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Effect of Maxigrain® enzyme supplementation of dietary brewers dried grain on the performance, digestibility and economic of production of starter broiler chickens

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Abstract

Two hundred and forty Arbor Acres strain day old chicks were used to determine the effect of Maxigrain® enzyme fortification of dietary brewers dried grains (BDG). Eight groups of 30 birds each were fed four diets that contain 0, 5, 10 and 15 % BDG with or without Maxigrain in a 2x4 factorial arrangement. The research lasted for 28 days during which data were collected on performance, nutrient utilization and production cost. Significant (P<0.05) increased was observed in average final body weight, body weight gain and feed intake as dietary BDG increased. However, this effect was higher when enzyme was added to BDG respectively. Increasing the BDG from 0 – 15 % significantly (P<0.05) reduced cost of feed consumed and increased feed cost with enzyme addition. The reversed trend was observed with cost per kg gain of broiler chicks fed BDG with enzyme supplementation. Birds fed BDG with enzyme had significantly (P<0.05) better nutrient utilization than their counterpart group. It can be concluded that the incorporation of up to 15 % BDG with 100 mg/kg Maxigrain® supplementation enhanced performance and economics of production.

Keywords: Brewers dried gain, Maxigrain®, starter broiler chicks, growth, production cost

Introduction

The high cost of feed ingredients in poultry production has reduced the rate of expansion of the poultry industry in developing countries like Nigeria. At present, cost of grains is compounded by its low production and high demand for human food, industrial use and as animal feeds. This competition has resulted to high cost of the finished products (meat and eggs) making them unaffordable by the general populace, thus reducing protein intake. FAO (1996) recommended a minimum protein intake of 58 g per day out of which 35 g should be of animal origin, but most Nigerians especially children eat less than 20 g protein per day thus, the incidence of malnutrition. Those affected by malnutrition will be unable to reach their full potentials which can undermine future learning potentials and inhibit economic growth. Broiler chickens remain the fastest source of animal protein supply because of its rapid growth due to their genetic composition and ability to efficiently utilize feed. However, the major limiting factor is the high cost of conventional feed ingredients. Therefore, any attempt to substitute the conventional feedstuffs in poultry feed will greatly reduce cost of production. Brewers dried grains (BDG) is an agro-industrial by-product considered as one of the most promising alternative because of its availability in large quantities (Oyedeji *et al*., 2008). This makes it a potentially good feed ingredient that can be exploited in order to reduce cost of poultry production. National Research Council, 1994 reported that the grains of most cereals are used for the production of beverages including beer and liquor, the residue left is BDG. Fombad and Mafeni (2013) reported that BDG has 20 % crude protein, 6 % ether extract, 15 % crude fibre,

4 % ash. McDonald *et al*. (1998) reported that BDG contain 25 % crude protein, and that it was fairly rich in amino acids 0.9 % lysine, 0.4 % methionine, 0.4 % tryptophan, 1.2 % phenylalanine, 1.1 % threonine and 1.6 % valine. However, Oyedeji *et al*. (2008) reported that a major limitation of BDG utilization in monogastric diet is the presence of high fibre content (24 %). Considering the fact that broiler chickens lack the digestive framework to elaborately digest high fibre in the diets, it becomes necessary therefore to incorporate exogenous enzyme into their diets in order to enhance the breakdown of the non-starch polysaccharides (NSP) present in the fibre. Some of the enzymes that have been used and found beneficial include glycanases, xylases, phytase, cellulolase, protease, Maxigrain, hemi-cell, (Atteh 2001;Alam, 2003; Bekatorou *et al.,* 2007;Ademola *et al.,* 2012; Alayande *et al.,* 2016; Sabo *et al.,* 2017; Ereke *et al.,* 2017). Therefore, it is imperative that the use of BDG as protein and energy source will require the use of enzyme to break-up the non-starch polysaccharides into easily digestible smaller polymers to improve its value and utilization. This study was thus carried out to determine the effect of Maxigrain(R) enzyme fortification of BDG on the performance, digestibility and economics of production of starter broiler chickens.

Materials and Methods

Location of the experiment

The study was carried out at the Poultry unit of the Livestock Teaching and Research Farm, University of Agriculture, Makurdi, Benue State, Nigeria. Makurdi is located between longitude 6-10^0 East and latitude 6-8^0 North of the equator. The area is warm with a minimum temperature range of 21.71^{0}C ± 3.43^0 C and a maximum temperature range of 32.98 ± 40.6 ^{0} C. Rainfall is between 508 mm to 1016 mm. The relative humidity is between 47 percent and 85 percent (TAC, 2011).

Source of feed materials

Brewers dried grain was purchased wet from Benue Brewery Limited, Makurdi. It was sun-dried on concrete floor to a moisture content of less than 10 % and packed into sacks for use. Other ingredients were purchased from the market and livestock stores.

Feed preparation and animal management

Eight starter broiler chicks' diets were formulated to contain 0 , 5, 10 and 15 % levels of BDG and fortified with either 0 or 100 mg Maxigrain® enzyme (Table 1). Broiler chicks of equal initial average weights were randomly allotted to the eight dietary treatments at rate of 30 birds per dietary treatment with 10 birds per replicate in a 5 week experiment period. The experiment was a 2x4 factorial arrangement in a completely randomized design. The birds were brooded under all standard management practices as described by Oluyemi and Roberts (2007). Feed and water were provided *ad-libitum*. The feed intake was determined weekly by subtracting the consumed feed from the initial feed supplied to each replicate group for the week. The daily feed intake per bird was determined by dividing the daily feed intake per replicate by the number of birds.

Body weight gain was determined by taking the weight of the birds per week and then subtracting the initial weight from the new weight. The difference of the two gives the weight gain. The average daily weight per bird was calculated by dividing the value of the replicate by the number of birds at seven days interval. Final body weight was determined by taking the weight of the birds per replicate at termination of the experiment and then divided by the number of birds per replicate. Feed conversion ratio

Table 1: Ingredients and composition of broiler starter diets

BDG Levels	0	0	5	5	10	10	15	15
Enzyme levels	-	+	-	+	-	+	-	+
Maize	48.20	48.20	44.96	44.96	42.45	42.45	37.63	37.63
FFBS	31.37	31.37	30.19	30.19	28.20	28.20	28.42	28.42
GNC	15.68	15.68	15.10	15.10	14.60	14.60	14.20	14.20
BDG	0.00	0.00	5.00	5.00	10.00	10.00	15.00	15.00
Bone meal	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Lysine	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Common salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**
Cal. Analysis								
CP (%)	23.00	23.00	23.00	23.00	23.00	23.00	23.00	23.00
ME (Kcal/kg)	3103	3103	3036	3036	3004	3004	2901	2901
CF (%)	3.42	3.42	4.31	4.31	15.19	15.19	6.03	6.03
Ca (%)	1.60	1.60	1.68	1.68	1.71	1.71	1.61	1.61
P (%)	0.69	0.69	0.86	0.86	0.86	0.86	0.85	0.85
Methionine (%)	0.33	0.33	0.33	0.33	0.34	0.34	0.35	0.35
Lysine (%)	0.12	0.12	0.12	0.12	0.11	0.11	0.13	0.13

***Premix supplied per kilogram: vitamin A, 1200IUmg; VitaminD3 mg, 1500IU mg; Vitamin B12,0.03 mg, Vitamin K3 5 mg; Vitamin B13 mg, Vitamin B2 6 mg, Vitamin B6, 5 mg Nicotine amide, 40 mg; Calcium, D-Pantothenate, 10 mg; Folic acid, 0.75 mg; D-Biotin, 0.075; Choline-Chloride, 375 mg; Antioxidant, 10 mg, Mn, 80 mg; Fe, 80 mg; Zn, 60 mg; Cu, 8 mg; I, 0.5 mg; Co. 0.2 mg, Se, 0.15 mg.FFSB – Full fat Soyabean, GNC – Groundnut cake, BDG – Brewers dry grain, CP – Crude protein, ME – Metabolizable energy, CF–Crude fibre, Ca – Calcium, P – Phosphorus ME = 37 x %CP + 81.8 x %EE + 35.5 x %NFE (Pauzenga, 1985)*Enzyme was added at 100 mg/Kg diet. T1=0 % BDG without enzyme, T10= 0 % BDG with enzyme, T2=5 % BDG without enzyme, T20= 5 % BDG with enzyme, T3=10 % BDG without enzyme, T30=10 % BDG with enzyme, T4= 15 % BDG without enzyme and T40= 15 % BDG with enzyme.**

was calculated as the ratio of feed intake to body weight gain.

Nutrient retention and chemical analysis

On the fourth week of the starter phase, two birds were selected per replicate and were placed in metabolic cage, fed a common diet and allowed to acclimatize for three days. On the third day, feed was withdrawn for 12 hours but water was given to the birds during the period. Afterwards, experimental diets were served to the respective birds and the faecal sample collection commenced which lasted for four days. Samples collected were labeled, weighed immediately and oven dried for 24 hours to a constant weight in the Nutrition laboratory, Department of Animal Nutrition, University of Agriculture Makurdi. The respective treatment replicate samples were pooled together and milled while sum-samples per treatment replicate was collected for proximate analysis according to AOAC (1990) standard methods.

Nutrient retention=

$$\frac{\text{Nutrients in feeds - Nutrients in faeces}}{\text{Nutrients in feeds}} \times 100$$

Economic analysis

Economic analysis of production was based on the cost of the diets as produced from the prevailing market price of ingredients at the time of purchase. This was used to compute the unit cost of feed produced, cost of feed consumed per kg weight gain, feed cost /gain for each diet, and benefit values of the diets in relation to the control

Statistical analysis

Data obtained were subjected to analysis of variance (ANOVA) using the procedure of Steel and Torrie (1980) in the Minitab (2014) software. Where significant ($P<0.05$) differences were observed, affected means were separated using the Duncan's Multiple Range Test (DMRT).

Results and Discussions

Proximate composition of the starter broiler chicks' diets is presented in Table 2. The dry matter (DM) value ranged from 90.25 % to 91.02 % in diet containing 10 % BDG without and with enzyme respectively. The percentage crude protein (CP) ranged between 24.07 % and 27.63 %. The highest value of crude protein in diet containing BDG could be due to fermentation process. BDG contains high percentage of protein and use of sorghum/barley by the breweries in producing their products. The dietary protein and energy levels in this study were within the recommended levels for broilers chicks raised in the tropics. Oluyemi and Roberts (2000) reported 23-24% for broiler starter. Pfizer (1996) and Aduku (2012) put the protein requirement of broiler starter at 23% and metabolizable energy requirement of 2800 - 3000 kcal/kg for optimal broiler performance in Nigeria.

The high energy and protein contents obtained in this study were adequate for promoting good growth performance in broiler chickens. Table 3 depicts effect of BDG and enzyme effect on growth performance of starter broiler. The average initial body weight of the broiler chicks ranged between 38.75 – 40.00 g/bird. Final body weight ranged from 670 to 775 g/bird as the BDG levels increased. The same trend was observed for average weight gain. Birds on BDG diets had significantly higher feed intake compared to the control. Such increased could be attributed to the bulky nature of BDG which limit the amount of energy available to the birds. The result corroborates the report of Ani *et al.* (2013) who opined increase in feed intake to increased CF content of the rice milling waste. The feed conversion ratio of the birds fed 15 % BDG supplemented with enzyme was similar to those fed control diet and significantly better than other BDG diets. The improvement in feed conversion ratio could be due to the action of enzyme in the diet and it has been reported that enzyme enhance the efficiency of feed utilization (Bawa *et al.,* 2012). This finding agreed with Adama *et al*. (2007) who reported good performance of broiler chicks when fed soluble brewers dried grains (SBDG) based diet.

Table 2: Proximate composition of the starter broiler experimental diets (% DM)

BDG Levels	0		5		10		15	
Enzyme Levels	-	+	-	+	-	+	-	+
DM (%)	90.77	90.92	90.87	90.38	90.25	91.02	90.55	90.67
CP (%)	24.10	24.07	24.08	24.21	27.63	26.92	25.61	25.58
CF (%)	7.33	7.19	7.66	7.29	7.70	7.19	7.25	7.21
EE (%)	5.66	5.63	5.44	5.95	6.22	5.52	4.96	4.99
Ash (%)	9.79	15.59	9.64	6.69	10.96	12.87	11.84	12.45
NFE (%)	58.12	52.52	58.18	60.86	52.49	52.50	55.34	54.77

BDG = brewers dried grain, DM = dry matter, CP= crude protein, CF= crude fibre, EE= ether extract, NFE= nitrogen free extract. (-) = without enzyme fortification; (+) = with enzyme fortification at 100 mg/kg of feed

Nworgu (2009) also reported higher body weight gain in broiler chickens fed varying BDG levels. Maxigrain® was observed to have significantly (P<0.05) increased the final body weight, improved feed intake and body weight gain of broiler chicks. The improvement in weight gain could be attributed to the hydrolyzing effect of Maxigrain on non-starch polysaccharide (NSP) present in the BDG, thereby, reducing its fibre level and increase feed intake and weight gain. This report confirms the similar broiler chickens responses with fibre sources and enzyme supplementation (Bawa *et al*., 2012). The cost of feed/kg progressively decreased with increased inclusion level of BDG. Esuga *et al.* (2008) also reported the effective degradation of β-manna in palm kernel cake by an appropriate enzyme to mannose, release the sugar and other digestible sugar molecules which may be absorbed and thus metabolized by monogastric animals for enhanced productivity. A similar pattern was observed in the feed cost per gain with values of #258.99 versus #220.66 for control and 15 % BDG respectively. Enzyme supplementation encouraged feed intake and relatively reduced cost per gain of the starter broiler chickens.

Table 3: Effect of dietary levels of BDG and enzyme supplementation on growth performance of starter broiler chicks

	Levels of BDG					Enzyme (mg/kg)		
Parameters	0	5	10	15	± SEM	(-)	(+)	± SEM
AIW (g)	39.17	39.17	40.00	39.17	0.00	38.75	40.00	0.00
FBW (g)	670.00^{c}	703.33^{b}	678.33^{c}	775.00^{a}	6.64^{*}	690.33^{b}	722.50^{a}	3.32^{*}
DBWG (g)	19.03^{c}	19.95^{b}	19.26^{c}	22.03^{a}	0.21^{*}	19.63^{b}	20.51^{a}	0.11^{*}
DFI (g)	37.14^{b}	41.89^{a}	41.23^{a}	41.89^{a}	0.24^{*}	39.71	41.37	0.12^{ns}
FCR	1.95^{a}	2.10^{b}	2.15^{b}	1.90^{a}	0.03^{*}	2.02	2.01	0.07^{ns}
Cost of FI ₦/bird	164.03	178.83	170.62	164.10	0.50	168.20	174.61	0.90
Feed cost (₦/kg)	258.99	271.40	266.20	220.66	1.80	259.05	253.72	3.60

^{a,b}Means within rows with different superscripts are significantly (P<0.05) different.^{NS}- Not Significant (P>0.05), * Significant (P<0.05) SEM= Standard error of mean FBW= Final body weight, DBWG= Dai ly body weight gain, DFI= Daily feed intake FCR= Feed conversion ratio, (-) = without enzyme fortification, (+) = with enzyme fortification at 100 mg/kg

The effect of interaction of BDG and Maxigrain® enzyme is presented in Table 4. There were significant (P<0.05) effects of dietary BDG and Maxigrain on final body weight, body weight gain, feed intake and feed conversion ratio. Nonetheless, improvement in performance was significantly higher at 15 % BDG and 100 mg/kg Maxigrain enzyme fortification. Ani *et al.* (2013) had earlier reported a similar improvement in the performance of broiler birds fed diet supplemented with enzyme. Other researchers have shown that exogenous enzymes complement the digestive enzymes of poultry by hydrolyzing the non-starch polysaccharides in cereal and vegetable proteins thereby, decreasing gut viscosity and thus, improved nutrient absorption. It is interesting to note that enzyme supplementation significantly increased the cost of feed consumed per bird. However, there was a corresponding reduction in the cost of producing per kg weight gain of birds in all the enzyme supplemented BDG diets such that the cost per kg gain in diet with 15 % BDG and 100 mg/kg Maxigrain supplement was the least with a value of ₦217.84 only. Enzyme supplementation of BDG, a fibre feed source, seems to be economically more

beneficial. The use of BDG supplemented with Maxigrain reduced levels of the conventional and expensive cereal grains. This result agrees with the findings of Midau *et al*. (2011) and Aguihe *et al*. (2015) who reported maximum profit with enzyme supplemented cassava peel meal in broiler chickens diets. In fact, the FCR value is the most sensitive factor in assessing performance and is an indication of excellent utilization of enzyme supplemented diets by the birds compared to the basal diets.Data obtained on nutrient retention are presented in Table 5. The dry matter, ether extract (EE), crude fibre (CF) and nitrogen free extract (NFE) were not significantly (P>0.05) influenced while percentage crude protein retention significantly (P<0.05) improved with increased level of dietary BDG. There was an improvement of 2.9 % in CP retention of birds with enzyme supplemented BDG.

Table 6 shows the interaction between dietary BDG and Maxigrain enzyme on nutrient retention of starter broiler chicks. Significant differences (P<0.05) was observed in crude protein, ether extract, and fibre with the exception of dry matter and nitrogen free extract. In all parameters measured, higher values were noted in birds fed all levels of BDG-enzyme supplemented diets compared to the non-supplemented groups. This may be attributed to the dietary supplemented enzyme ability to facilitate access of enzymes to intracellular starch granules, proteins and other nutrients by breaking down other-wise intact bonds between non-starch polysaccharides.

Table 4: Interaction of BDG level and enzyme fortification on growth performance of starter broiler chicks

BDG Levels	0		5		10		15		
Enzyme Levels	-	+	-	+	-	+	-	+	SEM
AIW (g)	38.33	39.00	38.33	40.00	40.00	40.00	38.00	38.00	0.00^{ns}
AFW (g)	676.67^{b}	663.33^{b}	680.00^{b}	726.67^{b}	688.33^{b}	668.33^{b}	718.33^{b}	831.67^{a}	13.23^{*}
ADFI (g)	36.19^{d}	38.09^{d}	40.37^{b}	43.41^{c}	42.17^{d}	40.28^{a}	40.09^{c}	43.69^{a}	0.18^{*}
ADWG (g)	19.22^{b}	18.84^{b}	19.31^{b}	20.59^{b}	19.55^{b}	18.97^{b}	20.41^{b}	23.64^{a}	0.43^{*}
FCR	1.88^{a}	2.02^{ab}	2.09^{ab}	2.10^{c}	2.15^{c}	2.14^{c}	1.96^{b}	1.84^{a}	0.05^{*}
Feed cost/bird (₦/kg)	162.31^{cd}	168.95^{bc}	173.61^{bc}	186.84^{a}	175.95^{b}	168.08^{bc}	158.67^{d}	172.92^{b}	0.05
Cost/kg gain (₦)	253.72	275.07	280.89	272.70	272.59	270.60	233.67	217.84	4.10

[a,b,c,d] Means within rows with different superscripts are significantly (P<0.05) different, SEM= Standard error of mean, *- significant (P<0.05), AIW = Average initial weight, AFW = Average final weight, DFI= Average daily feed intake, DBWG= Average daily body weight gai n, FCR= Feed conversion ratio, (-) = with (0 mg/Kg) enzyme fortification, (+) = with (100 mg/Kg) enzyme fortification

Table 5: Effect of dietary levels of BDG and Maxigrain® on nutrient retention coefficient of starter broiler chicken (%)

	BDG Levels (%)					Enzyme Levels		
Nutrients (%)	0	5	10	15	SEM	(-)	(+)	SEM
DM	72.13	72.29	72.09	72.09	0.06^{ns}	72.23	72.09	0.06^{ns}
CP	56.64^{ab}	57.90^{a}	59.32^{a}	58.47^{b}	0.31^{*}	57.25	58.91	0.31^{ns}
EE	61.64	63.22	66.41	65.30	0.26^{ns}	63.76	64.53	0.53^{ns}
CF	25.54	31.91	25.30	27.28	0.97^{ns}	25.26	29.74	1.93^{ns}
NFE	42.67	43.05	42.33	41.25	0.08^{ns}	41.29	43.10	0.56

[a, b] Means within rows with different superscripts are significantly (P<0.05) different, Ns- Not significant (P>0.05), *- Significant (P<0.05), DM= Dry matter, CP= Crude protein, CF= Crude fibre, EE = Ether extract, NFE = Nitrogen free extract, SEM=Standard error of mean, (-) = with (0 mg/Kg) enzyme fortification, (+) =With (100 mg/Kg) enzyme fortification

Table 6: Interaction of nutrient retention coefficient of BDG levels x Maxigrain(R) enzyme fortification of starter broiler chicks

BDG Levels (%)	0		5		10		15		
Enzyme Levels	-	+	-	+	-	+	-	+	± SEM
Nutrients (%)									
DM (%)	72.11	72.15	72.30	72.27	72.18	71.99	72.32	72.05	0.11^{ns}
CP (%)	55.97^{b}	57.30^{b}	57.97^{ab}	57.83^{ab}	57.70^{b}	60.94^{a}	57.36^{a}	59.57^{ab}	0.82^{*}
EE (%)	59.70^{b}	63.58^{ab}	64.22^{ab}	62.21^{ab}	67.57^{ab}	65.25^{ab}	66.61^{ab}	63.98^{ab}	1.06^{*}
CF (%)	30.28^{ab}	20.79^{ab}	30.81^{a}	33.00^{ab}	24.61^{ab}	25.98^{b}	33.27^{b}	21.28^{ab}	3.87^{*}
NFE (%)	42.30	43.04	43.89	42.21	44.02	40.23	42.80	39.67	0.50^{ns}

[a, b] Means within rows with different superscripts are significantly (P<0.05) different, Ns- Not significant (P>0.05), *=Significant (P<0.05), DM= Dry matter, CP= Crude protein, EE= Ether extract, NFE= Nitrogen free extract, (-) = with (0 mg/Kg) enzyme fortification, (+) = with (100 mg/Kg) enzyme fortification

Conclusion

The study showed that the use of brewers dried grain while cutting down the cost of production compromised performance. However, the incorporate BDG at 15 % and 100 mg/kg Maxigrain® improved performance and reduced production cost.

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