EFFICACY OF GRIT AND ENZYME SUPPLEMENTATION IN BREWERS' SPENT GRAINS-BASED DIET FOR BROILERS.

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ABSTRACT
The problem of high fibre diets may be addressed with the use of feed additives. A study was conducted to assess the efficacy of grit and enzyme supplementation in brewer's spent grain-based diets for starter and finisher broilers. Two diets were formulated to meet nutrient requirements of starter and finisher broilers. (Diets A & B) Diet A was supplemented with enzyme while diet B was not. A total of three hundred and sixty (360) starter broilers were used for the study. They were divided into two groups comprising one hundreds and eighty birds each. Birds in group I were fed diet A (enzyme supplemented diet) while birds in group two were fed diet B (non-enzyme supplemented diet). Before feeding the experimental diets, each group of birds were randomly fed grit (not part of the feed) at levels 0, 2, 4 and 6 grams/bird/month using 4 x 2 factorial in a completely randomized design. Management practices necessary for the different growth phases of birds were observed. Data collected were productive performance of starter and finisher broilers as well as carcass characteristics of finisher broilers. The statistical analysis was carried out using SAS/STAT & C software version 9.2 windows (SAS Institute, 2011). Productive performance of starter and finisher birds showed significant (P<0.05) difference. Carcass characteristics of finisher broilers recorded significant (P<0.05) difference. It is evident from the result that feeding of grit and enzyme supplementation in Brewers' Spent Grain (BSG) based – diet improved feed digestion, body weight gain and dressing percentage in birds. It is recommended that Brewers spent grain should be incorporated at 10 and 15% with grit and enzyme supplementation for broilers. Higher inclusion levels of BSG should be studied as well as the weekly feeding of grit to ascertain the efficiency and consistency of grit in the gizzard of birds.
Key word*: Grit enzyme supplementation, brewers' spent grains, broilers.*

INTRODUCTION

The alarming prices of poultry rations has become a concern to poultry farmers and consumers of poultry products. The limited supply of raw materials for poultry feed has resulted in continuous increase in the cost of feed production. The insufficiency of cereal grains and protein concentrates for poultry feed manufacture and high competition for same by human food industry have been the major obstacles to poultry development in Nigeria. Agunbiade *et al*, (2001) reported that the most important and expensive feed item constituting a large portion of the cost of livestock feed is energy concentrates, especially grain, like maize. Maize and its by-products have been playing key role as source of energy for monogastrics. Also, maize is also a major staple food in most developing countries, a raw material for industries and an emerging bio-ethanol stock as the world energy crises deepens. Therefore, the competition between man, industries and livestock for the use of maize for food, raw materials and feed respectively, has heightened the cost of maize often beyond the reach of livestock farmers. This result in high cost of poultry feed which constitute 70 – 80% of the total cost of production (Oruseibo and Smile, 2001). There is, therefore need to integrate animal production into allied processing industries to ensure the animals play a complementary rather than a competitive role with man in meeting feed and nutrient requirements (Chemost and Mayer, 2003; Kwari *et al*, 2004). To become a substitute, the feed ingredients as a matter of necessity, must compare with the conventional feed stuff in terms of nutritional composition. It must be cheap, easily accessed, locally available, widely distributed, non competitive food for man. The use of agro-industrial products (AIBs) such as brewers' spent grain (BSG) appears to be one of the options left for the livestock farmers in Nigeria in addressing the issue of competition between humans and animals for cereals and other conventional feed ingredients (Alade *et al*, 2002).

However, these AIBs are fibrous in nature with low digestibility and possess anti nutrients factors and their use in monogastrics diets is therefore limited, (Omeje *et al*, 2008) because monogastrics do not possess the enzymes necessary to digest these fibrous feed ingredients. It is, therefore, necessary to achieve a near complete breakdown of these fibrous materials not taken care of by the endogenous enzymes by supplementing exogenous enzymes in these feeds and administration of granite grit (Idachaba et al, 2013; Abeke *et al*, 2008) to avian species. According to Sonaiya (2005) biotechnological applications in the feed industry would optimize nutrient supply by these ingredients either by reducing the concentration of compounds that retard digestion or by increasing the concentration of by-pass protein, sulphur containing amino acid and soluble carbohydrates. Based on this finding, different additives like acids, emulsifiers, probiotics, feed flavours, enzymes and most recently

insoluble grit have been used to improve the potency of these fibrous materials, Graham *et al*., 2003; Tancharerat, *et al* 2014; Fuller, 2001; Abeke *et al*, 2013). In order to enhance the utilization of non-conventional feed stuffs such as brewers dried grain (BDG), nutritionist have resorted to the use of feed additives such as enzymes (Teleun, *et al* 2009) and stone grit (Atteh, 2003). These exogenous enzymes are organic catalyst added to feed to aid digestion of feed ingredients that are not digested by animal enzymes. They are not living organism but are products of living organisms such as yeast, fungi, bacteria and plant tissues. Exogenous enzymes have been used to circumvent the problem limiting the use of non-conventional feed ingredients. Acamovic (2001) reported that exogenous enzyme increase the digestibility of feed ingredients and reduce the incidence of wet droppings which may result from the presence of fibrous polysaccharides in the diets.

Maxigrain is a potent exogenous enzyme that can enhance the breakdown of the non starch polysaccharide present in AIBS thereby improving utilization in poultry diets (Tuleun *et al.,* 2009). Maxigrain is widely used in poultry nutrition and it readily available. It is important in optimizing the use of non conventional feedstuff, it improves weight gain in broiler birds, improves litter quality and dropping consistency, improves feed to gain ratio, improves egg production and shell quality (Acamovic, 2001).

Grit is a collection of hard small materials or a measure of relative coarseness of abrasive materials. In animal nutrition, grit is small particles used by birds to enhance mechanical digestion by abrasion in the gizzard. They are classified into soluble and insoluble grit. The soluble grit are those that dissolve easily in the gizzard and they include oyster shell, limestone, etc. The insoluble grits are non-digestive and are retained in the gizzard some of which include silica, mica, granite, etc. Insoluble grit such as granite remain in the gizzard and aid in the mechanical breakdown of feed. According to Atteh (2003) addition of stone grit to diet of poultry birds leads to improved feed utilization and efficiency. The abrasive action that occurs in the gizzard increases the amount of nutrients that can be extracted from the feed. Stone grit in poultry nutrition provides additional surface for grinding in the gizzard, helps to improve the digestibility of coarse and fibrous feed ingredients and also stimulate motility in the gizzard (Lesson and Summers, 2001). This study was carried to assess the effect of stone grit with enzyme supplement in Brewers' Spent Grain (BSG) based diets on the productive performance and carcass quality of broiler birds.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out at Fons Farms and Resort located in Uyo. Uyo is the capital city of Akwa Ibom State, Nigeria. It lies between latitude 4^{o} 2^{1} and longitude 7^{o} 45^{1} and 8^{o} 052^{1} south in the rain forest zone of Nigeria. It has annual rainfall of 2000mm to 3000mm and temperature range of 23-30^{o}c (Multinational Diaries, 2008).

Collection and processing of Experimental materials

Brewers' spent grain (BSG) was purchased from champion Breweries Plc and remnants of granite stone were collected from Julius Berger Road Construction site at Aka road, while enzyme (Maxigrain) was purchased from a commercial poultry shop, all in Uyo. The pieces of granite stone were washed, sundried and then crushed using a hammer. They were sieved into 2mm and 5mm sizes. The 2mm sized stone grits were for the starter broiler birds while the 5mm sized grits were for the finisher broilers birds used for the trials

Type of enzyme and Potency Test for Enzyme Activity

Maxigrain is a commercial enzyme. It is cellulotic enzyme and act 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. 1gm of cellulose acetate was mixed with 1.5g of enzyme dissolved in 5ml 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 materials become dirty brown at the bottom of the test tube and lighter at the top, coarse material at the bottom and finer at the top and air bubbles rings at the top of the mixture. The above result confirmed the potency of the enzyme.

Experimental Diets

Two Iso-nitrogenous broiler starter with crude protein of 20.56% and caloric density of 2850 were formulated using common level of BSG (10%). Diet 1 had 200g enzyme (Maxigrain) supplementation while diet 2 was not supplemented with enzyme. Other ingredients were adjusted in such a way that the diets met the nutrient requirement of starter broilers according to (NRC 1994) recommendation. The percent ingredient composition and chemical analysis of broiler starter are presented in Table I. Similarly, two Isonitrogenous broiler finisher with crude protein of 20.48 and caloric density of 2900 were formulated using a common level of BSG (15%). Diet 1 had maxigrain supplementation while diet 2 was not supplemented with maxigrain. The Percent ingredient composition and chemical analysis of broiler finisher are presented in Table 2.

EXPERIMENTAL BIRDS/DESIGN

A total of three hundred and sixty (360) day old broilers were used for the experiment. They were divided into two groups (A and B). Both groups had one hundred and eighty (180) birds each. The groups were further divided into four treatments of 45 birds and replicated 3 times with 15 birds. Before feeding the birds the experimental diets, they were fed grit at levels 0 g, 2 g, 4 g and 6 g per bird per month using a 4x2 factorial in a completely randomized resign. Thus, for each group, treatment 1(the control) had a 0 g grit, treatment 2 had 2 g grit, treatment 3 had 4 g grit while treatment 4 had 6 g grit. Immediately after the feeding of the grit, birds in group A were fed the enzyme supplement diet while birds in group B were fed the non enzyme supplemented diet. Normal brooding was carried out for two weeks during the experimental period. Wood shavings were used as litter material. Feed and water were provided *ad libitum* for all treatment groups accompanied by necessary prophylactic medication and vaccination. The birds were weighed at the beginning of the feeding trial and weekly thereafter. The starter phase of the experiment lasted four weeks (28 days).

At the end of the starter phase, a similar study was conducted on 4 weeks old broiler birds using three hundred and thirty six (336) birds which were divided into groups A and B. Both groups had one hundred and sixty eight (168) birds each. Each group was divided into four treatments of forty two (42) birds and replicated three (3) times with 14 birds. Grit was fed at levels 0 g, 2 g, 4 g and 6 g per bird per month for each group such that treatment 1(the control) had 0 g grit, treatment 2 had 2 g grit, treatment 3 had 4 grit while treatment 4 had 6g grit. The enzyme supplemented diet was fed to birds in group A while the non-enzyme supplemented diet was fed to birds in group B. Feed and water were provided *ad libitum* for all treatment groups accompanied by necessary prophylactic medications for broiler finisher. The birds were weighed at the beginning of the feeding trial and weekly thereafter. The finisher phase lasted four weeks (28 days).

Data Collection

In both starter and finisher phases, the initial body weight taken at the beginning of the experiment while the final body weight was taken at the end of the experiment. Weight gain was determined by subtracting initial body weight from final body weight. Data on feed was obtained by difference between the quantity of feed offered and the quantity of feed left over each day. Feed conversion ratio was determined by dividing feed intake by weight gain.

Carcass yield

At the end finisher phase chicken of similar body weights were selected from treatment groups (one bird per replicate), weighed and slaughtered by severing the jugular vein, they were thoroughly bled. The carcass were scalded in hot water for about a minute and feathers plucked off manually after which they were eviscerated by cutting through the vent. The dressed carcass weights were taken and expressed as percentage of live weights. Information on the carcass and organ weight evaluation assisted in monitoring feed stresses on the experiment.

Statistical Analysis

All the data collected in both trial for both broiler starter and finisher phases were subjected to analysis of variance (ANOVA) and means of the two factors separated using standard Error Means (SEM) while interaction effects were evaluated at 5% level of probability. The statistical analysis was carried out using SAS/STAT & C software version 9.2 windows (SAS Institute, 2011).

Table 1: Percentage ingredients and nutrients composition of experimental broiler starter

% 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	4.00	4.00
Limestone	3.00	3.00
Bone meal	1.50	1.50
Salt	0.30	0.30
Vit-min premix*	0.30	0.30
Lysine	0.20	0.20
Meth	0.10	0.10
Maxigrain(g)	0.20	-
Total	**100.00**	**100.00**
Chemical Analysis		
Crude Protein	25.56	22.56
Crude fibre	5.62	5.62
Ether extracts	4.43	4.43
ME(M cal/Kg)	2850.00	2850.00

- To provide the following per Kg of feed: Vitamin A, 10,000iu; Vitamin D_3, 2000iu; Vitamin E, 12mg Vitamin K, 2mg; Vitamin B_1; 1.5mg; Vitamin B_2, 4mg; vitamin B_6, 1.4mg; Vitamin B_{12}, 12mg; Niacin, 1.5mg; Pantothenic acid, 5mg; folic acid, 5mg; Biotin, 2mg; Choline chloride, 100mg; Manganese, 75mg; Zinc, 5mg; iron 2mg; copper, 5mg; iodine, 1.0mg; Selenium 2.0mg; Cobalt, 5mg; Antioxidant, 125mg.

Source: field data, (2017)

Table 2: Percentage ingredients and nutrients composition of experimental broiler finisher

Ingredients	Enzyme supplemented feed	Non-enzyme supplemented feed
Maize	53.00	53.00
SBM	14.60	14.60
BSG	15.00	15.00
GNC	10.00	10.00
Fish meal	2.00	2.00
Limestone	3.00	3.00
Bone meal	1.50	1.50
Salt	0.30	0.30
Vit-min premix*	0.30	0.30
Lysine	0.20	0.20
Methionine	0.10	0.10
Maxigrain	0.20	-
Total	**100.00**	**100.00**
Chemical Analysis		
Crude Protein	20.48	20.48
Crude fibre	6.02	6.02
Ether extracts	4.40	4.40
ME(M cal/Kg)	2900.00	2900.00

- To provide the following per Kg of feed: Vitamin A, 10,000iu; Vitamin D_3, 2000iu; Vitamin E, 12mg Vitamin K, 2mg; Vitamin B_1; 1.5mg; Vitamin B_2, 4mg; vitamin B_6, 1.4mg; Vitamin B_{12}, 12mg; Niacin, 1.5mg; Pantothenic acid, 5mg; folic acid, 5mg; Biotin, 2mg; Choline chloride, 100mg; Manganese, 75mg; Zinc, 5mg; iron 2mg; copper, 5mg; iodine, 1.0mg; Selenium 2.0mg; Cobalt, 5mg; Antioxidant, 125mg.

Source: field data, (2017).

Results and discussion

The productive performance of starter broilers and finisher broilers are presented on Tables 3 and 4 while the carcass characteristics of finisher broilers are presented in Table 5.

Table III: The productive performance of starter broilers fed grit and enzyme supplementation in BSG – Based diets

	Factors									
	A		B							
Parameters	1	2	1	2	3	4	**SEM**	**A**	**B**	**AB**
AIBW(g)	70.2	72.7	71.58	71.33	71.38	71.52	1.29	NS	NS	NS
AFBW(g)	751.66[a]	722.47[b]	727.16[b]	735.00b[a]	741.00b[a]	745.00[a]	8.13	*	*	NS
ABWG (g)	681.46[a]	649.65[b]	655.41[b]	663.33[b]	669.50[b]	673.97[b]	8.29	*	*	NS
AFI (g)	1410.00[a]	1400.00[b]	1441.75[a]	1445.00[a]	1375.00[b]	358.33[b]	30.16	*	*	NS
FCR	2.06[a]	2.10[b]	2.20[a]	2.17[a]	2.05[b]	2.00[b]	0.05	*	*	NS

[abc] Means within the same factor on the same row with different superscripts are significantly different

A = Enzyme B = Grit

AIBW = Average Initial Body Weight

AFBW = Average Final Body Weight

ABWG = Average Body Weight Gain

AFI = Average Feed Intake

FCR = Feed Conversion Ratio

Source: Field data (2017)

Table IV: The productive performance of finisher broilers fed grit and enzyme supplementation in BSG Based diets

	Factors									
	A		B							
Parameters	1	2	1	2	3	4	**SEM**	**A**	**B**	**AB**
AIBW(g)	724.10	724.50	733.00	734.33	737.33	733.33	7.9	NS	NS	NS
AFBW(g)	2154.17[a]	2062.08[b]	1992.50[c]	2070.00b[b]	2167.50[a]	2202.50[a]	36.1	*	*	NS
ABWG (g)	1409.58[a]	1337.17[b]	1259.33[c]	1335.67[a]	1430.17[a]	1468.33[a]	35.9	*	*	NS
AFI (g)	3262.50[a]	2690.00[b]	3175.00[a]	3041.67[b]	2900.00[b]	2788.33[b]	89.3	*	*	NS
FCR	2.32[a]	1.99p[b]	2.251[a]	2.28[b]	1.94[c]	1.90[c]	0.09	*	*	NS

[abc] Means within the same factor on the same row with different superscripts are significantly different

Factor A = Enzyme, Factor B =Grit

AIBW = Average Initial Body Weight

AFBW = Average Final Body Weight

ABWG = Average Body Weight Gain

AFI = Average Feed Intake

FCR = Feed Conversion Ratio

Source: Field data (2017)

Table V: Carcass characteristics of finisher Broilers fed Grit and enzyme supplementation in BSG Based Diet

	Factors									
	A		B							
Parameters	1	2	1	2	3	4	**SEM**	**A**	**B**	**AB**
Live Weight (g)	238.33[a]	2132.08[b]	2129.17[b]	2252.50b[a]	2330.66[a]	2319.17[a]	81.43	*	*	NS
Dressed Weight (g)	1900.00[a]	1622.90[b]	1661.17[b]	1602.50[b]	1825.00[a]	1856.70[a]	183.91	*	*	NS
Dressed Percentage (%)	79.67[a]	76.11[b]	78.03	77.53	78.03	79.5	1.02	*	NS	NS
Thigh	14.51[a]	9.22[b]	11.94	11.53	11.97	12.02	0.4	*	NS	NS
Wing	38.37[a]	8.55	8.41	8.16	8.6	8.55	0.57	NS	NS	NS
Breast	19.67[a]	14.39[b]	17.00	16.68	17.19	17.16	0.54	*	NS	NS
Gizzard	2.57[a]	2.56	2.59	2.6	2.57	2.49	0.06	NS	NS	NS
Liver	2.53[a]	2.58	2.50	2.57	2.57	2.5	0.05	NS	NS	NS

[abc] Means within the same factor on the same row with different superscripts are significantly different

Source: Field data (2017)

There were significant differences (P<0.05) in enzyme and grit fed birds but there was no significant interaction (P>0.05) in enzyme and grit on average final body weights of starter broilers. There was a significant difference (P<0.05) in average body weight gain of birds fed enzyme supplemented diet. There was also a significant difference in (P<0.05) in average body weights gain of birds fed grit. The weight gain of birds fed enzyme supplemented diet were higher than that of birds fed non-enzyme supplemented diet. The body weight gain of birds fed grit increased as grit level increased. However, there was no interaction (P>0.05) of enzyme and grit on average body weight gain of birds. The feeding of grit and enzyme to starter broilers resulted in heavier body weight as grit level increased. This results in the improved final body weight gain in birds fed enzyme and grit. The improved body weight gain may have been as a result of the ability of the birds to utilize nutrients from the digestion of feed caused by the actions of enzyme and grit on BSG. Enzyme increased the surface area of BSG making nutrients accessible by bird's enzyme while the sharp edges of the grit must have aided the gizzard to crush BSG into smaller particles for easy digestion. This result is similar to that of Jones and Taylor (1999), who reported heavier body weight of birds when birds were fed enzyme and grit. The significant difference in body weight gain expressed by birds when diet was supplemented with enzyme may have been because enzyme provided a larger surface area on BSG based diet for bird's enzyme to gain access for digestion of feed and nutrient uptake by birds. The result also agrees with the report of Erener *et al.,* (2016) who reported improved body weight gain of birds fed grit and enzyme supplementation. Average feed intake of birds showed a significant (P<0.05) difference in birds fed enzyme supplemented and non-enzyme supplemented diets. Feed intake was lower in birds fed non-enzyme supplemented diet and that depressed body weight gain. Birds fed grit also expressed a significant difference (P<0.05) in feed intake. Intake was decreased as grit level increased but weight gain was improved.

The high intake expressed by birds in the control expresses a characteristics feature of fibre, showing that fibre dilutes nutrient availability. In effort to meet up the nutrient requirements, birds in the control consumed more feed than grit – fed birds. The result suggests that grit helped the gizzard to release nutrients to birds making them to meet with the nutrient required for improved growth. This result agrees with Idachaba, (2013) and Adeniyi (2009) who observed a decrease in feed consumption as grit level increased.

Feed conversion ratio was better in birds fed enzyme supplemented feed and on birds fed grit and improved as the grit level increased. This suggests that nutrient available from BSG were well converted to body gain. These findings agree with Waugh *et al*, 2016.

In the finisher phase, finishing birds showed significant difference (p<0.05) in body weight changes. There was also significant difference (p<0.05) in feed intake of birds fed enzyme and grit feed intake was lower on birds fed non enzyme diet and birds without grit. The birds fed grit and enzyme supplemented diet had higher final body weight and higher body weight gain. The implication of the significance expressed in body weight changes may be that cellulose in the BSG was broken down by enzyme and diet was also crushed by grit in the gizzard leading to improved digestion and nutrient utilization. This was evident by the weight gain of birds fed grit and enzyme compared to birds in the control. The findings agree with Erener *et al,* (2016) and Idachaba (2013) who reported improved final body weight gain with grit feeding.

The lower feed intake expressed by birds fed no grit or enzyme could have probably been because of the absence of enzyme meant for the digestion of fibre. Fibre also increase gut full and bulking effects which presents a feeling of satiety and poor nutrient uptake. This observation agrees with the findings of Mateos *et al.,* (2012) who reported the different physio-chemical properties of fibre when included in feed. The poor utilization of nutrient depressed weight gain and feed conversion ratio of birds without grit and enzyme.

The carcass characteristics of finisher broilers were also improved with grit feeding and enzyme supplementation. The live dressed weights and dressing percentage of birds significantly (p<0.05) improved than that of birds fed non enzyme supplemented diets and grit. The improved live weight recorded may have been as a result of the higher body weights gain recorded by birds. The dressed weight confirmed that weight of grit in the gizzard did not constitute the high weight recorded by live weight of birds. The significant difference (p<0.05) expressed by live weight, dressed weight and dressing percentage of birds fed enzyme and grit agree with the findings of Idachaba (2013), who reported high values in live weight, dressed weight as well as dressing percentage.

CONCLUSION

Brewers' spent grain is becoming more fibrous because it is further recycled in the brewing process. This represents a threat to broiler feeding because of the variation in nutrient composition. Grit and enzyme in this study improved the digestion of brewers' spent grains as observed in higher weight gain and dressing percentage of birds with decreased feed intake at 10% and 15% BSG inclusion levels for both starter and finisher broilers.

RECOMMENDATION

It is recommended that

(1) BSG should be incorporated at 10% and 15% with grit and enzyme supplementation for broilers

(2) Weekly and monthly feeding of grit should be studied to compare the efficiency and consistency of grit in the gizzard.

(3) Further studies be conducted with higher levels of grit (above 6g) in broiler production since decreased feed intake with higher weight gain were obtained as grit levels increased.

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