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Effects of Dietary Replacing Corn with Bakery by-product with or without Enzyme Supplementation on Performance of Laying Hens

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Abstract*—The objectives of this experiment was to investigate effects of dietary replacement of maize with bakery by-product (BB) with or without enzyme supplementation on the performance of laying hens and egg quality characteristics. A total number of 180 Hy-Line Leghorn hens were weighed and distributed between 30 cages with almost same egg production (EP) level among the cages. Six iso-caloric and iso-nitrogenous diets were formulated (ME=2900 kcal/kg and crude protein= 15.20 g/100 g diet) based on catalogue of Hy-line. The experiment was conducted as a 3×2 factorial arrangement of treatments including three replacement levels (0, 50, and 100%) of corn with dried bakery byproduct replacement) and enzyme supplementation (0 and 0.06 g/100 g diet of Hemicell®, a commercial β-mannanase-based enzyme product). Each of 6 experimental diet fed hens in 5 replicates with 6 birds per each replicate (cage). The hens' performance including hen-day egg production% (EP), egg weight (EW) and feed intake (FI) was measured for 4 weeks and egg mass (EM, g/hen/day) as well as feed conversion ratio (FCR, g feed: g egg) was calculated. The data was analyzed based on completely randomized designusing GLM procedure of SAS. Replacing dietary corn with BB had no significant effect on egg production (%), except in week 2. Egg production in group of 100% corn-replacement in week 2 was lower than the other dietary groups. However, the overall EP for weeks 1-4 was not significantly affected by replacing dietary corn with BB. In addition, EM and FCR were not significantly affected by dietary treatment. Egg weight was affected by dietary corn-replacement in weeks 1 and 2; however, no significant difference was found in weeks 3 and 4. Egg quality characteristics were not affected by dietary treatment. Enzyme supplementation had no significant effect on performance of hens and egg quality traits. From the results of this experiment it can be concluded that dietary corn can be totally replaced with bakery by-products with no adverse effect on performance and egg quality. In addition, β-mannanase has no beneficial effect on performance of hens fed on corn- or bakery by-product-based diets.

Keywords-Bakery by-products, performance, laying hens, egg quality

I. INTRODUCTION

Improvements in the efficiency of poultry production must rely on obtaining maximum nutrient utilization from feedstuffs, which would also enable the use of a wide range of ingredients currently considered inferior. Corn has been used consistently as a major ingredient for poultry rations because of its high energy content and low cost. However, its price is increasing because of the limited world yield in covering the demands for both humans and livestock. In addition, as corn markets tighten and corn supplies go to nonagricultural uses such as ethanol production, there appears to be a need for alternative grain sources for pullet and layer rations. So, it is important to search for other alternative cheap energy sources which can solve this problem. Minimizing the feed cost could be achieved through the use of untraditional cheaper feed ingredients or improving utilization of common feeds by using some feed additives (i.e., enzymes). Attention, therefore, should be drawn towards the use of some local by-products. In the last few years, bakery by-product (BB) had been used as an alternative energy source to substitute corn in poultry diets. The BB could replace corn for its relatively lower cost in poultry feeding. Some of these by-products thrown in the garbage fermented and cause an environmental pollution. Several investigators analyzed BB and found that it contains suitable amounts of nutrients. Slominski *et al.* (2004) reported 119 g kg–1 protein (as-fed basis), 378 g kg–1 starch, 84 g kg–1 sugars, 81 g kg–1 fat, 87 g kg–1 NSP and 14.34 MJ kg–1 TMEn for BB in Canada. Damron *et al.* (1965) provided evidence that BB can be included in broiler diets without adversely affecting their performance. Patrick and Schaible (1980) reported that BB might be used to replace part of the grain fed to poultry as energy source. Waldroup *et al.* (1982) reported that the fat content of the samples varies from 5.3 to 14.4%. Dale and Duke (1987) reported that BB nutritive value varies widely. Radwan (1995) found that incorporating of 25 % BB into Baladi chick diets at levels 10, 20, 30 or 40 % had no detrimental effect on body weight or dressing %, while, FI was increased, FCR was impaired. On the other hand, inclusion of BB into Baladi chick diets resulted in a higher economical efficiency as compared to the control diet.

Poultry diet is predominantly composed of plant ingredients, mainly cereals and vegetable proteins plus a little amount of animal proteins. Most of feed ingredients contain non-digested parts (cellulose, xylose, arabinose, galactonic acid) which inhibit feed utilization and birds performance (Alam, *et al*., 2003). At high dietary concentrations, the feeding value of cereals, particularly those with low apparent metabolizable energy (AME), are reduced and result in a poor bird performance (Choct, *et al*., 1996). It is demonstrated that, based on the historical evidence, a laying hen diet composed of 60-65% soybean meal and 20-25% corn contains an amount of galactomannan expected to deteriorate hen performance by about 7.5 points in adjusted feed conversion. Legume seed (including soybean) are known to contain galactomannans. Of 163 types of legume seeds tested, 75% contained mucilage-yielding endosperms (Anderson, 1949). Mucilage is a classical term for viscous polysaccharide polymers that include galactomannan. On a weight basis, galactomannan is five times as viscous as starch, and is one of the most viscous polysaccharides known (Whistler and Smart, 1953). Mannose and galactose are also present as significant proportions of the non-starch polysaccharides of many commonly used feedstuffs such as wheat, maize, sorghum, barley, oats and rye (Chesson, 1987) and canola meal (Slominski and Campbell, 1990). This type of composition data does not establish the exact content of galactomannan since other types of polymers could contain mannose and galactose. It does indicate the upper limit of galactomannan content. Soybean meal, one of the most widely used feed components has the largest mannose and galactose percentages of the feed components. The galactomannan from soybeans has been purified and soybean hulls have a high content of galactomannan (Whistler and Saarnio, 1957).

Hemicell® is a patented enzyme-based feed ingredient with primary enzymatic activity, endo-β-D-mannanase which degrades galactomannan polymers. It has been believed the effectiveness of Hemicell® in improving the feed/grain performance of poultry and swine feeds is primarily due to the degradation of galactomannans that are present in currently used feed formulations by the endo-B-D-mannanase enzyme activity present in Hemicell®.

Recent studies on the inclusion of BB in the laying hen diets are rare, so the objectives of this study were to further evaluate the nutritional worth of BB in laying hen diets and to determine the effectiveness of an exogenous dietary enzyme.

II. Materials And Methods

A total number of 180 Hy-Line Leghorn hens were weighed and distributed between 30 cages with almost same egg production (EP) level among the cages. Six iso-caloric and iso-nitrogenous diets were formulated (ME=2900 kcal/kg and crude protein= 15.20 g/100 g diet) based on catalogue of Hy-line (table 1). The experiment was conducted as a 3×2 factorial arrangement of treatments including three replacement levels (0, 50, and 100%) of corn with dried bakery byproduct replacement) and enzyme supplementation (0 and 0.06 g/100 g diet of Hemicell®, a commercial β-mannanase-based enzyme product). Each of 6 experimental diet fed hens in 5 replicates with 6 birds per each replicate (cage). The hens' performance including hen-day egg production% (EP), egg weight (EW) and feed intake (FI) was measured for 4 weeks and egg mass (EM, g/hen/day) as well as feed conversion ratio (FCR, g feed: g egg) was calculated. The data was analyzed based on completely randomized design using GLM procedure of SAS.

III. Results And Discussion

Effects of replacing dietary corn with BB on EP (%), EM (g/hen/day) and EW (g) of laying hens in this study are presented in tables 2 to 4, respectively. Replacing dietary corn with BB had no significant effect on egg production (%), except in week 2. Egg production in group of 100% corn-replacement in week 2 was lower than the other dietary groups. However, the overall EP for weeks 1-4 was not significantly affected by replacing dietary corn with BB. In addition, EM and FCR were not significantly affected by dietary treatment. Egg weight was affected by dietary corn-replacement in weeks 1 and 2; however, no significant difference was found in weeks 3 and 4. Egg quality characteristics were not affected by dietary treatment (tables 5 and 6). Enzyme supplementation had no significant effect on performance of hens and egg quality traits. We could not find any record in literature investigating effects of dietary inclusion of BB on laying hens' performance. However, it has been reported that BB could be successfully used in broilers diets. El-Yamny, *et al*. (2003) reported that incorporating 25% BB in Japanese quail diet as untraditional ingredients enhanced body weight, body gain, FI and FCR at the market age compared with other dietary treatments. Abdullatif *et al*. (2004) who fed 5 levels of BB (0 , 5, 10, 20 and 30%) to broiler chicks showed that inclusion of up to 30% BB in the broiler diets had no harm effect on the performance of the birds. Boros *et al*. (2004) reported that the use of BB in concert with an effective enzyme supplement in broiler chicken diets would allow for optimum growth performance. Effective use of BB in poultry diets can be expanded by supplementation with exogenous enzymes to enhance nutrient digestibilities and reduce variability due to negative processing effects.

From the results of this experiment it can be concluded that dietary corn can be totally replaced with bakery by-products with no adverse effect on performance and egg quality. In addition, β-mannanase has no beneficial effect on performance of hens fed on corn- or bakery by-product-based diets.

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TABLE 1. COMPOSITION AND INGREDIENTS OF THE EXPERIMENTAL DIETS

	Level of corn replacement with bakery byproduct (%)		
	0	50	100
Corn	62.22	29.80	-
Bakery byproduct	-	29.70	56.99
Soybean meal	21.49	19.38	17.40
Wheat bran	0.20	5.00	9.50
Vegetable oil	4.02	4.02	4.02
Limestone	4.72	4.56	4.42
Dicalcium phosphate	1.05	1.17	1.28
Oyster shell	5.00	5.00	5.00
Common salt	0.35	0.35	0.35
Vit. & Min. premix[1]	0.50	0.50	0.50
Lys-HCl	0.22	0.24	0.26
DL-Met	0.28	0.29	0.30
Hemicell[2]	-	-	-
Calculated analysis			
ME (Kcal/ kg)	2900	2900	2900
Crude protein (%)	15.20	15.20	15.20
Ether extract	6.16	8.53	10.71
Crude fiber	2.89	2.92	2.95
Calcium	4.00	4.00	4.00
Available phosphate	0.31	0.31	0.31
Linoleic acid	3.75	3.28	2.84
Arg	0.91	0.91	0.91
Lys	0.90	0.90	0.90
Met	0.51	0.51	0.51

[1]The vitamin and mineral premix provide the following quantities per kilogram of diet: vitamin A, 10,000 IU (*all-trans*-retinal); cholecalciferol, 2,000 IU; vitamin E, 20 IU (α-tocopheryl); vitamin K3, 3.0 mg; riboflavin, 18.0 mg; niacin, 50 mg; D-calcium pantothenic acid, 24 mg; choline chloride, 450 mg; vitamin B12, 0.02 mg; folic acid, 3.0 mg; manganese, 110 mg; zinc, 100 mg; iron, 60 mg; copper, 10 mg; iodine, 100 mg; selenium, 0.2 mg; and antioxidant, 250 mg

[2] Hemicell: A commercial cocktail enzyme with main activity of β-mannanase

TABLE 2. EFFECTS OF DIETARY REPLACEMENT OF CORN WITH BAKERY BYPRODUCT ON HEN-DAY EGG PRODUCTION (%) DURING 4-WEEK EXPERIMENTAL PERIOD

Treatments	Hen-day egg production (%)				
Weeks	1	2	3	4	1-4
Corn replacement by bakery byproduct					
0 % replacement	56.54	65.27[a]	57.93	56.15	55.35
50 % replacement	60.11	63.09[a]	54.56	51.38	57.34
100 % replacement	58.13	52.97[b]	56.54	53.76	58.92
Enzyme (E)					
No enzyme	58.46	60.05	55.15	54.49	56.91
Hemicell	58.06	60.84	57.53	53.04	57.50
SEM	1.663	1.662	1.161	1.155	0.982
CV	16.82	16.49	12.37	12.89	10.29
	P values				
Bakery (B)	0.61	0.00	0.47	0.25	0.36
Enzyme (E)	0.89	0.69	0.29	0.52	0.77
B × E	0.06	0.06	0.08	0.31	0.71

a-b Means within a column (within main effects) with no common superscript differ significantly ($p < 0.05$).

TABLE 3. EFFECTS OF DIETARY REPLACEMENT OF CORN WITH BAKERY BYPRODUCT ON EGG MASS (G/HEN/DAY) DURING 4-WEEK EXPERIMENTAL PERIOD

Treatments	Egg mass (g/hen/day)				
Week	1	2	3	4	1-4
Corn replacement by bakery byproduct					
0 % replacement	38.90	39.88	37.31	35.28	37.84
50 % replacement	40.09	42.05	38.73	36.36	39.31
100 % replacement	41.11	42.67	39.81	38.44	40.51
Enzyme (E)					
No enzyme	40.04	42.97	37.20	36.07	39.07
Hemicell	40.03	40.09	40.02	37.32	39.36
SEM	1.087	1.205	0.833	0.853	0.709
CV	16.28	17.40	12.95	13.95	10.83
	P values				
Bakery (B)	0.99	0.63	0.48	0.33	0.33
Enzyme (E)	0.73	0.25	0.10	0.47	0.84
B × E	0.54	0.75	0.79	0.56	0.62

TABLE 4. EFFECTS OF DIETARY REPLACEMENT OF CORN WITH BAKERY BYPRODUCT ON EGG WEIGHT (G)DURING 4-WEEK EXPERIMENTAL PERIOD-2

Treatments	Egg weight (g)				
Week	1	2	3	4	1-4

Corn replacement by bakery byproduct					
0 % replacement	71.67[a]	69.40[a]	68.85	68.28	68.89
50 % replacement	66.46[b]	68.55[ab]	67.58	68.04	68.63
100 % replacement	68.77[ab]	67.92[b]	68.32	68.22	69.75
Enzyme (E)					
No enzyme	69.08	69.13	67.74	68.37	68.64
Hemicell	68.86	68.12	68.76	67.99	69.54
SEM	0.834	0.221	0.475	0.301	0.450
CV	7.24	1.93	4.17	2.64	3.90
	P values				
Bakery (B)	0.03	0.01	0.52	0.94	0.58
Enzyme (E)	0.88	0.06	0.27	0.54	0.33
B × E	0.27	0.91	0.07	0.43	0.36

a-b Means within a column (within main effects) with no common superscript differ significantly ($p < 0.05$).

TABLE 5. EFFECTS OF DIETARY REPLACEMENT OF CORN WITH BAKERY BYPRODUCT ON EGG CHARACTERISTICS FOR EGG SAMPLING ON WEEK 5 OF EXPERIMENT

Treatments	Egg characteristics			
Week	Yolk weight	Egg index	Yolk height	Haugh unit
Corn replacement by bakery byproduct				
0 % replacement	19.70	73.46	1.64	89.83
50 % replacement	19.92	72.37	1.64	88.59
100 % replacement	19.98	73.91	1.64	88.03
Enzyme (E)				
No enzyme	19.82	73.27	1.63	89.66
Hemicell	19.91	73.22	1.64	87.98
SEM	0.178	0.486	0.009	0.851
CV	5.38	3.97	3.04	5.74
	P values			
Bakery (B)	0.82	0.41	0.99	0.68
Enzyme (E)	0.81	0.95	0.52	0.33
B × E	0.65	0.16	0.40	0.23

TABLE 6. EFFECTS OF DIETARY REPLACEMENT OF CORN WITH BAKERY BYPRODUCT ON EGG CHARACTERISTICS FOR EGG SAMPLING ON WEEK 5 OF EXPERIMENT-CONTINUE

Treatments	Egg characteristics			
Week	Yolk color	Shell %	Shell weight	Shell thickness
Corn replacement by bakery byproduct				
0 % replacement	6.00	10.95	7.84	0.323
50 % replacement	6.25	10.92	7.63	0.327
100 % replacement	6.75	10.78	7.56	0.323
Enzyme (E)				
No enzyme	6.22	10.99	7.69	0.328
Hemicell	6.44	10.77	7.67	0.321
SEM	0.281	0.181	0.125	0.002
CV	26.69	9.92	9.76	4.62
	P values			
Bakery (B)	0.54	0.91	0.67	0.83
Enzyme (E)	0.69	0.54	0.96	0.21
B × E	0.13	0.08	0.99	0.59