EFFECTS OF CORN DISTILLERS DRIED GRAINS ON THE PERFORMANCE AND EGG QUALITY OF LAYING HEN

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ABSTRACT

A study was conducted to determine the effects of corn distillers' dried grain (CDDG) on the performance and egg quality of laying hens. The hens were fed dietary inclusions of CDDG at 0, 10, 20, 30 and 40% for a period of eight weeks. Average feed intake, weight gain, feed conversion ratio and nitrogen economy varied significantly (P<0.05) among dietary treatments. Birds fed 30% dietary CDDG had the highest feed intake (127.00 g/bird/day). Feed conversion ratio (FCR) was inversely related to increasing levels of dietary treatments with CDDG. Among hens fed dietary CDDG, those fed 10% dietary the best feed conversion ratio (6.3) and highest weight gain (20.10 g/bird/day). Nitrogen retention was the highest (88.6%) in birds fed control diet and lowest (61.2%) in birds fed 30% dietary CDDG. Hen-day production (HDP) and Haugh Unit (HU) were significantly affected (P<0.05) by dietary treatments. Birds fed 20% dietary CDDG had the highest (61%) HDP, while birds fed 0% CDDG (control diet) had the lowest HDP (52.2%). Birds fed 20% dietary CDDG had the highest HU value (88.7) while birds fed 0% dietary CDDG (control) had the lowest (81.2) value. Birds fed 20% CDDG performed best in terms of HDP, egg quality, cost-benefit ratio. Laying hens can be fed CDDG at 10-20% inclusion level. Inclusion levels of CDDG above this level were observed to have counter-productive effects on the production performance of bird; this observation is as a result of high fibre level of CDDG.

Keywords: Corn distillers' grain, Laying hens, Feed intake, Weight gain, Feed conversion ratio, Nitrogen economy, Egg quality

INTRODUCTION

Poultry production in Nigeria has witnessed a decline primarily due to the astronomical rise in the cost of poultry feeds. Major causes of high cost of feeds are due to high cost of energy and protein feedstuffs. The consequence of the high cost of poultry feeds is the astronomic increase in the price of poultry products (Okoye *et al.,* 2006). Dietary energy constitute up to 50% of a balanced poultry diet. Cereal grains which constitute the major source of energy in poultry diets are also consumed by man (Bolu and Balogun, 1998a). This competition may result in increasing poultry product price and reduced reduce affordability due to increased relative cost of animal production (Leaflets, 2008).

Corn Distiller's dried grains (CDDG) is a by-product of corn milling and fermentation for ethanol production. It contains all the nutrients found in the corn kernel, except starch, which has been fermented to ethanol and carbon dioxide. Thus, CDDG have been useful for animal feed production in the last decade (Cheon, 2008). In addition, CDDG has been reported to be a rich source of energy and protein, and therefore a promising replacement for corn and soybean meal in feed production

(Shurson, 2003; Leaflet, 2008; Cheon *et al.,* 2008). CDDG was used as a feed ingredient in poultry diets, partially due to its ample supply of unidentified growth factors, which can be vitamins and other synthesized products during fermentation (Cromwell *et al.,* 1993; Batal, 2007; Bregendahl *et al.,* 2008). Thus, feeding CDDG resulted in improved overall performance of broilers and laying hens (Lumpkins *et al.,* 2004; 2005). However, the use of CDDG is limited by high fibre content, variability in the compositions due to source and specific amino acids (Belyea *et al.,* 1998; 2004).

Excretion of nitrogen especially as volatilized ammonia lost to the atmosphere is currently a global concern. In the United States, poultry (including laying hens) is one of the largest contributors of atmospheric NH_3 emissions among domestic animal species, accounting for 27% of the total NH_3 emissions in 2002. Ammonia adversely affect the health and production of poultry through deciliation of the trachea, corneal ulcers, impairment of macrophage function, reduced lung function, lower egg production and lower body weight gains, but it may also cause eutrophication of surface water resources and nuisance odours (Spiehs *et al.,* 2002; Noll *et al.,* 2007).

Several research have reported decreased nitrogen excretion and ammonia emissions in laying hens fed high fibre and reduced crude protein, without causing depressed egg production and nitrogen balance though, may lower nutrient digestibility (Parsons *et al.,* 2006; Leaflet, 2008). This study investigated the effects of feeding CDDG on the performance, egg quality and nitrogen balance in laying hens. Cost-benefit ratio of feeding levels of CDDG in poultry was also determined

MATERIALS AND METHODS

Housing and Management: Three hundred and sixty (360), 18-week-old bovan black growers were housed in battery cages. Feed and water were given *ad libitum*. Prior to the experiment, the birds were fed a pre-lay diet until hen-day production was 5%. Thereafter, they were fed the control diet containing 0% CDDG for two weeks until hen-day production became 50%.This was done to acclimatize the birds to the experimental condition, new diet and also to maintain a stable egg production. Thereafter, hens were fed the experimental diets (varying levels of CDDG) at about 21 weeks of age.

Dietary Treatments: Five diets were formulated to meet the NRC (1994) nutrient requirements for laying hens. The diets were formulated to include 0, 10, 20, 30 and 40% corn CDDG (Table 1). Corn CDDG was analysed for proximate composition using the methods outlined by AOAC (1990). Gross Energy (GE) was determined using the bomb calorimeter. Metabolizable Energy (ME) was obtained by deducting the GE faeces from the GE in feed using the following formula: S = 100 (T - B) + B / s, where S = energy value of test ingredient, T = energy value of basal + test ingredient, B = energy value of basal diet and s = level of supplementation of test ingredient in the diet (Bolu and Balogun, 1998b).

Nitrogen was determined using the micro-Kjeldahl method and the crude protein content was calculated as nitrogen × 6.25. Ether extract and ash contents were determined using a Soxhlet extraction method and by wet-ashing in a muffle furnace, respectively (AOAC, 1990).

Samples of formulated diets were also subjected to proximate analysis to determine the contents of metabolizable energy, crude protein, crude fibre, ether extracts and ash. Diets fed were isocaloric (2,600 kcal/kgME) and isonitrogenous (17.5% CP) (AOAC, 1990).

Parameters Measured: Data collected include feed intake, feed conversion ratio, weight gained, egg quality and percentage nitrogen retention. Feed intake was measured every week by collecting left over feed, and deducting from the initial ration supplied. Feed intake was recorded on a weekly basis throughout the period of experiment. Birds were weighed at the beginning of the experiment and on a weekly basis to obtain the weekly weight gained. Feed conversion ratio (feed gain ratio) was calculated as: FCR = Feed consumed / Weight gain. Eggs collected from each dietary treatment were recorded daily to determine the hen-housed production which was used to obtain the weekly hen-day production.

Hen-day production was then calculated as: HHP = Number of egg produced/Number of hen-days x 100, where Hen-day = Number of hens x Number of days in lay.

Four eggs were collected three times in a week from each treatment, weighed and used for egg quality analyses. Eggs were broken on to a flat surface to measure the heights of the albumen and yolk with the use of a spherometer. The yolk width/diameter was measured using the vernier calliper. Weights of albumen and yolk were also taken using the electronic weighing balance. Haugh unit was calculated from the records of egg weight and albumen height as: HU =100 X Log (H-1.7 X $W^{0.37}$+ 7.56), where HU = Haugh unit, H = albumen height (mm) and W = weight of the egg (g) (Haugh, 1937). Yolk index was calculated thus: YI = height of yolk (HY) / width of yolk (WY). The relative specific density (RSD) of egg was determined by measuring the volume displaced by egg when immersed in water in a graduated cylinder. Relative specific density was then calculated as: RSD = weight of egg (g) / volume of egg (cm^3).

During the last week of the experiment, a total collection of faeces was made for three days. The faecal samples were collected, dried and analysed for nitrogen contents using kjeldahl method (AOAC, 1990). The percentage nitrogen retention was obtained from nitrogen balance and nitrogen in feed. Thus, % nitrogen retention = NI – NE / NI x 100, where NI = nitrogen intake and NE = nitrogen excreted.

A cost-benefit analysis was conducted to determine the cost-benefit ratio (CBR) of the various inclusion levels of CDDG. Cost-benefit ratio was obtained as the cost of feed consumed to produce a dozen eggs. It was calculated as: CBR = Cost (in Naira) of feed consumed to produce 12 eggs / Cost (in Naira) of 12 eggs.

Statistical Analysis: The study employed completely randomised block design. Data were analysed using analysis of variance (ANOVA). Significant differences among treatment means were separated using the least significant difference (LSD). A probability level of $P < 0.05$ was employed in all the analysis.

RESULTS

Average daily feed intake varied significantly ($P<0.05$) among dietary treatments. Birds fed diet containing 40% dietary CDDG had the lowest feed intake (105.00 g/bird/day) while birds fed 30% dietary CDDG had the highest feed intake (127.00 g/bird/day), which was same as birds fed the control diet. Feed conversion ratio (FCR) was inversely related to increasing level of dietary treatments with CDDG. Layers fed control diet (0.00% dietary CDDG) had feed conversion ratio of 5.90 while the lowest feed conversion ratio of 7.50 was recorded for birds fed 30% dietary CDDG. Birds fed diet containing 10% dietary CDDG had the highest feed conversion ratio (6.3) among the dietary treatments with CDDG inclusion. Nitrogen retention was the highest (88.6%) in birds fed control diet and lowest (61.20%) in birds fed 30% dietary CDDG. There was no mortality recorded throughout the period of experimentation (Table 2).

Average number of eggs and Hen-Day Production (HDP) (Table 3) were significantly affected ($P<0.05$) by dietary treatments. Birds fed 20% dietary DDG had the highest (61%) HDP and highest (56) number of eggs per week while birds fed 0% DDG (control diet) had the lowest HDP (52.2%) and birds fed 40% DDG had the lowest (41) average number of eggs per week.

There were significant changes ($p<0.05$) among dietary treatments for egg weight, yolk height, albumen height, albumen weight and yolk weight while yolk width and yolk index were not affected ($p<0.05$) by dietary treatments. Birds fed 30% dietary DDG had the highest albumen height (7.8mm) while birds fed 10% dietary DDG (diet B) had the lowest albumen height (6.9 mm).Birds fed 30% dietary DDG had the highest albumen weight(36.3g) while birds fed 40% dietary DDG (diet E) had the lowest albumen weight (33.4g).

Haugh unit (Table 4) was significantly affected ($p<0.05$) by dietary treatments. Birds fed 20% dietary DDG had the highest value

Table 1: Composition of corn distillers' dried grain based diets fed to laying hen

Ingredients	0%	10%	20%	30%	40%
Maize	55.2	49.6	44.4	38.8	33.2
Wheat	12.0	10.8	9.6	8.4	7.2
Soybean meal	24.0	20.8	18.4	16.0	14.0
Oyster shell	8.0	8.0	8.0	8.0	8.0
Bone Meal	1.2	1.2	1.2	1.2	1.2
Layers' Premix	0.2	0.2	0.2	0.2	0.2
Methionine	0.2	0.2	0.2	0.2	0.2
Lysine	0.1	0.1	0.1	0.1	0.1
Salt	0.3	0.3	0.3	0.3	0.3
CDDG	0.0	10.0	20.0	30.0	40.0
Total	100.0	100.0	100.0	100.0	100.0
CP (%)	17.0	17.4	17.8	18.1	18.6
ME(Kcal/kg)	2604.0	2623.4	2643.5	2662.7	2682.4

**Layers' Premix supplied per Kg of diets; Vitamin A: 8 x 10^6, Vitamin D_3: 1500 IU, Vitamin E: 101 IU, Vitamin K_3: 1.5 mg, Vitamin B_1: 1.6 mg, Vitamin B_2: 4 mg, Vitamin B6: 1.5 mg, Vitamin B_{12}: 0.0 mg, Niacin: 20 mg, Pantothenic acid: 5 mg, Folic acid: 0.05 mg, Biotin: 0.75 mg, Choline chloride: 1.75 x 10^4 mg, Cobalt: 0.2 mg, Copper: 0.2 mg, Iodine: 1 mg, Iron: 20 mg, Manganese: 40 mg, Selenium: 0.2 mg, Zinc: 80 mg, Antioxidant: 1.25 mg N.B: ME- Metabolizable Energy (calculated), CP-Crude Protein (calculated).*

Table 2: Effects of graded levels of corn distillers' dried grain diets on the performance of laying hen

CDDG inclusion levels	Feed intake (g/bird/day	Weight gain (g/bird/day)	FCR	Nitrogen Retention (%)	Mortality* (%)
0%	127.0 ± 2.04[a]	21.5 ± 0.11[a]	5.9 ± 0.13[d]	88.6 ± 0.48[a]	0
10%	126.6 ± 3.22[a]	20.1 ± 0.68[b]	6.3 ± 0.11[c]	83.2 ± 1.22[b]	0
20%	108.3 ± 3.25[b]	17.1 ± 0.56[c]	6.3 ± 0.13[c]	84.7 ± 1.42[b]	0
30%	127.0 ± 2.15[a]	16.9 ± 0.32[c]	7.5 ± 0.23[a]	61.2 ± 2.26[d]	0
40%	105.0 ± 3.21[b]	15.6 ± 0.14[d]	6.8 ± 0.14[b]	72.5 ± 2.68[c]	0

*Means in the same column having different superscripts are significantly different at $p<0.05$, * the percentage mortality was not significant.*

Table 3: Effects of graded levels of corn distillers' dried grain diets on laying performance of layers and the cost-benefit ratio of laying hen

CDDG Inclusion level	Average No of Egg	Hen-Day Production	Feed Cost Naira/Kg	Cost Benefit Analysis
0%	48.0 ± 3.26[b]	52.2 ± 1.84[a]	82.4 ± 2.56[a]	0.9 ± 0.38[a]
10%	49.0 ± 2.18[b]	53.0 ± 2.62[ab]	76.1 ± 2.42[b]	0.8 ± 0.34[a]
20%	56.0 ± 5.04[a]	61.0 ± 1.84[c]	70.8 ± 5.88[c]	0.6 ± 0.32[a]
30%	51.0 ± 5.36[ab]	55.6 ± 2.62[b]	65.8 ± 4.58[cd]	0.7 ± 0.36[a]
40%	41.0 ± 2.28[c]	52.6 ±1.78[a]	62.0 ± 3.83[d]	0.8 ± 0.36[a]

Means in the same column having different superscripts are significantly different at P<0.05. N.B: Feed cost per kilogram was applicable at the time the experiment was performed.

Table 4: Effects of graded levels of corn distillers' dried grain diets on egg quality traits of laying hen

Treatment	Egg Weight (g)	Yolk Height (mm)	Albumen Height (mm)	Yolk Width (mm)	Albumen Weight (g)	Yolk Weight (g)	Haugh Unit	Yolk Index	Relative Specific Density
0%	52.5 ± 1.24[b]	15.2 ± 0.20[a]	7.0 ± 0.41[cd]	3.7±0.12[a]	35.2±0.16[b]	12.1±0.02[a]	81.7±0.12[c]	4.0±0.21[a]	1.2±0.11[a]
10%	51.9 ± 1.82[c]	15.4 ± 0.24[a]	6.9 ± 0.21[d]	3.6±0.18[a]	35.2±0.14[b]	11.5±0.03[b]	85.5±2.98[b]	4.1±0.31[a]	1.2±0.11[a]
20%	54.0 ± 1.12[a]	14.9 ± 0.08[b]	7.6 ± 0.22[b]	3.6±0.12[a]	36.1±1.04[ab]	11.1±0.31[c]	88.7±0.02[a]	4.1±0.22[a]	1.2±0.12[a]
30%	52.1 ± 1.81[bc]	14.7 ± 0.11[c]	7.8 ± 0.12[a]	3.6±0.21[a]	36.3±0.21[a]	10.6±0.40[c]	86.3±0.71[b]	4.0±0.13[a]	1.2±0.12[a]
40%	50.1 ± 2.02[c]	14.8 ± 0.18[bc]	7.4 ± 0.40[bc]	3.7±0.14[a]	33.4±0.16[c]	11.9±0.41[b]	88.1±0.24[b]	4.1±0.12[a]	1.3±0.12[a]

Means in the same column having different superscripts as significantly different at P<0.05.

(88.7) while birds fed 0% dietary DDG (control) had the lowest (81.2) value. Relative Specific Density (Table 4) was similar (1.2) among dietary treatments during the egg analysis period.

DISCUSSION

The lower feed intake observed with birds fed 40% CDDG could be due to the increasing fibre level and dustiness of the feed as the level of CDDG increased in the diets. It could be probable that at the 30% level of the inclusion of CDDG the tolerable limit of layers for fibre had exceeded the threshold hence the decrease in feed intake. Birds have been reported to eat to satisfy energy requirement (NRC, 1994). Fibre is a nutrient diluent especially for monogastric animal and therefore reduces nutrient density. Birds fed high fibre diets are expected to increase voluntary feed intake (Batal and Dale, 2006; Bolu *et al.,* 2012). Okoye *et al.* (2006) reported decreased feed intake when birds were fed sorghum malt at 30% inclusion level due to dustiness of the feed. Feed intake observed for in this study corroborated the findings of Waldroup *et al.* (1981; 2007) and Leaflets (2008), who suggested 25% and 20% of CDDG inclusion, respectively, as accepted levels in poultry diets. Lowest feed conversion ratio (7.5) observed in birds fed 30% CDDG could be related to their low body weight gained in spite of their high feed intake (Quant *et al.,* 2011). This means birds could not efficiently convert feed consumed into body weight, hence the decrease in feed conversion ratio, which can also be attributed to the increasing fibre level with increasing levels of CDDG. Bolu *et al.* (2012) reported low feed utilisation as a result of high fibre level in broilers fed graded levels of CDDG. Nitrogen retention decreased with increasing levels of CDDG (Fastinger *et al.,* 2006; Roberts *et al.,* 2007). This is contrary to the findings of Leaflet (2008) who reported an increase in nitrogen retention with increasing CDDG levels despite the increased nitrogen excretion, while egg production increased.

Birds fed 20% dietary CDDG performed best in terms of HDP and average number of eggs per week. Leaflet (2008) suggested that CDDG could be fed to laying hens in commercial settings, and can be fed at up to 15 to 20% of the diet with no adverse effects on egg production. However, HDP and average number of eggs per week decreased as dietary CDDG rose above 20%. Ghazalah *et al.* (2011) studied the effects of DDGS as replacement for soya bean and reported a decrease in average egg production as dietary inclusion of DDGS increased.

Since there was significant difference observed with egg weight, yolk height, yolk index yolk weight, albumen weights and heights, it means the variables were affected by the dietary treatment (Roberson *et al.,* 2005). In terms of albumen height and weight, birds fed 30% CDDG diet had the best performance. The higher the Haugh unit value, the better the albumen quality. Birds fed 20% CDDG had highest values for haugh unit and a better albumen quality. Lumpkins *et al.* (2005) and Mahmoud and Sheila (2011) did not observe variations in egg interior qualities as a result of dietary DDG fed to laying hens. However, Jung and Batal (2009) observed that the incorporation of 20% DDGS to laying hens diets significantly increased Haugh units.

Specific gravity, according to Mahmoud and Sheila (2011) is a good indicator of egg shell quality when value is around 1.080 or above. The results in this experiment indicated an average relative specific density of 1.2 during egg analysis period. Lumpkins *et al.* (2005) who reported that laying hens fed 15% corn CDDGS had no negative effect on egg shell specific gravity. In the same vein, Mahmoud and Sheila (2011) reported that similar specific gravity was observed among dietary treatments when birds were fed a graded level of corn CDDGS at 5 – 25%.

Birds fed 20% CDDG had the highest cost-benefit ratio (0.6) which means profit was being maximised at 20% CDDG. This could be related to the high hen-day production recorded in Diet C (20%). In summary, birds fed on 20% dietary CDDG performed best. This agreed with Lumpkins *et al.* (2004) who suggested a maximal inclusion level of 10 to 12% CDDGs may be used in commercial layers' diets.

Conclusion: Birds fed 20% DDG performed best in terms of HDP, Average number of eggs, egg quality, cost-benefit ratio and general performance, it can be concluded that laying hens can be fed DDG at 10 – 20% inclusion level. Inclusion levels of DDG above this level was observed to be counter-productive as it affected production performance of bird; this observation is as a result of the high fibre level of the feed. Inclusion of DDG in poultry diet also minimized the cost of feed in poultry production generally since the cost of feed decreased with increasing DDG inclusion level.

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