enzyme had not being able to cause any detrimental effect on the growth and development of broiler chicken.

3.6 Treatment Combination Effect of Dietary Rice Offal and Enzyme (Natuzyme®) Supplementation on Performance of Finisher Broiler Chicken

The final body weight, daily body weight and feed conversion ratio were significantly (P<0.05) affected among the growth performance indices of finisher broiler chickens. Final body weight gain were not significantly affected at the starter phase but statistical differences (P<0.05) were observed at the finisher phase with treatment 4 and 6, (10% and 15% rice offal with enzyme supplementation) having the higher body weight gain. This result is in line with the finding of Maikano [25] who reported that the inclusion of rice offal up to 15% has no adverse effect on broilers' performance. Studies by Dafwang and Damang [6] had recommended a unit of 15% rice offal with enzyme supplementation. This showed that addition of enzyme caused a significant difference in the performance of broilers in terms of weight gain. The higher daily weight gain observed among birds fed 10% rice offal with enzyme supplementation showed that the birds were able to convert the feed with the help of enzyme into body tissues than their counterpart without enzyme. This result is in line with the report of Pinhewo [31] who reported that addition of Natuzyme® plus in the chicken diets increased live weight gain but the rate of increase was not significant. This result is also in line with Bedford [32] who reported that a range of factors has been advanced to explain the unpredictable response of animal performance to enzyme supplementation, which include cereal types, growing condition, age of animal, processing of diet, nutrient density and

Table 9. Treatment combination effect of dietary rice offal and enzyme (Natuzyme®) Supplementation on growth performance of finisher broiler chicken

Parameters	Experimental diet								
	T_1	T_2	T_3	T_4	T_5	T_6	T_7	SEM	P
	Control	ER5	NER5	ER10	NER10	ER15	NER15		
Initial weight (g)	135.00	136.67	136.67	136.67	135.00	136.67	136.67	1.41	0.91 ^{ns}
Final weight (d)	1699.52^{ab}	1662.96^{a}	1640.09^{ab}	1852.59^{a}	1559.58^{b}	1750.19^{ab}	1532.96^{b}	74.25	0.01*
Daily weight gain (g)	27.94^{ab}	27.26^{ab}	26.85^{ab}	30.64^{a}	25.44^{b}	28.82^{b}	24.93^{ab}	1.32	0.01*
Daily feed intake (g)	66.07	70.24	66.46	72.12	66.07	70.71	67.89	2.17	0.33 ^{ns}
Feed conversion ratio	2.38^{a}	2.44^{bc}	2.62^{ab}	2.37^{a}	2.61^{bc}	2.45^{ab}	2.75^{c}	0.11	0.03*
Daily protein intake (g)	14.54	14.62	15.45	15.86	14.59	15.56	14.93	0.48	0.33 ^{ns}
Protein efficiency ratio (g)	0.55	0.54	0.57	0.52	0.57	0.53	0.60	0.03	0.36 ^{ns}

T_1 = Control diet, T_2 = 5% rice offal with enzyme T_3 = 5%rice offal without enzyme, T_4 10% Rice offal with enzyme, T_5 10% rice offal without enzyme, T_6 15% Rice offal with enzyme, T_7 = 15% rice offal without enzyme. NER = No enzyme rice offal, ER = Enzyme rice offal, P = probability value for main effect, SEM= Standard error of mean

Table 10. Main effect of dietary rice offal or enzyme (Natuzyme®) supplementation on apparent digestibility of finisher broiler chicken

Parameters	Rice offal level (%)					Enzyme level (%)			
	5	10	15	SEM	P	0	0.025	SEM	P
Dry matter (%)	78.92[a]	67.57[b]	70.66[ab]	3.80	0.06	73.72	71.04	2.51	0.47
Crude protein (%)	73.20[a]	72.84[b]	66.31[ab]	2.56	0.14	69.32	72.25	2.09	0.34
Ether extract (%)	92.55	91.35	89.81	1.41	0.42	91.42	91.05	1.15	0.82
Crude fibre (%)	25.38	19.64	25.68	4.30	0.55	23.91	23.22	3.51	0.89
Nitrogen free extract (%)	86.35[a]	78.24[b]	79.17[b]	2.32	0.05	80.58	81.58	1.89	0.81

SEM= Standard error of mean, P = Probability value, 0% = no enzyme, 0.025% = enzyme, p = probability value for main effect, a[b] = means on the same row with different superscripts are significantly (P>0.05) different

Table 11. Interaction effect of dietary rice offal by enzyme (Natuzyme®) supplementation on apparent digestibility of finisher broiler chicken

Rice Offal X Enzyme		DM	CP	EE	CF	NFE
5% RO	0%	84.250	68.737	93.547	29.947	85.267
	0.025%	73.573	77.657	91.550	20.810	87.433
10% RO	0%	70.477	74.120	92.040	22.133	80.627
	0.025%	64.653	71.560	90.660	17.137	75.867
15% RO	0%	66.430	65.090	88.683	19.647	76.900
	0.025%	74.883	67.533	90.943	31.710	81.437
SEM		4.35	3.54	1.94	7.47	3.47
P		0.115	0.318	0.533	0.222	0.369
LS		NS	NS	NS	NS	NS

SEM = Standard error of mean, P = Probability value, LS = level of significance, NS = Not significant (P<0.05), RO = Rice Offal, DM = Dry Matter, CP = Crude Protein, CF = Crude Fibre, EE = Ether Extract, NFE = Nitrogen Free Extract

Table 12. Treatment combination effect of dietary rice offal and enzyme (Natuzyme®) supplementation on apparent digestibility of finisher broiler chicken

Parameters	Experimental diets								
	T_{1C}	T_2 ER5	T_3 NER5	T_4 ER10	T_5 NER10	T_6 ER15	T_7 NER15	SEM	P
Dry matter (%)	69.40[b]	84.25[a]	73.57[a]	70.48[ab]	64.65[b]	66.43[b]	74.88[a]	4.33	0.01
Crude protein (%)	68.74[ab]	77.65[a]	74.12[ab]	71.56[ab]	65.09[b]	67.53[ab]	76.08[ab]	3.54	0.01
Ether extract (%)	93.55	91.55	92.04	90.66	88.68	90.94	94.37	1.94	0.49
Crude fibre (%)	17.33	29.95	20.18	22.13	17.14	19.65	31.71	7.47	0.71
Nitrogen free extract (%)	76.28	85.27	87.43	80.63	75.85	76.90	81.44	3.47	0.19

T_1(c) = Treatment Combination, T_2 = 5% rice offal with enzyme T_3 = 5% Rice offal without enzyme, $T_{4=}$ 10% Rice offal with enzyme, $T_{5=}$ 10% rice offal without enzyme, $T_{6=}$ 15% Rice offal with enzyme, T_7 = 15% rice offal without enzyme. NER = No enzyme rice offal, ER = Enzyme rice offal, P = probability value, SEM= Standard error of mean

enzyme dose. In contrast, many observed an improvement in feed conversion ratio in broilers fed diets based on corn and soybean meal supplemented with enzymes added in broiler diet allow supplementation of endogenous enzyme production improves the assimilation of nutrients by the birds [33].

3.7 Main Effect of Dietary Rice Offal or Enzyme (Natuzyme®) Supplementation on Apparent Digestibility of Finisher Broiler Chicken

Result of main effect of apparent digestibility of nutrients by finisher broiler chickens fed dietary

level of rice offal or enzyme supplementation are presented in Table 10: There were no significant differences (p>0.05) on rice offal main effect across the treatment group except nitrogen free extract that were significantly affected. Enzyme main effects also showed no significant difference (P>0.O5) across the parameters.

The significant rice offal main effect on apparent digestibility could be as a result of negative response of bird to high fibre diets. This is in confirmation with the study of Onyimonyi and Ugwu [34] who reported that high levels of inclusion of fibrous feedstuffs in poultry diets result in negative responses because of reduced nutrient utilization and metabolic depression. Longe and Adekoya [35] opined that high dietary fibre depresses apparent digestibility of dry matter and nitrogen free extract; decreases daily body weight and makes feed to gain ratio poorer. The depressing effect on apparent digestibility has been found to be due to greater rate passage.

3.8 Interaction Effect of Dietary Rice Offal by Enzyme (Natuzyme®) Supplementation on Apparent Digestibility of Finisher Broiler Chickens

There was no significant interaction between enzyme and rice offal effect on apparent digestibility of finisher broiler chicken; showing that rice offal acted upon by enzyme neither improved nor depressed the value of the diets, for broiler chickens.

3.9 Treatment Combination Effect of Dietary Rice Offal and Enzyme Supplementation on Apparent Digestibility of Finisher Broiler Chickens

There were significant differences in dry matter digestibility and crude protein while ether extract, crude fibre and nitrogen free extract were not significantly affected. From the result shown in Table 8, there was a high digestibility at 5% and 10% rice offal inclusion level with enzyme supplementation but at 15%, there was a decrease digestibility with enzyme inclusion. This showed that the higher the rice offal level the lower the digestibility with enzyme inclusion. This is in agreement with the findings of Isikwenu et al. [36] who reported that crude fibre as a factor depressing nutrient digestibility, absorption, availability and utilization. Crude fibre entraps nutrient in insoluble complex which it forms in the cell wall of plant and this resist digestion by the endogenous enzyme in the gastrointestinal tract of poultry and other non ruminant animals [37]. Abeke et al. [38] also reported that fibrous feed decrease the digestibility of crude protein and ether extract. There was also a possibility that the presence of fibre may speed up the rate of passage of feed through the simple stomach of monogastric animal. From the present study, crude fibre was not significantly affected, this implied that the digestive system of finisher broiler chicken were able to utilized diets containing fibre up to 15%. Crude fibre value in this study which ranged from 17.14 to 31.71. The higher value of crude fibre was observed among birds fed 15% rice offal without enzyme supplementation. This indicates that broiler finisher chickens can handle fibre up to 15% without any adverse effect on growth and digestibility of nutrient. This is in agreement with the study carried out by Dafwang and Damang [6] who indicated that rice offal can be added at the level of 10 to 15% without any adverse effect on broiler finisher chicken.

4. CONCLUSION

The following conclusion was drawn based on the result of the findings:

- Broiler starter chicks could utilize 15% rice offal when supplemented with or without enzyme.
- The inclusion of natuzyme enzyme up to 0.25 mg /kg improved the performance of broilers chicken.
- The enzyme use in this study did not have a positive effect on apparent digestibility of broiler chiken.

5. RECOMMENDATIONS

The following recommendations were drawn from the study:

- No enzyme is required at this level for starter chicks.
- Broiler finisher diets having 15% rice offal should be supplemented with enzyme.
- Rice offal can be included at 10% and 15% in broiler finisher diets with or without enzyme supplementation

ETHICAL APPROVAL

As per international standard written ethical permission has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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