African Journal of Agricultural Research Vol. 5(20), pp. 2782-2786, 18 October, 2010
Available online at http://www.academicjournals.org/ajar
ISSN 1991-637X ©2010 Academic Journals

Full Length Research Paper

Development of feed package for layers using low energy agro-industrial by products

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Accepted 30 July, 2010

A feeding trial of 20 weeks duration was conducted using 240 point-of-lay Hy-line layers to study the nutritive value of diets containing low-energy agro-industrial by-products namely wheat bran, maize bran, rice bran, brewers' spent grains and cocoa pod husk on laying performance. The experimental diets were formulated to be iso-caloric and iso-nitrogenous. They contained an average of 16.3% crude protein and metabolisable energy of 10.38 MJ/kg. Each dietary treatment was replicated four times in a completely randomized design. The initial average live weight of the experimental birds was 1.75 kg. Feed and water were provided *ad libitum.* Among the production parameters studied were feed intake, body weight gain, feed conversion ratio, hen-day production, hen-housed egg production, egg weight, mortality, shell thickness, and Haugh unit. In addition, cost-benefit analysis was carried out to establish the economic feasibility of the experimental diets. With the exception of feed intake which showed significant response ($p < 0.05$) to dietary treatments, all the other production parameters showed a non-significant positive response ($p > 0.05$). Cost per kilogram diet was reduced when agro-industrial by-products were used. Dietary treatment T_2 supported the best egg production with a net revenue of GH¢371.30. Seasonal increases in the prices of conventional feedstuffs like maize and fishmeal would make the use of agro-industrial by-products in poultry diets even more attractive.

Key words: Feed package, low energy agro-industrial by-product, layer hens, performance.

INTRODUCTION

The survival of the poultry industry in most developing countries in the future will, undoubtedly, depend on the ability of poultry industry to compete with humans for the available food supply (Ranjhan, 1999). Cereal demands for direct human use are expected to increase as more than half of the human race is undernourished and the world population is still increasing (FAO, 1992; 2002; 2006). In most countries maize, which constitute the major portion of poultry diet, is rather expensive and it is the main reason for the high cost of diet ranging between 60 and 80% of the total cost of production (Pond et al., 1991; Reddy, 1996; Adesehinwa, 2007).

Many agricultural and agro-industrial by-products that could profitably be used are available locally but are not fully exploited for the feeding of livestock (Okon and Ogunmodede, 1995; Nelson et al., 2007; Rhule et al., 2007). Such feedstuffs include fibrous by-products such as wheat bran, maize bran, rice bran, brewers spent grains and cocoa pod husks. These agro-industrial by-products, although containing potentially toxic components, can be improved by various treatments such as chemical, mechanical, pelleting, grinding and other processing techniques and safely included in compounded poultry feeds in relatively low proportions (El Hag and Omer, 1986; Nelson et al., 2004; Donkoh et al., 2005). The importance of identifying and utilizing these locally available feedstuffs in formulating poultry diets has been emphasised time and again (Ravindran and Blair, 1992; Donkoh et al., 2005; Nelson et al., 2006).

In most studies, wheat bran, maize bran, rice bran, brewer's spent grains and cocoa pod husk, have been

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used individually with maize, a high-energy feedstuff, to meet the energy requirements of poultry. However, there is a paucity of information on the effect of combining these low energy ingredients to partially replace maize in laying hens' diets. This study, was therefore undertaken to ascertain whether a combination of agro-industrial products, namely: wheat bran, rice bran, maize bran, brewers' spent grains and cocoa pod husks can efficiently reduce the amount of maize normally included in layer diets and to provide poultry farmers with a feed package of lower amount of maize at affordable prices.

MATERIALS AND METHODS

Animals, dietary treatments and experimental design

Two hundred and forty (240) Hy-Line brown pullets at point of lay (24 weeks old) were used in the study and randomly allotted equal numbers to three experimental diets using the completely randomised design. There were four replicates per treatment, giving 80 birds per treatment. The layer hens had free access to the experimental diets and water for 20 weeks (140 days).

Three experimental diets (Table 1) were formulated and designated as T_1 (Control), T_2 and T_3. They were formulated to meet the National Research Council (NRC, 1994) nutrient requirements for laying hens. The diets were also formulated to be iso-caloric and iso-nitrogenous using Microsoft Excel Solver. The calculated chemical compositions of the experimental diets are presented in Table 2.

Chemical analysis

The major ingredients (wheat bran, rice bran, maize bran, brewers' spent grains and cocoa pod husks) used in formulating the experimental diets as well as the experimental diets were subjected to proximate analysis using the procedures of the Association of Official Analytical Chemists (1990).

Data collection

Data were collected on feed consumption, growth rate, egg production, egg weight, egg shell thickness, internal egg quality, mortality and economics of production.

Economy of production

The amount of money realized from the sale of eggs produced minus the cost of feed consumed for each dietary treatment was estimated.

Statistical analysis

The dietary treatment effects on the parameters measured were statistically analyzed. Differences between means were determined by the use of the Duncan's multiple range test (Steel et al., 1997). The computations were performed using the general linear models procedures of the Statistical Analysis System Institute Inc. (1987).

RESULTS AND DISCUSSION

The proximate composition of the experimental diets is shown in Table 3. The crude protein contents of the experimental diets were about the same. Dietary treatment T_1 (control diet) was slightly higher in crude protein than those of T_2 and T_3 (agro-industrial by-products based diets). These values fall within the range (16 - 17%) recommended by (NRC, 1994) for layer chickens. Crude fibre content of both dietary treatments T_2 and T_3 were higher than the control diet (T_1) and can be attributed to the inclusion of the agro-industrial by-products. The ether extract contents of the agro-industrial by-products based diets were both higher than the control diet (T_1). The nitrogen-free extract values obtained for the experimental diets were almost similar.

The overall performance of the layer hens with respect to the parameters measured are presented in Table 4. Though dietary treatments one (control) and agro-industrial by-products based diets (T_2 and T_3) were different with regards to the absence of agro-industrial by-products in the control diets, they supported similar performances. There were significant differences ($P < 0.05$) in the average daily feed intake among the various treatments (Table 4). Average daily feed Intake of birds on dietary treatments T_2 and T_3 were higher ($P < 0.05$) than those on the control diet (T_1). The feed intakes of birds recorded in this study were higher than the 110 g/bird/day recommended by NRC (1994). Throughout the experimental period, feed intake of experimental birds was affected by the inclusion of agro-industrial by-products. In a similar experiment conducted by Babatunde and Oluyemi (2000), it was indicated that feed consumption increased correspondingly with incremental levels of these agro-industrial by-products.

The difference in feed intake between dietary treatment T_1 (control diet) and the other two dietary treatments might be due to the high fibre contents of the agro-industrial by-product-based diets. Shim et al. (1989) and Pond et al. (1989) reported that feed intake is high on fibrous diets. Donkoh et al. (2004) reported mean daily feed intake of 116.4 to 120.5 g when they fed diets with agro-industrial by-products to laying chickens. The initial body weights of the experimental birds were similar, averaging 1.52 kg. During the feeding trial, body weight gain was not significantly ($P < 0.05$) affected by dietary treatments. However, the slightly depressed weight gain for birds on dietary treatment T_3 could be attributed to the high levels of fiber in the diet. Nelson et al. (2007) reported reduction in body weight for birds fed on agro-industrial by-products based diet compared with that of birds on a proprietary commercial diet. The addition of fibre to the diet can lead to a lower apparent digestibility of starch and minerals and thereby depress weight gain (Fernandez and Jorgensen, 1986; Graham and Aman, 1987).

Generally, birds fed diets containing the agro-industrial by-products (rice bran, maize bran, wheat bran, brewers' spent grains and cocoa pod husk) (dietary treatments 2 and 3) produced the highest number of eggs, even though the differences were not significant. According to Polin and

Table 1. Percentage composition of experimental diets.

Ingredient	T1	T2	T3
Maize	55	45	35
Fish meal	13	13	13
Soya bean meal	2	2	2
Wheat bran	21.2	12.08	2.0
Maize bran	0	12.68	23.34
Rice bran	0	2.15	10.95
Brewers' spent grain	0	2.0	2.81
Cocoa pod husk	0	2.29	2.1
Oyster shell	8.5	8.5	8.5
Vit/mineral premix (Allvit MA)	2.5	2.5	2.5
Salt	2.5	2.5	2.5

Table 2. Calculated chemical composition (g/kg).

Crude protein	163.9	163.9	163.9
Crude fibre	38.9	59.5	72.8
Lysine	10.2	10.9	11.3
Methionine	7.9	8.5	7.1
Cystine	2.8	3.6	3.6
Calcium	37.6	37.8	37.8
Phosphorus	7.5	7.3	6.5
ME (MJ/kg)	10.38	10.38	10.38

Table 3. Proximate composition of experimental diets (% DM Basis).

Composition	T1	T2	T3
Moisture	11.3	12.0	10.5
Crude protein	16.7	16.6	16.2
Ether extract	2.88	3.57	4.12
Crude fibre	3.9	6.0	6.7
Ash	4.6	4.7	5
Nitrogen free extract	60.62	57.13	57.48

Wolford (1972), there is a correlation between feed intake and the rate of egg production, and that as feed consumption increased egg production also increased significantly. Mortality did not show any consistent trend in this experiment. A total of four (4) deaths were recorded in this experiment; three (3) under dietary treatment T_2 and one (1) under dietary treatment T_3. Although mortality has been described as one of the key features of feeding high levels of some agro-industrial by-products to poultry (Clarke et al., 1981), one of the deaths recorded in this study, according to post mortem examination, was associated with reproductive disorders and specifically impacted oviduct. The mean egg weight recorded for birds on dietary treatments T_1, T_2 and T_3 were similar, indicating that inclusion of various agro-industrial by-products in nutritionally-balanced laying hens' diets had no adverse effect on egg weight. The appreciable level of fat in the agro-industrial by-products based diets might have accounted for the egg weight of birds fed these diets.

Results of the study revealed no significant effect of dietary treatments on egg shell thickness. The shell thickness of the eggs produced by the experimental birds were all well above the value (0.3 mm) reported to be optimum for thickness of chicken egg shells (El-Boushy, 1966) which will not adversely result in breakages. This

Table 4. Effect of dietary treatments on the performance of laying hens.

Parameter	T1	T2	T3	SEM
Average feed intake (g/bird/day)	123.75[a]	138.75[b]	135.00[b]	2.18*
Average initial body weight (kg/bird)	1.52	1.51	1.52	0.01[NS]
Average final body weight (kg/bird)	1.69	1.67	1.65	0.04[NS]
Average body weight gain (kg/bird)	0.17	0.16	0.13	0.004
Hen-day egg production (%)	75.28	83.93	78.04	0.34[NS]
Hen-housed egg production (%)	75.28	80.79	76.06	0.32[NS]
Mortality (%)	0.00	0.75	0.25	0.19[NS]
Mean egg weight (g)	57.20	57.21	57.30	0.17[NS]
Mean shell thickness (mm)	0.34	0.33	0.34	0.002[NS]
Mean yolk colour score	1.00	1.01	1.00	0.007[NS]
Mean Haugh unit	83.96	83.93	83.97	0.31[NS]
Number of (egg breakages) cracks (%)	12.04	16.19	12.04	2.44[NS]

SEM - Standard error of mean; NS - Not significantly different ($p < 0.05$); * - Significantly different ($p > 0.05$).

Table 5. Costs and benefits from feeding the different layer diets.

Parameter	T1	T2	T3
Feed cost/kg (GH¢)	0.07	0.05	0.05
Feed intake (g/bird/day)	123.75	138.75	135.00
No. of days on feed	140	140	140
No. of birds on diet	80	80	80
Total cost of feed over the period (GH¢)	99.38	81.12	83.46
Average daily egg production	58.62	64.63	60.85
Average egg weight (g)	57.20	57.21	57.30
Price per tray of 30 eggs (GH¢)	1.50	1.0	1.50
Value of eggs (GH¢)	410.37	452.42	425.94
Net revenue	310.99	371.30	342.48

US$ 1.0 = GH¢ 1.5.

agrees with the number of eggs recorded as breakages in the present study. The results of the yolk colour score also indicated no significant differences in yolk colouration among various dietary treatments. Haugh unit values of eggs for the various treatments (Table 3) did not show any adverse effects. The results of the cost-benefit analysis are presented in Table 5. The cost benefit analysis derived from feeding various dietary treatments indicated that the inclusion of rice bran, maize bran, brewers' spent grains and cocoa pod husk in laying hen diets resulted in economic gains. The cost per kilogram of both dietary treatments T_2 and T_3 were lower than the control diet (T_1). Similarly, the results indicate that dietary treatments T_2 and T_3 (the agro-industrial by-products based diets) yielded the highest net revenues of GH¢371.30 and GH¢342.48, respectively as against GH¢310.99 for dietary treatment T_1 (control). This was due solely to the huge price disparities between the agro-industrial by-products used to partially replace maize in diets T_2 and T_3 and sole maize in T_1.

Conclusion

It can be concluded from this experiment that since the dietary treatments supported similar performances, diets can contain up to five agro-industrial by-products such as wheat bran, rice bran, maize bran, brewers' spent grains and cocoa pod husks with dietary fibre levels of 6.7% without adverse effects on egg production. The inclusion of wheat bran, rice bran, maize bran, brewers' spent grains and cocoa pod husks confers considerable economic advantage by reducing feed cost and increasing net revenue without sacrificing performance. Since feed cost accounts for about 70% of total cost of egg production, the utilization of such agro-industrial by- products could

be of economic benefit to egg producers. Seasonal increases in prices of conventional feedstuffs like maize and fishmeal would make the use of agro-industrial by-products even more attractive.

ACKNOWLEDGEMENT

The authors are grateful to the Agricultural Services Sector Investment Project (AgSSIP) of the Council for Scientific and Industrial Research (CSIR), in Ghana, for sponsoring this project.

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