GROWTH PERFORMANCE IN PRE-GROWTH PHASES OF LAYER CHICKENS FED STONE GRIT AND ENZYME SUPPLEMENTATION IN BREWERS' SPENT GRAINS BASED- DIET

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Abstract
An experiment was conducted to assess the influence of stone grit and enzyme supplementation in brewers' spent grains based- diets on growth performance of chicks and pullets. Three hundred and sixty (360) two weeks old chicks were used for the experiment. They were divided into two groups (A and B) of 180 birds each. Each group was further divided into four treatments with 45 birds and each treatment was replicated three times with 15 birds. Grit was fed to all birds using a 4x2 factorial in a Completely Randomized Design at levels 0 g, 2 g, 4 g and 6 g per bird per month. Thus for each group, treatment 1 (control) had 0 g grit, treatment 2 had 2 g grit, treatment 3 had 4 g grit while treatment 4 had 6 g grit. Immediately after feeding the grit to the birds, birds in group A were fed the enzyme supplemented diet while birds in group B were fed the non – enzyme supplemented diet. The chick phase lasted for 42 days. At the end of the chick phase, a similar study was conducted on two months old pullets using three hundred and thirty-six birds which were divided into groups (A and B) of 168 birds. Each group was divided into four treatments of forty-two birds and each treatment was replicated three times with 14 birds. Grit was administered at levels 0 g, 2 g, 4 g, and 6 g per bird per month before feeding the enzyme supplemented feed to birds in group A and non- enzyme supplemented feed to birds in group B. The grower phase lasted for 84 days. In both phases, feed and water were provided ad libitum for all treatment groups accompanied by prophylactic medications and vaccination. The birds were weighed at the beginning of the feeding trial and weekly thereafter. Data collected in both phases were subjected to analysis of variance(ANOVA) and means of the two factors separated using Standard Error of Means while the interaction effect was evaluated at 5 % level of probability. It was concluded that grit feeding and enzyme supplementation in 10 % and 15 % brewers spent grains based –diet of chicks and pullets improved body weight changes, feed intake and feed conversion ratio of birds. It is recommended that higher levels of grit and BSG (with enzyme supplementation) should be studied in both pre growth developmental phases of layer chicken to leverage the potential of BSG as a feed ingredient.

Key words: Performance, Pre-Growth, Layer chicken, Stone grit, Enzyme

INTRODUCTION

In efforts to reduce the prices of animal feeds, nutritionists have incorporated alternative feed ingredients in animal feed formulation to replace the highly priced conventional feed ingredients such as maize, sesame seed, soya bean, fish meals. Alternative ingredients are mostly by-products of agriculture like cassava peels and tiger nut residue, shrimp waste, maize sievate. They also include agro industrial waste like brewers spent grains and palm kernel cake. Others are feedstuff not regarded as food by man but may be accepted by animals as food like moringa leaves, cola rostrata, cassia tora seed meal, raw senna obtusifolia seed meal. These products have been studied and proven to partially or completely replace the conventional ingredients (Ndak e*t al*. 2022; Usoro and Christopher 2022, Usoro *et al.* 2025a; Usoro *et al.* 2025b; Christoper et al. 2022; Evans *et al* 2023; Assam *et al.* 2024; James *et al*., 2024; Ukpana *et al*. 2024). Their ability to replace the

conventional feed ingredients is examined by their availability, accessibility, nutritional composition, effect on the overall bodily performance of the animal and the economics of their usage as they compete with the conventional ingredients.

The integration of these products into animal nutrition has been a trend over the years. This is to ensure animals play complementary rather than competitive role with man in meeting their feed and nutrient requirements. BSG is the by-product of beer and it is the most abundant by-product generated from the beer brewing process (Xiros and Christakopoulos, 2012; Mussato, 2014). It could be an option for addressing the issue of competition between humans and animals for cereals and other conventional ingredients. This is because it is cheap, easily accessed, locally available, widely distributed, not edible by man as such, not competed for by man. However, high crude fibre in BSG limits its use in poultry because poultry do not possess fibrolytic enzymes, therefore care is taken not to include them in levels that will affect their feed conversion efficiency. Biotechnological applications in animal nutrition have indicated that feed additives like prebiotics, (Ukpanah *et al.,* 2022), enzyme and grit (Usoro and Christopher, 2023) render fibrous polysaccharides and other nutritional factors utilizable by poultry. Exogenous enzymes are organic catalysts added to feed to aid the digestion of feed ingredients that are not digested by animals' enzyme. The use of enzymes in feed industry is a known practice and outcomes of their usage have been encouraging because they have been reported to degrade structural carbohydrates and utilization of phosphorus from complex compounds. Usoro and Christopher (2022) has reported that maxigrain in brewers spent grain based- diet improved growth performance of broilers. Grit is rock fragments ingested by extensively raised birds as they scavenge. They are insoluble and non – digestible but are retained in the gizzard to enhance mechanical digestion (Adeniji, 2009). Granite grit is crushed granite stone, they are insoluble and therefore, do not constitute nutrient but improve the overall nutritional value of feed (Usoro and Christopher, 2023). The pre phases of layer bird production are the chick and pullet phases. The chick phase lasts between 0-8 weeks of the birds' age while the grower phase lasts between 9- 22 weeks of the birds' age. However, the end of the grower phase is ascertained when 10 % lay of the pullets is noticed. This is mostly dependent on breed and nutrition. (Isaac et al. 2011). Farmers tend to pay less attention to birds during these preceding phases and are more emphatic on the layer phase of chickens. To achieve high productivity of layer production, good nutrition which involves the provision of good quality and quantity of feed as well as prevention of feed wastage (Usoro et al. (2023) amongst others should commence in pre- layer developmental growth phases. It is on this premise that the study on growth performance in pre growth phases of layer chickens fed grit and enzyme supplementation in brewers' spent grains based-diets is studied

Methodology

The experiment was carried out at the poultry unit of the Teaching and Research Farm of University of Uyo, Uyo. Uyo is the capital of Akwa Ibom State, Nigeria. It lies between lattitudes 4 4 and longituide 745 and 8 052 5. It has annual rainfall of 300 mm and temperature range of 23 to 30° C (Multinational Daries, 2008).

Collection and Processing of Experimental Materials

Brewers' spent grains (BSG) was sourced from Champion Breweries Plc, remnants of granite stone were picked from Julius Berger Road construction site at Aka while enzyme (Maxigrain) was purchased from a commercial poultry shop, all in Uyo. The pieces of granite stones were washed, sundried and crushed using a hammer. They were sieved into 2 mm size

Type of Enzyme and Potency Test for Enzyme Activity

Maxigrain is a commercial enzyme. It is cellulotic enzyme and acts on cellulose. The

potency of the enzyme was tested before the commencement of the experiment using cellulose acetate and distilled water in the Animal Science Laboratory, Faculty of Agriculture, University of Uyo. 1 gram of cellulose acetate was mixed with 1.5 gram of enzyme dissolved in 5 ml of distilled water and allowed to stand for 24 hours. The material was wholly suspended in solution with air spaces clearly visible and fluid, deep straw coloured. Colour of test material became dirty brown at the bottom of the test tube and lighter at top, coarse material at the bottom and finer at the top and air bubbles (foam) rings at the top of the mixture. The above result confirms the potency of the enzyme.

Experimental diets

The chick mash

Two isonitrogenous and isocaloric experimental chick mash were formulated with 10 % BSG inclusion level and other feed ingredients were adjusted such that diets met nutrients requirement of chicks according to NRC (1994). One of the diets was supplemented with 200 g maxigrain while the other was not supplemented with enzyme. Percent ingredient composition and calculated analysis is presented in Table 1

The grower mash

Two experimental grower mash was prepared for the pullets with 15 % BSG and other feed ingredients were adjusted such that diets met nutrients requirement of pullets according to NRC (1994). One of the diets was supplemented with 200 g maxigrain while the other was not supplemented with enzyme. Percent ingredient composition and calculated analysis is presented in Table 2

Table 1: Percent Ingredients and Nutrient Composition of Experimental Chick Mash

Ingredients (%)	Enzyme supplemented feed	Non- enzyme supplemented feed
Maize	50.00	50.00
*SBM	20.00	20.00
*BSG	10. 00	10.00
*GNC	10.00	10.00
Fish meal	3.00	3.00
Lime stone	4.00	4.00
Bone meal	2.0	2.0
Salt	0.30	0.30
*Vit-min-premix	0.30	0.30
Lysine	0.20	0.20
Methionine	0.20	0.20
Maxigrain	0.20	-
Total	100.00	100.00
Calculated Analysis		
Crude protein %	18.00	18.00
Crude Fibre	5.60	5.60
Ether extract	4.40	4.40
ME(Mcal/kg)	2800.00	2800.00

*SBM-Soybean meal, BSG-Brewers Spent grains, GNC-Groundnut cakeTo provide the following per Kg of feed: Vitamin A, 10,000iu; Vitamin D_3, 2000iu; Vitamin E, 12 mg; Vitamin K, 2mg; Vitamin B1, 1.5mg; Vitamin B_2 , 4mg; Vitamin B12,12mg;nNiacin, 15mg: Pantothenic acid, 5 mg; folic acid, 5 mg; biotin, 2 mg; choline chloride, 100 mg; manganese, 75 mg; zinc, 5 mg; iron, 2 mg; copper, 5 mg; iodine, 1.0 mg; selenium, 2.0 mg; cobalt, 5 mg; antioxidant, 125 mg

Table 2 Percent Ingredients and Nutrient Composition of Experimental Grower Mash

Ingredients(%)	Enzyme supplemented feed	Non-enzyme supplemented feed
Maize	50.00	50.00
SBM	15.00	15.00
BSG	15. 00	15.00
GNC	10.00	10.00
Fish meal	2.10	2.10
Lime stone	5.00	5.00
Bone meal	2.0	2.0
Salt	0.25	0.25
*Vit-min-premix	0.25	0.25
Lysine	0.20	0.20
Methionine	0.20	0.20
Maxigrain	0.20	-
Total	100.00	100.00
Chemical analysis		
Crude protein	16.00	16.00
Crude Fibre	5.00	5.00
Ether extract	4.40	4.40
ME(Mcal/kg)	2630.00	2630.00

*SBM-Soybean meal, BSG-Brewers Spent grains, GNC-Groundnut cake,To provide the following per Kg of feed: Vitamin A, 10,000iu; Vitamin D_3, 2000iu; Vitamin E, 12 mg; Vitamin K, 2mg; Vitamin B1, 1.5mg; Vitamin B_2 , 4mg; Vitamin B12,12mg;nNiacin, 15mg: Pantothenic acid, 5 mg; folic acid, 5 mg; biotin, 2 mg; choline chloride, 100 mg; manganese, 75 mg; zinc, 5 mg; iron, 2 mg; copper, 5 mg; iodine, 1.0 mg; selenium, 2.0 mg; cobalt, 5 mg; antioxidant, 125 mg

Experimental birds and design

Three hundred and sixty (360) two weeks old chicks were used for the chick phase of the experiment. They were divided into two groups (A and B) of 180 birds each. Each group was further divided into four treatments with 45 birds and each treatment was replicated three times with 15 birds. Grit was fed to birds using a 4x2 factorial in a Completely Randomized Design at levels 0 g, 2 g, 4 g and 6 g per bird per month. Thus for each group, treatment 1(also served as control) had 0 g grit, treatment 2 had 2 g grit, treatment 3 had 4 g grit while treatment 4 had 6 g grit. Immediately after feeding the grit to the birds, birds in group A were fed the enzyme supplemented diet while birds in group B were fed the non – enzyme supplemented diet. Brooding was carried out for two weeks during the experimental period. Feed and water were provided *ad libitum* for all treatment groups accompanied by prophylactic medications and vaccination. The birds were weighed at the beginning of the feeding trial and weekly thereafter. The chick phase lasted for 42 days.

At the end of the chick phase, a similar study was conducted on two months old pullets using three hundred and thirty- six birds which were divided into groups A and B. Both groups had one hundred and sixty-eight birds. Each group was divided into four treatments of forty-two birds and each treatment was replicated three times with 14 birds. Grit was administered at levels 0 g, 2 g, 4 g, and 6 g per bird per month before feeding the enzyme supplemented feed to birds in group A and non- enzyme supplemented feed to birds in group B. Feed and water were provided *ad libitum* for all treatment groups accompanied by prophylactic medications and

vaccination. The birds were weighed at the beginning of the feeding trial and weekly thereafter. The grower phase lasted for 84 days.

Data collection

Data on growth performance were collected in both chick and pullet developmental growth phases using the following parameters:

Initial weight –weight of birds before the commencement of the feeding trial.

Final weight- weight of birds at termination of the experiment.

Body weight gain- the difference between final body weight and initial body weight.

Feed intake – the difference between feed offered to the birds and the leftover feed.

Feed conversion ratio- feed intake divided by the body weight gain.

Data Analysis

Data collected in both phases were subjected to analysis of variance (ANOVA) and means of the two factors separated using Standard Error of Means while the interaction effect was evaluated at 5 % level of probability. The statistical analysis was carried out using SAS/STATRC software version 9.2 for windows (SAS Institute, 2011)

Results and Discussion

The growth performance of chicks and pullets fed grit and enzyme supplementation in brewers' spent grains based –diet are presented in Tables 3 and 4.

Table 3: The growth performance of chicks fed stone grit and enzyme supplementation in brewers' spent grains **based –diet**

	FACTORS								
	A		B						
Parameters	1	2	1	2	3	4	SEM	A	B
AIBW(g)	67.83	66.50	67.58	68.58	67.08	66.10	0.90	NS	NS
AFBW (g)	714.00^{a}	679.33^{b}	692.33	694.66	700.00	699.66	6.36	*	NS
ABWG (g)	644.25^{a}	612.41^{b}	624.00^{b}	626.75^{b}	631.97^{a}	630.00^{a}	6.79	*	*
AFI (g)	1229.50	1296.08	1333.83^{a}	1306.50^{a}	1215.00^{ab}	1195.83	12.50	NS	*
FCR	1.90^{b}	2.05^{a}	2.13^{a}	2.08^{ba}	1.80^{c}	1.89^{c}	0.51	*	*

^{ab} Means within the same factor on the same row with different superscripts are significantly (P<0.05) different, A Enzyme, B- Stone grit, AIBW-Average initial body weight, ABWG- Average body weight gain, AFI- Average feed intake, FCR- Feed conversion ratio, AFBW-Average final body weight,

The values for average initial body weights of birds fed enzyme and non- enzyme supplemented diets were 67.83 g, and 66.50 g, while values of birds fed grit were 67.58 g, 68.58 g, 67.08 g and 66.10 g for treatments 1, 2, 3 and 4 respectively. There was no significant ($p>0.05$) effect on the initial body weight of birds fed enzyme or grit. The values for average final body weight of birds fed enzyme and non-enzyme supplemented diet were 714.00 g and 679.33 g while the values for birds fed grit were 692.33 g, 694.66 g, 700.00 g and 699.66 g for treatments 1, 2, 3 and 4 respectively. There was a significant ($p<0.05$) effect on the final body weight of birds fed enzyme and non- enzyme supplemented diet. The birds fed enzyme had the higher value for body weight. There was no significant ($p>0.05$) effect in final body weight

of birds fed grit. There was also no interaction of grit and enzyme fed birds. The values for average body weight gain of chicks fed enzyme supplemented feed and non- enzyme supplemented feed were 644.25 g and 612. 41 g while values for birds fed grit were 624.00 g, 626.75 g, 631.97 g and 630. 00 g for treatments 1, 2, 3 and 4 respectively. There was a significant ($p<0.05$) effect on the average body weight gain of birds fed enzyme supplemented and non-enzyme supplemented diet. Body weight gain also showed a significant ($p<0.05$) effect in grit-fed birds. There was no interaction between grit and enzyme fed birds. The values for average feed intake of birds fed enzyme and non-enzyme supplemented diets were 1229.50 g and 1296.08 g, while values of birds fed grit were 1333.83 g, 1306.50 g, 1215.00 g and 1195.03 g for treatments 1, 2, 3 and 4 respectively. There was no significant ($p>0.05$) effect on the average feed intake of birds fed enzyme supplemented and non- enzyme supplemented diet but there was a significant ($p<0.05$) effect on the average feed intake of birds fed grit. There was no interaction between grit and enzyme fed birds. The values for feed conversion ratio of birds fed enzyme and non- enzyme supplemented diets were 1.90 and 2.05 while values of birds fed grit were 2.13, 2.08, 1.80 and 1.89 for treatments 1, 2, 3 and 4 respectively. There was a significant ($p<0.05$) effect on the feed conversion ratio of birds fed enzyme supplemented and non-enzyme supplemented diet. Feed conversion ratio also showed a significant ($p<0.05$) effect in grit-fed birds. There was no interaction between grit and enzyme fed birds.

Table 4: The growth performance of pullets fed stone grit and enzyme supplementation in brewers' spent grains based –diet

Parameters	1	2	1	3	4	SEM
AIBW(g)	720.00	718.00	710.83	709.16	709.16	711.68
AFBW (g)	1360.00	1360.00	1353.33	1361.67	1333.33	1396.67
ABWG (g)	640.02	641.83	644.17	649.17	624.17	624.17
AFI (g)	1367.50^{b}	1416.69^{a}	1433.83^{a}	1400.00^{a}	1396.67^{b}	1195.83^{c}
FCR	1.90^{a}	2.13^{b}	2.15^{a}	2.06^{ba}	2.03^{a}	1.82^{b}

^{Ab} Means within the same factor on the same row with different superscripts are significantly ($P<0.05$) different A-Enzyme, B- Stone grit, AIBW-Average initial body weight, AFBW-Average final body weight gain, ABWG- Average body weight gain, AFI- Average feed intake, FCR- Feed conversion ratio

The values for average initial body weights of birds fed enzyme and non- enzyme supplemented diets were 720.00 g, and 718.00 g, while values for birds fed grit were 710.83 g, 709.16 g, 709.16 g and 711.68 g for treatments 1, 2, 3 and 4 respectively. The values for average final body weight of birds fed enzyme and non-enzyme supplemented diet were 1360.00 g and 1360.00 g while the values for birds fed grit were 1353.33 g, 1361.67 g, 1333.33 g and 1396.67 g for treatments 1, 2, 3 and 4 respectively. The values for average body weight gain of birds of birds fed enzyme supplemented feed and non- enzyme supplemented feed were 640.02 g and 641.83 g while values for birds fed grit were 644.17 g, 649.17 g, 624.17 g and 624. 17 g for treatments 1, 2, 3 and 4 respectively.

There was no significant ($p>0.05$) effect on the body weight changes of birds fed both enzyme and grit. Body weight changes also showed no interaction between grit and enzyme fed – birds. The values for average feed intake of birds fed enzyme and non- enzyme supplemented diets

were 1367.50 g and 1416.69 g, while values of birds fed grit were 1433.83 g, 1400.00 g, 1195.83 g, 1195. 83 g for treatments 1, 2, 3 and 4 respectively. There was a significant ($p<0.05$) effect on both the average feed intake of birds fed enzyme supplemented and non- enzyme supplemented diet as well as average intake of birds fed grit. There was no interaction between grit and enzyme fed birds. The values for feed conversion ratio of birds fed enzyme and non-enzyme supplemented diets were 1.90 and 2.13 while values of birds fed grit were 2.15, 2.06, 2.03 and 1.82 for treatments 1, 2, 3 and 4 respectively.

Discussion

The significant ($p<0.05$) effect observed in the final body weight of chicks fed enzyme supplemented diet could be as a result of the activity of the enzyme (maxigrain) on BSG based diet for chicks. The enzyme activity must have broken down the polysaccharide chains and exposed the nutrients embedded in the fibre matrix of BSG to chicks' own enzyme for digestion and absorption. These results agree with Erener *et al.* (2016) who reported improved final body weights of chicks fed grit. The significant ($p<0.05$) difference expressed in body weight gain of enzyme and grit -fed chicks could be as a result of the availability of nutrients to birds for absorption from diets in all experimental groups. These findings agree with Usoro and Christopher (2023) who reported improved body weight changes in broiler birds fed enzyme and grit. The significant ($p<0.05$) effect on the average feed intake of chicks fed grit was evident in the quantity of feed consumed by each treatment group of birds. The consumption of feeds by birds reduced as grit level increased. It is possible that grit in the grit -fed birds aided the gizzard in the mechanical breakdown of feed, making available nutrients for birds and that must have led to satiety with less quantity of feed compared to the quantity of feed consumed by the non- grit fed birds. The significant ($p<0.05$) effect in feed conversion ratio of birds fed enzyme supplemented feed and birds fed grit could be attributed to the action of enzyme and grit. Feed conversion ratio was improved in birds fed higher levels of grit in treatments 3 (1.80) and 4 (1.89) which had 4 g and 6 g levels of grit respectively. It was also better in birds fed enzyme supplemented diets (1.90) compared to birds fed the non -enzyme supplemented diet (2.05). However, the feed conversion ratio of birds in all treatment groups were within the normal range for chickens. The findings agree with the submission of Abeke et al. (2013) and Idachaba et al. (2013) who reported improved feed conversion ratio with grit feeding.

Feed conversion ratio of birds fed non-enzyme supplemented diet was higher (2.13) than that of birds fed enzyme supplemented diet (1.90). Birds in Treatment1 (control- no grit) had higher FCR (2.15) than birds fed the different levels of grit. The possible reason for the higher FCR observed in birds without enzyme and grit may be that feed passage in the gastro-intestinal tract was faster than in birds fed enzyme and grit, being that dietary fibre shortens intestinal transit time, a characteristic feature of fibrous diet that does not allow excessive deposition of energy in the system. This result is in tandem with Usoro *et al.* (2025a) who reported low feed intake of broiler birds fed grit and tiger nut residue. The improved feed conversion ratio observed in birds fed enzyme supplemented diet and birds fed grit may be attributed to the low feed intake recorded by birds in grit and enzyme- fed treatment groups resulting in satiety and nutrient availability. However, the results of feed conversion ratio obtained in this study are within the feed conversion ratio or pullets

Conclusion

Nutrition plays important role in growth and productivity of birds. Growth performance indices were used to evaluate the influence of grit and enzyme supplementation in 10 % and 15 % brewers spent grains based –diet on pre developmental growth phases of layer chickens.

From the study, it is concluded that chicks expressed improved body weight changes, feed intake and feed conversion ratio with 10 % BSG inclusion level. Grower birds also showed significant ($p< 0.05$) effect in feed intake and feed conversion ratio with 15 % BSG inclusion level.

Recommendation

It is recommended that:

1. Nutritionist could incorporate 10 % and 15% brewers' spent grains in chick and grower diets respectively
2. Higher levels of grit and BSG (with enzyme supplementation) should be studied in both pre growth developmental phases of layer chicken production to leverage on the potential of BSG as a feed ingredient

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