Effects of Increasing Concentrations of Corn Dried Distiller's Grains with Solubles on the Egg Production and Internal Quality of Eggs

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Summary and Implications

Four diets were formulated to contain 0, 17, 35 or 50% corn DDGS. A total of 240 54-week-old single-comb White Leghorn laying hens were assigned to one of four dietary treatments and fed for a 24-week experimental period. Two sets of the experimental diets were formulated and each diet was fed for 12 weeks. Egg production, feed consumption, egg component, yolk color, Haugh unit during storage times, and shell breaking strength were measured. Egg production, egg weight, egg mass, feed intake, and feed efficiency were adversely affected by the highest level of DDGS in the diet (50%) during the first 12-week period. Once diets were reformulated to include an increased concentration of both lysine and methionine, differences among the dietary treatments were reduced, as the performance of the 50% DDGS diets was greatly improved. Over the last 6 weeks of study, no differences in egg production, egg weight and feed intake among the DDGS treatments were found. DDGS diets positively affected the internal quality of eggs during storage. Improved yolk color and Haugh unit were observed as the dietary DDGS levels increased, but the increase in Haugh unit was significant only when the DDGS level was 50%. Shell weight percentage was increased in 50% DDGS diet. It was suggested that up to 50% of DDGS could be included in the layer's diet without affecting egg weight, feed intake, egg mass, fee efficiency, and egg production as long as digestible amino acids were sufficient in DDGS-added diets.

Introduction

Corn dried distiller's grains with solubles (DDGS) are widely used in the US as an economical alternative source for protein, energy, and available phosphorus. As the production of bioethanol has increased rapidly in recent years, increased quantity of DDGS becomes available for feed industry. Corn DDGS have been safely added up to 10 or 15% in laying hen diets without adversely affecting laying performance and egg production. Recent studies indicated that addition of 20% DDGS in laying hen diets had no adverse effects on egg quality and egg production. Also, layers fed diets containing 0, 23, 46, and 69% corn DDGS for 8 weeks showed that egg production increased linearly, while egg weight decreased linearly as corn DDGS level increased. As a result, egg mass was not influenced by corn DDGS concentration in the diet. It was also found that yolk color was improved as DDGS level increased, but Haugh unit, eggshell weight, egg components were not influenced by the DDGS concentration in the diets. This indicated that feeding high concentrations of DDGS to laying hen diets would not have adverse effects on egg production and egg quality. However, it was a short-term study (8 weeks), and the effects of long-term feeding high concentrations of DDGS to laying hens are unknown.

An additional unknown in the use of DDGS with higher dietary concentrations is the possibility of virginiamycin as a residue in the feed ingredient. Virginiamycin is typically added in ethanol production processes to control the growth of lactic acid bacteria, therefore to prevent potential yield loss of ethanol. Therefore, there is a possibility that virginiamycin residues are present in DDGS themselves and diets containing DDGS. Virginiamycin residues are restricted to concentrations of 0.1 ppm in poultry products (meat and egg).

The objectives of this study were to investigate the effects of long-term feeding of high-level dietary corn DDGS (up to 50%) on the laying performance, egg components and egg shell quality, yolk color, and Haugh unit during storage and to explore to possibility of virginiamycin residue in diet containing higher concentrations of DDGS.

Materials and Methods

- A total of 240 54-week-old Single-comb White Leghorn laying hens were used.
- Diets were formulated to have four levels of corn DDGS (0, 17, 35, and 50%) and fed for 24 wks.
- After the first 12-week experiment period, diet formulas were modified by addition of lysine and methionine in an attempt to meet the production requirements of laying hens fed the 50% DDGS diets.
- Virginiamycin residue in the DDGS diets was determined using the bioautograph technique assay and the plate assay of virginiamycin.
- Hen performance was determined by egg production, egg weight, egg mass, feed consumption, and feed efficiency.
- Internal quality of egg was determined by measuring yolk color, Haugh unit, egg components, and shell breaking strength.

Statistical Analyses

This experiment used a completely randomized design. The data were analyzed by one-way ANOVA with the GLM procedure of SAS institute by one variation (treatment or week), and Duncan's multiple range test was used to separate the means.

Results

- The virginiamycin in the DDGS was negligible.
- The highest DDGS level (50%) had the lowest egg production, egg mass, feed efficiency and egg weight, and control diet (0% DDGS) had the best results for all the parameters listed above.
- Significant reductions in feed intake, egg production and egg weight were observed when the hens were fed the 50% DDGS diets due to an amino acid deficiency but these values dramatically increased once diets were reformulated with increased methionine and lysine.
- The low laying hen performance before diet reformulation was probably due to overestimation of lysine and methionine in DDGS. However, after diet reformulation, the differences of laying hen performance of hens among the four DDGS treatments gradually decreased and disappeared after 4 weeks.
- Egg production, feed intake, and egg weight were not significantly affected by the DDGS levels for the last 6 weeks of the experimental period.
- Laying hens responded to high-protein, high-fat, and high-fiber corn DDGS with reduced egg production and egg mass, but unchanged egg weight.
- No difference in egg weight among treatments during last 6-week period indicated that when amino acids (lysine and methionine) in corn DDGS diets are sufficient, egg weight may not be affected by DDGS levels, but if diet is not balanced for nutrient content, a decrease in egg production and egg mass can occur in the diet with high DDGS inclusion.
- As DDGS level increased, the yolk color score increased linearly.
- Haugh unit of eggs from the hens fed 50% DDGS had higher Haugh units than other dietary treatments during all storage times, suggesting that high DDGS in the diet may have positive effects in maintaining the physical state of egg albumin.

Conclusion

Up to 50% DDGS can be fed to laying hens without significant effect on egg production, feed intake, feed efficiency, egg mass and egg weight with sufficient digestible amino acid. Once the 50% DDGS diet was further supplemented with lysine and methionine, there were no differences in egg production, feed intake and egg weight during last 6 weeks between the high DDGS diet and the positive control. The decreased egg production, feed intake, egg mass and egg weight observed before the diet reformulation is most likely due to an amino acid deficiency, as all performance parameters were improved after additional amino acids were supplied in the diets. DDGS positively affected Haugh units in the 50% DDGS diet, and yolk color was improved linearly as DDGS level increased. Eggshell strength and egg component were inconsistently affected by DDGS treatments.

Acknowledgement

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Table 1. Effect of diets with various levels of corn dried distiller's grains with solubles (DDGS) on laying rate, egg mass, egg weight, feed intake, feed efficiency, and body weight change during the 24-week feeding period[1]

Item		DDGS diets (%)				SEM
		0	17	35	50	
Egg production, %		87[a]	83[b]	84[ab]	62[c]	1.1
Egg mass, g/hen/day		56.0[a]	51.8[b]	53.6[ab]	39.1[c]	0.9
Egg weight, g/egg		64.7[a]	63.3[bc]	64.0[ab]	62.6[c]	0.4
Feed intake, g/hen/day		104.4[a]	104.2[a]	106.0[a]	92.2[b]	1.1
Feed efficiency, g egg/kg feed		531.6[a]	487.6[b]	501.9[b]	431.8[c]	6.9
Body weight (kg)[2]	Start	1.56	1.50	1.62	1.51	
	End	1.57	1.50	1.62	1.56	
	Change	0.02	0.00	0.00	0.05	0.03

[a,b,c]Means with no common superscript in the same row differ significantly (P < 0.05)
[1]Values are means of data collected every 2 weeks for 24-week feeding period.
[2]Values are means of 10 experimental unit (EU).

Table 2. Effects of dried corn distiller's grains with solubles on egg internal quality (yolk color, Haugh unit, and egg composition) during 24-week-long period[1]

		Haugh unit[3]				Components[4]		
	Yolk	Storage time				Weight %		
Treatments	Color[2]	0 week	1 week	2 week	3 week	Yolk	Albumen	Shell
0% DDGS	5.5[d]	80.5[b]	76.4[b]	73.7[b]	72.4[b]	26.5	63.7	9.8[b]
17% DDGS	7.0[c]	81.8[b]	78.0[b]	75.6[b]	73.7[b]	26.8	63.4	9.8[b]
35% DDGS	7.9[b]	82.3[b]	78.3[b]	76.0[b]	74.3[b]	26.8	63.4	9.9[b]
50% DDGS	8.7[a]	85.3[a]	82.3[a]	79.9[a]	78.2[a]	26.5	63.3	10.1[a]
SEM	0.12	0.77	0.79	0.84	0.83	0.20	0.24	0.08

[a,b,c,d]Means in the same column with different letters differ significantly (P < 0.05).
[1]Values are means of data collected every 2 weeks for 24-week feeding period.
[2]Yolk color score ranges from 1 to 10, n = 600
[3]Haugh unit equation: 100*log (height-0.01*5.6745*(30*weight^0.37-100) +1.9), n=150
[4]Values are means of 600 eggs