Evaluation of limit feeding varying levels of distillers dried grains with solubles in non-feed-withdrawal molt programs for laying hens

L. Mejia, E. T. Meyer, D. L. Studer, P. L. Utterback, C. W. Utterback, C. M. Parsons, and K. W. Koelkebeck[1]

Department of Animal Sciences, University of Illinois at Urbana-Champaign, Urbana 61801

ABSTRACT An experiment was conducted with 672 Hy-Line W-36 Single Comb White Leghorn hens (69 wk of age) to evaluate the effects of feeding varying levels of corn distillers dried grains with solubles (DDGS) with corn, wheat middlings, and soybean hulls on long-term laying hen postmolt performance. The control molt treatment consisted of a 47% corn:47% soybean hulls (C:SH) diet fed ad libitum for 28 d. Hens fed the other 7 treatments were limit fed 65 g/hen per day for 16 d, and then fed 55 g/hen per day for 12 d. Hens on treatments 2 and 3 were fed 49% C:35% wheat middlings (WM) or SH:10% DDGS diets (C:WM:10DDGS, C:SH:10DDGS). Hens on treatments 4 and 5 were fed 49% C:25% WM or SH:20% DDGS diets (C:WM:20DDGS, C:SH:20DDGS). Those on treatments 6 and 7 were fed 47% C:47% DDGS (C:DDGS) or 47% WM:47% DDGS (WM:DDGS) diets. Those on treatment 8 were fed a 94% DDGS diet. At 28 d, all hens were fed a corn-soybean meal layer diet (16% CP) and production performance was measured for 36 wk. None of the hens fed the molt diets went completely out of production, and only the C:SH and C:SH:10DDGS molt diets decreased hen-day egg production to below 5% by wk 4 of the molt period. Postmolt egg production was lowest ($P < 0.05$) for the C:WM:20DDGS treatment. No differences ($P > 0.05$) in egg weights were detected among treatments throughout the postmolt period. In addition, no consistent differences were observed among treatments for egg mass throughout the postmolt period. Overall results of this study indicated that limit feeding diets containing DDGS at levels of 65 or 55 g/hen per day during the molt period did not cause hens to totally cease egg production.

Key words: molting, distillers dried grains with solubles, laying hen, egg production

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INTRODUCTION

The commercial egg industry commonly uses induced molting procedures to rejuvenate flocks for a second laying cycle. The main objective of a molting program is to cause hens to totally cease egg production and enter a nonreproductive state (Webster, 2003). Implementing an induced molting program can result in a 30% higher profit margin for producers when compared with an all-pullet operation (Bell, 2003). Recently, the molting of commercial layers has been under increased scrutiny by animal rights groups, which have voiced that this practice is stressful and one that negatively affects the welfare of the hen (Koelkebeck and Anderson, 2007). Therefore, current research has been focused on developing non-feed-withdrawal molting programs that can be widely used in the industry.

Effective non-feed-withdrawal molting methods include the feeding of high wheat middlings (Biggs et al., 2003), a combination of wheat middlings and corn (Biggs et al., 2004), different ratios of alfalfa or layer diet (Donalson et al., 2005), or a combination of corn and soybean hulls (Biggs et al., 2004), among many others. In recent years, it has been recognized in the feed industry that increasing quantities of corn distillers dried grains with solubles (**DDGS**) have entered the ingredient market (Lumpkins et al., 2005). The ingredient DDGS has become a relatively inexpensive feed ingredient in many areas and may be a good ingredient to use in diets for non-feed-withdrawal molt programs. However, previous research in our laboratory (Biggs et al., 2004) showed that high-corn and high-DDGS diets (94 to 96%) fed ad libitum did not cause hens to totally cease egg production. In contrast, Mejia et al. (2010) reported that limit feeding high-DDGS diets did result in totally ceased or zero egg production in a non-feed-withdrawal molt program. Therefore, the objectives of the current study were to evaluate if limit feeding varying levels of DDGS with corn, wheat middlings,

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[1]Corresponding author: kkoelkeb@illinois.edu

and soybean hulls in molt diets would result in a total cessation of egg production during the molt period and provide for acceptable postmolt performance in a non-feed-withdrawal molt program for laying hens.

MATERIALS AND METHODS

All animal care procedures were approved by the university Institutional Animal Care and Use Committee. An experiment was conducted using 672 Hy-Line W-36 Single Comb White Leghorns hens (69 wk of age). The hens were housed in a caged layer house of commercial design, with water and feed provided for ad libitum consumption, and hens were exposed to a 17-h daily photoperiod before the start of the experiment. Six replicate groups of 14 hens each (2 adjacent cages containing 7 hens/cage, 60.9 × 58.4 cm) were allotted to 8 dietary treatments in a completely randomized design so that mean BW was similar for each treatment. The first molt treatment (control) consisted of a 47% corn (**C**):47% soybean hulls (**SH**) diet (**C:SH**) fed ad libitum for 28 d. Hens on the other 7 treatments were limit fed 65 g/hen per day for 16 d, and then fed 55 g/hen per day for 12 d. These levels of feed intake match the range of intakes recommended in the current W-36 commercial management guide (Hy-Line International, 2009). Hens on treatments 2 and 3 were fed 49% C:35% wheat middlings (**WM**) or SH:10% DDGS (**C:WM:10DDGS**, **C:SH:10DDGS**). Hens on treatments 4 and 5 were fed 49% C:25% WM or SH:20% DDGS (**C:WM:20DDGS**, **C:SH:20DDGS**). Those on treatments 6 and 7 were fed 47% C:47% DDGS (**C:DDGS**) and 47% WM:47% DDGS (**WM:DDGS**). Those on treatment 8 were fed a high 94% DDGS diet. The 8 molt diets were formulated to contain 2% Ca and at least 0.25% nonphytate P, using NRC (1994) table values (Table 1).

At the start of the experiment (d 1), birds were fed their respective diets. The original intent was to limit feed the experimental molt diets (treatments 2 to 8) to 65 g/hen per day for 28 d; however, hens on all but one of those treatments still had hen-day egg production in excess of 10% at 16 d. Thus, feed intake was decreased to 55 g/hen per day on d 17 in attempt to better induce a molt. On d 29, all hens were fed a 16% CP layer diet (Table 1), and this diet was fed until 109 wk of age. The experiment consisted of a 4-wk molt period (69 to 72 wk), followed by a 36-wk postmolt production period (73 to 109 wk). Two days before feeding the molt diets, the photoperiod was reduced from 17 to 10 h/d. The daily photoperiod was increased to 12 h on d 21, and then to 13 h on d 28. Thereafter, the daily photoperiod was increased by 30 min/wk until a 17-h photoperiod was established.

Egg Production and Performance

Egg production performance was measured for 40 wk after initiating the feeding of the molt diets. Egg production and mortality were recorded daily throughout the 40-wk experimental period. Egg-specific gravity, using the flotation method with NaCl solutions varying in specific gravity from 1.056 to 1.100 g/cm^3 in 0.004 increments, was measured weekly for all eggs produced on 2 consecutive days during each week from wk 7 to 10, every 4 wk from wk 14 to 30, and then each week from wk 37 to 40. Egg weight and mass (calculated using hen-day egg production and mean egg weight) were measured on all eggs produced on 2 consecutive days every week during wk 7 to 10, every 4 wk from wk 14 to 30, and then every week from wk 37 to 40. Feed consumption was measured every week from wk 1 to 12. Body weights of all hens were measured 6 d before the onset of the experiment and at the end of the molt period (d 28).

Statistical Analysis

All data were analyzed by ANOVA procedures appropriate for a 1-way completely randomized design (Steel and Torrie, 1980). Fisher's protected least significant difference test was used to determine significant differences ($P < 0.05$) among treatment means.

RESULTS

Hens fed the C:SH and C:SH:10DDGS diets lost 25.0 and 19.5% BW, respectively, by the end of the 28-d molt period (Table 2). Hens fed the C:SH diet lost the most BW ($P < 0.05$) of hens on any treatment, followed by those on the C:SH:10DDGS treatment. Body weight loss of hens on the other treatments was less, with hens fed the C:WM:10DDGS, C:SH:20DDGS, and WM:DDGS diets losing 13.0, 14.1, and 12.9%, respectively, of initial BW. Hens on the C:WM:20DDGS, C:DDGS, and DDGS diets lost only 10.7, 7.2, and 6.5%, respectively, of initial BW by d 28. There were no differences ($P > 0.05$) in mortality among treatments during the molt period. There were also no significant differences in mortality ($P > 0.05$) among treatments during the postmolt period.

The decrease in daily hen-day egg production during the 28-d molt period is shown in Figure 1, and the weekly averages are shown in Table 3. None of the hens on the dietary treatments went completely out of production, and only hens fed the C:SH and C:SH:10DDGS molt diets decreased hen-day egg production to below 5%. For the entire 28-d molt period, hens fed the C:SH:20DDGS, C:DDGS, and WM:DDGS molt diets produced significantly ($P < 0.05$) more eggs than hens on 4 of the other 5 treatments. Postmolt (wk 5 to 40) hen-day egg production was numerically highest for the C:SH and C:SH:10DDGS molt treatments, but was not significantly different from the C:WM:10DDGS, C:SH:20DDGS, C:DDGS, WM:DDGS, and DDGS molt treatments. Postmolt egg production was lower ($P < 0.05$) for the C:WM:20DDGS molt treatment than for the C:SH and C:SH:10DDGS treatments.

Table 1. Composition of the experimental molt diets (%) containing corn (C), soybean hulls (SH), wheat middlings (WM), and corn distillers dried grains with solubles (DDGS) and the postmolt layer diet

Item	C:SH	C:WM:10DDGS	C:SH:10DDGS	C:WM:20DDGS	C:SH:20DDGS	C:DDGS	WM:DDGS	DDGS	Layer
Ingredient									
Corn	47.15	49.12	49.24	49.15	49.22	47.13	0.00	0.00	68.8
Soybean hulls	47.10	0.00	35.00	0.00	25.00	0.00	0.00	0.00	0.00
Wheat middlings	0.00	35.00	0.00	25.00	0.00	0.00	47.23	0.00	0.00
DDGS	0.00	10.00	10.00	20.00	20.00	47.13	47.23	94.50	0.00
Soybean meal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.4
Meat and bone meal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.5
Limestone	4.10	4.87	4.30	4.89	4.48	4.93	4.90	4.85	8.5
Dical[1]	1.00	0.36	0.82	0.31	0.65	0.16	0.00	0.00	1.00
DL-Methionine	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Mineral mix[2]	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Vitamin mix[3]	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Calculated analysis[4]									
CP	9.19	12.17	10.77	13.41	12.41	16.92	20.02	25.89	16.00
ME_n, kcal/kg	1,894	2,655	2,193	2,766	2,435	3,039	2,407	2,927	2,807
Ca	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	3.80
Nonphytate P	0.25	0.25	0.25	0.25	0.25	0.25	0.33	0.37	0.40

[1]Dicalcium phosphate.

[2]Provided per kilogram of diet: manganese, 75 mg from manganese oxide; iron, 75 mg from iron sulfate; zinc, 75 mg from zinc oxide; copper, 5 mg from copper sulfate; iodine, 0.76 mg from ethylene diamine dihydroiodide; selenium, 0.1 mg from sodium selenite.

[3]Provided per kilogram of diet: vitamin A from vitamin A acetate, 4,400 IU; cholecalciferol, 1,000 IU; vitamin E from α-tocopheryl acetate, 11 IU; vitamin B_{12}, 0.011 mg; riboflavin, 4.4 mg; D-pantothenic acid, 10 mg; niacin, 22 mg; menadione sodium bisulfate complex, 2.33 mg.

[4]Based on NRC (1994) feed composition tables.

Table 2. Body weight loss during the molt period (%)

Treatment[1]	d 28 BW loss
47% corn:47% soybean hulls fed ad libitum	25.0[a]
C:WM:10DDGS	13.0[cd]
C:SH:10DDGS	19.5[b]
C:WM:20DDGS	10.7[d]
C:SH:20DDGS	14.1[c]
C:DDGS	7.2[e]
WM:DDGS	12.9[cd]
DDGS	6.5[e]
Pooled SEM	0.95

[a–e]Means within a column without a common superscript differ significantly ($P < 0.05$).

[1]The last 7 diets were fed at a rate of 65 g/hen per day for 16 d and 55 g/hen per day for 12 d. C:WM:10DDGS = 49% corn:35% wheat middlings:10% corn distillers dried grains with solubles (DDGS) diet; C:SH:10DDGS = 49% corn:35% soybean hulls:10% DDGS diet; C:WM:20DDGS = 49% corn:25% wheat middlings:20% DDGS diet; C:SH:20DDGS = 49% corn:25% soybean hulls:20% DDGS diet; C:DDGS = 47% corn:47% DDGS diet; WM:DDGS = 47% wheat middlings:47% DDGS diet; DDGS = 94% DDGS diet.

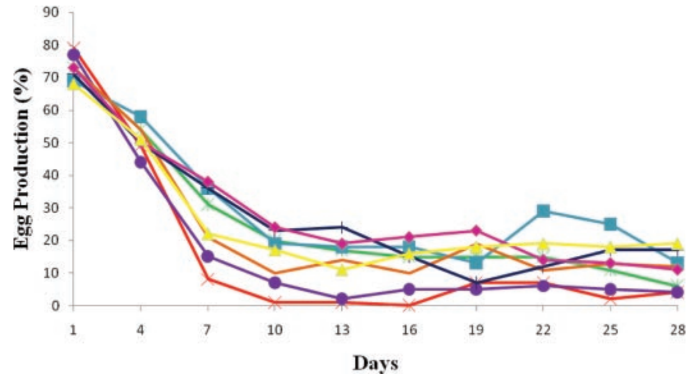

Figure 1. Daily hen-day egg production during the molt period of hens fed a corn:soybean hulls diet (×), hens fed a 49% corn:35% wheat middlings:10% corn distillers dried grains with solubles (DDGS) diet (*), hens fed a 49% corn:35% soybean hulls:10% DDGS diet (●), hens fed a 49% corn:25% wheat middlings:20% DDGS diet (■), hens fed a 49% corn:25% soybean hulls:20% DDGS diet (—), hens fed a 47% corn:47% DDGS diet (+), hens fed a 47% wheat middlings:47% DDGS diet (♦), and hens fed a 94% DDGS diet (▲). Color version available in the online PDF.

Feed intake during the 28-d molt period was lowest ($P < 0.05$) for hens fed the C:SH molt diet ad libitum (Table 4). Feed intake for hens on the other limit-fed treatment diets was similar to the amount of feed that was offered, except for the C:SH:10DDGS treatment. Feed intake of all diets was reduced during wk 3 and 4 of the molt period.

Postmolt egg weight and egg mass values (wk 7 to 10, wk 37 to 40, and wk 7 to 40) are shown in Table 5. No differences ($P > 0.05$) in egg weights were detected among treatments throughout the postmolt period. No consistent differences were observed among treatments for egg mass during the early postmolt period (7 to 10 wk). However, during wk 37 to 40, hens on the C:WM:20DDGS, WM:DDGS, and DDGS treatments had significantly lower ($P < 0.05$) egg mass than hens on the C:SH and C:SH:10DDGS treatments.

For egg-specific gravity, some significant differences ($P < 0.05$) were observed among treatments for the 7- to 10-wk postmolt period (Table 6). However, no differences ($P > 0.05$) in egg-specific gravity were detected among treatments for the 37- to 40-wk postmolt period. The C:DDGS and DDGS treatments yielded lower ($P < 0.05$) egg-specific gravity values for the entire postmolt period (wk 7 to 40) when compared with the C:SH treatment.

DISCUSSION

The objective of the present study was to determine if limit feeding varying levels of DDGS with corn, wheat middlings, and soybean hull molt diets would yield acceptable postmolt performance in a non-feed-withdraw-

Table 3. Effect of non-feed-withdrawal molting treatments on hen-day egg production (%) during the 4-wk molt period and 36-wk postmolt period[1]

Treatment[2]	Molt period wk 1	wk 2	wk 3	wk 4	wk 1 to 4	Postmolt period, wk 5 to 40
C:SH	45[c]	3[d]	3[f]	4[d]	14[d]	72[a]
C:WM:10DDGS	51[abc]	18[bc]	16[bc]	15[bc]	25[ab]	68[ab]
C:SH:10DDGS	45[c]	6[d]	7[ef]	4[d]	16[d]	73[a]
C:WM:20DDGS	54[ab]	20[ab]	18[ab]	21[a]	28[a]	65[b]
C:SH:20DDGS	50[abc]	13[c]	11[de]	11[c]	21[c]	70[ab]
C:DDGS	56[a]	25[a]	12[cd]	15[bc]	27[a]	68[ab]
WM:DDGS	54[a]	21[ab]	21[a]	15[b]	28[a]	67[ab]
DDGS	46[bc]	14[c]	15[bcd]	18[ab]	23[bc]	67[ab]
Pooled SEM	2.9	2.2	1.7	1.5	1.3	2.0

[a–f]Means within a column without a common superscript differ significantly ($P < 0.05$).

[1]Data are means of 6 groups of 14 hens each.

[2]C:SH = 47% corn:47% soybean hulls diet fed ad libitum. The last 7 diets were fed at a rate of 65 g/hen per day for 16 d and 55 g/hen per day for 12 d. C:WM:10DDGS = 49% corn:35% wheat middlings:10% corn distillers dried grains with solubles (DDGS) diet; C:SH:10DDGS = 49% corn:35% soybean hulls:10% DDGS diet; C:WM:20DDGS = 49% corn:25% wheat middlings:20% DDGS diet; C:SH:20DDGS = 49% corn:25% soybean hulls:20% DDGS diet; C:DDGS = 47% corn:47% DDGS diet; WM:DDGS = 47% wheat middlings:47% DDGS diet; DDGS = 94% DDGS diet.

Table 4. Effect of non-feed-withdrawal molting treatments on feed intake (g/hen per day) during the 4-wk molt period[1]

Treatment[2]	wk 1	wk 2	wk 3	wk 4	wk 1 to 4
C:SH	44.4^{d}	58.5^{c}	49.3^{c}	38.4^{c}	47.6^{d}
C:WM:10DDGS	55.0^{bc}	63.8^{ab}	56.0^{ab}	52.7^{ab}	56.9^{ab}
C:SH:10DDGS	46.0^{d}	60.0^{bc}	52.4^{bc}	47.8^{b}	51.5^{c}
C:WM:20DDGS	57.3^{ab}	62.4^{abc}	55.5^{ab}	54.9^{a}	57.5^{ab}
C:SH:20DDGS	49.8^{cd}	62.3^{abc}	55.7^{ab}	53.5^{ab}	55.3^{bc}
C:DDGS	60.6^{a}	63.2^{ab}	56.6^{a}	53.5^{ab}	58.5^{ab}
WM:DDGS	59.0^{ab}	64.9^{a}	57.9^{a}	55.0^{a}	59.2^{a}
DDGS	47.7^{d}	62.8^{ab}	56.8^{a}	54.9^{a}	55.6^{ab}
Pooled SEM	1.94	1.46	1.39	2.02	1.34

[a–d]Means within a column without a common superscript differ significantly ($P < 0.05$).

[1]Data are means of 6 groups of 14 hens each.

[2]C:SH = 47% corn:47% soybean hulls diet fed ad libitum. The last 7 diets were fed at a rate of 65 g/hen per day for 16 d and 55 g/hen per day for 12 d. C:WM:10DDGS = 49% corn:35% wheat middlings:10% corn distillers dried grains with solubles (DDGS) diet; C:SH:10DDGS = 49% corn:35% soybean hulls:10% DDGS diet; C:WM:20DDGS = 49% corn:25% wheat middlings:20% DDGS diet; C:SH:20DDGS = 49% corn:25% soybean hulls:20% DDGS diet; C:DDGS = 47% corn:47% DDGS diet; WM:DDGS = 47% wheat middlings:47% DDGS diet; DDGS = 94% DDGS diet.

al molt program for laying hens. Traditional molting procedures, which involve feed withdrawal, have been severely criticized by animal rights groups (Bell and Kuney, 2004). These groups have claimed that the feed withdrawal period is harmful to hens (Webster, 2003). For this reason, alternative methods that do not require a period of feed withdrawal have been developed. Non-feed-withdrawal molting programs that use available and economical feed ingredients have great applicability in the commercial laying hen industry. Previous non-feed-withdrawal methods that have been studied are feeding low-protein, low-energy diets (Anderson, 2002), high levels of zinc (Park et al., 2004), high wheat middlings (Biggs et al., 2003), different ratios of alfalfa and layer diet (Donalson et al., 2005), or a combination of corn and wheat middlings (Biggs et al., 2004), which have all been effective methods for molting laying hens. However, previous research in our laboratory (Biggs et al., 2004) showed that high-DDGS diets (94 to 96%) fed ad libitum were not as effective because they did not cause hens to reduce egg production adequately. In contrast, limit feeding these high-DDGS diets (94 to 96%) was shown to be effective in non-feed-withdrawal molting programs (Mejia et al., 2010).

Wheat middlings, SH, and DDGS are readily available and economical feed ingredients and have previously been used for induced molting in laying hens. In the current study, the levels of feed consumption during the molt period were equal to 5.45 and 6.36 kg of feed/100 hens per day. These levels were chosen to simulate the levels that are recommended by Hy-Line International for W-36 hens molted by a non-feed-withdrawal method (Hy-Line International, 2009). Previous research in our laboratory documented that these feed intakes are from 50 to 70% of what hens would consume for a 94 to 96% DDGS diet during the molt period (Biggs et al., 2004). All dietary treatments in the current study decreased egg production and BW during the molt period. However, only 2 dietary treatments (C:SH and C:SH:10DDGS) reduced egg production to

Table 5. Effect of limit feeding molt diets containing varying levels of DDGS on egg weight and egg mass from 7 to 10 wk, 37 to 40 wk, and 7 to 40 wk[1]

	Egg weight (g/egg)			Egg mass (g egg/hen per day)		
Treatment[2]	7 to 10 wk	37 to 40 wk	7 to 40 wk	7 to 10 wk	37 to 40 wk	7 to 40 wk
C:SH	61.4^{a}	62.7^{a}	62.5^{a}	41.2^{b}	46.0^{a}	47.5^{ab}
C:WM:10DDGS	61.6^{a}	64.0^{a}	63.2^{a}	39.6^{b}	41.5^{abc}	44.6^{abc}
C:SH:10DDGS	61.8^{a}	63.9^{a}	63.2^{a}	43.0^{ab}	45.6^{a}	48.0^{a}
C:WM:20DDGS	62.8^{a}	64.5^{a}	63.3^{a}	43.5^{ab}	38.1^{c}	42.7^{c}
C:SH:20DDGS	62.3^{a}	64.5^{a}	63.8^{a}	42.9^{ab}	44.7^{ab}	46.5^{abc}
C:DDGS	62.7^{a}	64.5^{a}	63.9^{a}	41.7^{b}	41.4^{abc}	44.9^{abc}
WM:DDGS	62.3^{a}	64.2^{a}	63.4^{a}	46.3^{a}	39.7^{bc}	44.2^{abc}
DDGS	61.8^{a}	64.0^{a}	63.2^{a}	41.5^{b}	39.8^{bc}	43.4^{bc}
Pooled SEM	0.58	0.63	0.60	1.52	1.75	1.48

[a–c]Means within a column without a common superscript differ significantly ($P < 0.05$).

[1]Data are means of 6 groups of 14 hens each.

[2]C:SH = 47% corn:47% soybean hulls diet fed ad libitum. The last 7 diets were fed at a rate of 65 g/hen per day for 16 d and 55 g/hen per day for 12 d. C:WM:10DDGS = 49% corn:35% wheat middlings:10% corn distillers dried grains with solubles (DDGS) diet; C:SH:10DDGS = 49% corn:35% soybean hulls:10% DDGS diet; C:WM:20DDGS = 49% corn:25% wheat middlings:20% DDGS diet; C:SH:20DDGS = 49% corn:25% soybean hulls:20% DDGS diet; C:DDGS = 47% corn:47% DDGS diet; WM:DDGS = 47% wheat middlings:47% DDGS diet; DDGS = 94% DDGS diet.

Table 6. Effect of non-feed-withdrawal treatments on egg-specific gravity (g/cm^3) during the postmolt period[1]

Treatment[2]	wk 7 to 10	wk 37 to 40	wk 7 to 40
C:SH	1.0808[a]	1.0726[a]	1.0772[a]
C:WM:10DDGS	1.0800[abc]	1.0726[a]	1.0769[ab]
C:SH:10DDGS	1.0805[ab]	1.0719[a]	1.0767[ab]
C:WM:20DDGS	1.0804[abc]	1.0720[a]	1.0762[abc]
C:SH:20DDGS	1.0801[abc]	1.0718[a]	1.0761[abc]
C:DDGS	1.0790[bc]	1.0708[a]	1.0751[c]
WM:DDGS	1.0804[ab]	1.0721[a]	1.0765[ab]
DDGS	1.0789[c]	1.0720[a]	1.0758[bc]
Pooled SEM	0.0005	0.0006	0.0005

[a–c]Means within a column without a common superscript differ ($P < 0.05$).

[1]Data are means of 6 groups of 14 hens each.

[2]C:SH = 47% corn:47% soybean hulls diet fed ad libitum. The last 7 diets were fed at a rate of 65 g/hen per day for 16 d and 55 g/hen per day for 12 d. C:WM:10DDGS = 49% corn:35% wheat middlings:10% corn distillers dried grains with solubles (DDGS) diet; C:SH:10DDGS = 49% corn:35% soybean hulls:10% DDGS diet; C:WM:20DDGS = 49% corn:25% wheat middlings:20% DDGS diet; C:SH:20DDGS = 49% corn:25% soybean hulls:20% DDGS diet; C:DDGS = 47% corn:47% DDGS diet; WM:DDGS = 47% wheat middlings:47% DDGS diet; DDGS = 94% DDGS diet.

below 5% and BW by 20 to 25% by wk 4 of the molt period. All other dietary treatments had greater than 10% egg production even at the end of the 28-d molt period. Biggs et al. (2004) observed a similar type of response with a high 94 to 96% DDGS molt diet in an earlier study.

The responses in egg production and BW among dietary treatments during the molt period in the current study are somewhat different from those obtained in our earlier study (Mejia et al., 2010) with molt diets containing DDGS. In the earlier study, limit feeding diets containing a high level of DDGS resulted in rapid total cessation of egg production and very large losses in BW, so much that feeding of these diets had to be terminated after 18 d. The DDGS used in the current study was light colored, which is typical of high-quality DDGS, whereas the DDGS used in the previous study was dark colored, with low lysine digestibility (Mejia et al., 2010). Fastinger et al. (2006) suggested that the color score of a DDGS sample may provide a rapid method for identifying DDGS sources with poor amino acid digestibility. Indeed, when the 2 DDGS samples used in our studies were evaluated in a precision-fed cecectomized rooster assay in our laboratory, it was determined that the DDGS used in the earlier study (Mejia et al., 2010) contained only 0.35% digestible lysine and 2.625 kcal/g of ME_n, whereas the DDGS used in the current study contained 0.61% digestible lysine and 3.214 kcal/g of ME_n. These results strongly suggest that the quality or source of DDGS has a large effect on the responses obtained when using this ingredient in molt diets.

Differences in the percentage of BW loss were observed among treatments for the 28-d molt period. Baker et al. (1983) concluded that a BW loss of approximately 27 to 31% produced optimal postmolt performance; thus, this range of BW loss could be associated with certain physiological changes associated with optimal postmolt performance. However, only hens fed the C:SH diet had a BW loss of 25% and none of the DDGS treatments had a BW loss higher than 20% in the current study.

Some differences were also observed in postmolt egg production (wk 5 to 40) among treatments, with the C:SH and C:SH:10DDGS diets yielding higher egg production ($P < 0.05$) than the C:WM:20DDGS diet. In addition, the C:SH and C:SH:10DDGS yielded numerically higher (4 to 6%) egg production than all the other diets containing DDGS. These differences may be related to the length of rest or to ovarian and oviduct regression during the molt period. The rejuvenation that occurs as a result of a molt is related to total regression of the ovary and oviduct during the molt, and a BW reduction by 25% during induced molts achieved total regression of the ovary and oviduct (Brake and Thaxton, 1979). The less than desirable BW loss discussed above for hens fed the molt diets containing DDGS (6.5 to 19.5%) probably did not result in total ovarian and oviduct regression and probably explains the lower egg production observed in the current study. Similar types of differences among treatments were observed for long-term, postmolt egg-specific gravity (wk 7 to 40). The C:SH diet yielded significantly higher ($P < 0.05$) egg-specific gravity than the C:DDGS and DDGS molt diets and yielded numerically higher values than the other diets containing DDGS. As discussed above, these differences were probably related to the BW loss, which was much less than optimal, particularly for the C:DDGS (7.2%) and the DDGS (6.5%) dietary treatments. These overall results of the current study indicate that limit feeding diets containing varying levels of DDGS diets at levels of 65 or 55 g/hen per day during a 28-d molt period did not cause hens to totally cease egg production, did not produce sufficient BW losses near 25% during the molt period, and did not yield optimal postmolt egg production performance.

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