Nonwithdrawal Molting Programs

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Primary Audience: Poultry Extension Specialists, Egg Producers, Researchers

SUMMARY

In the commercial egg industry the management practice of using feed withdrawal to induce a flock to molt has been under extreme scrutiny. This is because animal rights groups have voiced their concern about using this practice. Thus, about 5 yr ago, the United Egg Producers (UEP) commissioned 5 universities to conduct experiments to develop alternative molting programs that used nonwithdrawal feeding programs to molt laying hens. The studies conducted to date used techniques ranging from feeding hens without added salt in the diet to using readily available, low-cost feed ingredients to develop molt diets that are low in energy level and protein content. The results of these studies indicated that molting laying hens without feed withdrawal could be done successfully. Research at the University of Illinois found that feeding laying hens diets consisting of wheat middlings, soybean hulls, and corn (low protein and low energy) were successful in providing for acceptable postmolt egg production performance and economic benefit compared with using a standard feed withdrawal method. Therefore, after 5 yr of experimenting with nonwithdrawal molting methods done in several university settings, the egg industry has successfully adopted these methods of molting laying hens. In addition, based on the finding of these experiments, the UEP has revised their recommended molting guidelines to state that only nonwithdrawal molting methods will be permitted after January 1, 2006. Thus, these guidelines will apply to approximately 82% of the US egg industry.

Key words: laying hen, induced molting, nonwithdrawal molt diet, wheat middlings, soybean hulls

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DESCRIPTION OF PROBLEM

There are several types of induced molting programs that are used in today's commercial egg industry. These programs vary mainly in the length of feed withdrawal and the type of molt diet fed following the feed-withdrawal period. All of these programs involve the use of feed withdrawal to produce a cessation of egg production and recommend using withdrawal periods of varying lengths. In one study, the flock was deprived of feed until they reached a target BW loss. The length of feed withdrawal in this program is usually at least 10 d and can be longer [1]. Other molting programs that have involved the use of a short feed-withdrawal period (4 to 5 d) have yielded good postmolt egg performance results [2].

In recent years, concern for the well-being of hens during an induced molt has been expressed by animal activists groups. Two such groups, United Poultry Concerns and the Association of Veterinarians for Animal Rights, have petitioned the USDA and FDA to eliminate induced molting of laying hens in the United States. They contend that hens experience stress

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Table 1. Composition of experimental molt diets and layer diet (Study 1)

Ingredients and analysis	Corn molt diet	Wheat middlings molt diet	Layer diet
		(%)	
Ground yellow corn	94.70	0.00	68.70
Wheat middlings	0.00	95.35	0.00
Soybean meal (dehulled)	0.00	0.00	18.40
Limestone	4.00	4.00	8.50
Meat and bone meal[1]	0.00	0.00	2.50
Dicalcium phosphate	0.65	0.00	1.25
Iodized salt	0.30	0.30	0.30
Trace mineral mix[2]	0.15	0.15	0.15
Vitamin premix[3]	0.20	0.20	0.20
Calculated analysis[4]			
CP (%)	8.10	14.30	16.00
ME_n (kcal/kg)	3,172.00	1,900.00	2,865.00
Calcium (%)	1.68	1.63	3.80
Available phosphorus (%)	0.20	0.28	0.45

[1]Meat and bone meal = 50% protein, pork meal (Effingham FS, Effingham, IL).
[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, 0.75 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 bisulfite complex, 2.33 mg.
[4]Based on NRC (1994) feed composition tables [17].

and extreme cruelty due to the removal of feed that is necessary to induce a molt. Because of these concerns, industry organizations have called for research to be conducted in this area. The United Egg Producers (**UEP**) recommended that producers and university researchers work together to develop alternative molting techniques that do not involve the use of feed withdrawal to initiate a molt. Many food companies such as McDonalds, Burger King, and Wendy's International have told companies that supply them with eggs not to use feed withdrawal programs to initiate a molt. Currently, many legislators in Washington, DC, are being pressured by animal rights groups to force the egg industry to disallow the practice of induced molting. Thus, the development of viable and economical methods of induced molting without feed withdrawal is very important.

Previous research studies conducted on nonwithdrawal feeding programs have utilized various techniques to induce a molt. Among them has been the feeding of high levels of zinc and the use of alternative feed ingredients. In one study, laying hens were fed very high levels of zinc and it was found that egg production was slightly better and egg weights were heavier for hens induced to molt when fed 1% zinc acetate and 1% zinc propionate compared with a conventional feed withdrawal method [3]. In a study using cottonseed diets, researchers found that feeding hens a diet containing 50% finely ground cottonseed produced voluntary feed intake reduction. This method was determined to be equivalent in effectiveness to a complete feed withdrawal program [4]. In another study, the feeding of a diet composed mostly of grape pomace containing 10 ppm of thyroxine was effective in supporting similar postmolt performance as a conventional feed withdrawal method [5]. Thus, the above-mentioned studies and many others have documented that laying hens can be molted by other means than a conventional feed withdrawal.

Because of the previously mentioned pressures of animal rights groups on the egg industry to ban the practice of induced molting of hens by feed withdrawal, the UEP commissioned 5 universities to conduct research in this area in 1999. The purpose of this was to have each university develop alternative molting programs that could be presented to the egg industry and easily adopted by producers. The 5 universities included the University of Nebraska, North Carolina State University, University of California, University of Arkansas, and the University of Illinois.

Research on alternative molting programs at the University of Nebraska revolved around the feeding of "nutrient-balanced" diets (1,250 kcal of ME_n/lb, 10 and 12.5% protein, 1.5% calcium, and 0.5% available phosphorus) with 0% added salt compared with a conventional feed withdrawal program [6]. Their program also called for increasing the photoperiod to 16 or 24 h of light for 1 wk before the initiation of the molt treatments. In their research, the level of sodium did not affect feed intake; however, cessation of lay and BW loss were not as complete as those hens molted by an 8- to 10-d fasting method. In addition, they found that fasted birds had better eggshell quality in the postmolt production period. In the work conducted at North Carolina State University, 4 molting techniques were compared that consisted of a no-molt group; a long fast (12 d followed by a full-fed diet, 16% protein, 2% calcium); a short fast (5 d followed by feeding a low protein/energy maintenance diet (10% protein, 1,650 kcal of ME_n/kg) containing corn, soybean hulls, and wheat middlings to 28 d; and feeding the low protein, low energy diet full-fed to 28 d [7]. In this work, all hens (66 wk of age) were given 24 h of light 1 wk before the start, and then placed on 9 h of total light per day until d 28. The photoperiod was increased to 14 h on d 28 and to 16.5 h on d 31 and the hens were fed a standard layer diet from d 28 to the end at 107 wk of age. The results indicated that using a low protein, low energy molt diet without fasting provides good postmolt results and is feasible for the industry to use. Furthermore, the nonfasting method resulted in comparable egg production, egg income, and feed costs compared with the fasting methods. In the research at the University of California, 5 field tests using paired houses on 3 California commercial egg farms were conducted [8]. Relative performance of flocks molted by traditional feed removal methods was evaluated compared with flocks fed diets with low levels of sodium, calcium, and protein. In general, egg production and BW losses differed between the 2 molting methods during the first 4 wk of the test, but performance after that was similar. Mixed economic results were noted between the 2 methods used. In the work done at the University of Arkansas, the approach was to feed hens a molt diet containing supplemental iodinate thyroxine (T_4) [9]. This work has shown promise and the authors have been granted a patent license agreement to continue doing the work.

Our approach at the University of Illinois has been to develop a nonwithdrawal feeding program that is easy for the industry to implement, and that uses feed ingredients that are inexpensive and readily available. Our hypothesis has been that an acceptable nonwithdrawal feeding program could be implemented by feeding a molt diet that is low in energy and protein and palatable to the birds. We have used nonwithdrawal molting diets composed of wheat middlings, soybean hulls, corn gluten meal, and other ingredients by themselves and in combination with corn. Thus, the following report is a summary of research that we have done. Funding for this research was provided by a number of sources [10].

MATERIALS AND METHODS

In the studies that we conducted, DeKalb White and Hy-Line W-36 hens were used and housed in a commercial-type cage layer facility with 3 hens per cage (72 in.^{2}/hen). In all studies, the photoperiod was reduced from 17 to 10 h per d at the start of each study, which began in the summer months and lasted for 44 wk (4 wk for the molt period and 40 wk for the postmolt lay period). After the molt period all hens were fed a layer diet (16% protein, 2,865 kcal of ME_n/kg) from wk 5 to 44, and the photoperiod was gradually increased to 17 h following the molt period. Experimental set-up, data measurement and collection, and statistical analysis for all studies reported herein were previously described in our earlier work [11]. For all studies reported herein, all data were analyzed by ANOVA procedures appropriate for a 1-way completely randomized design. The Fisher's protected least significant difference test was used to determine significant differences among treatment means [12].

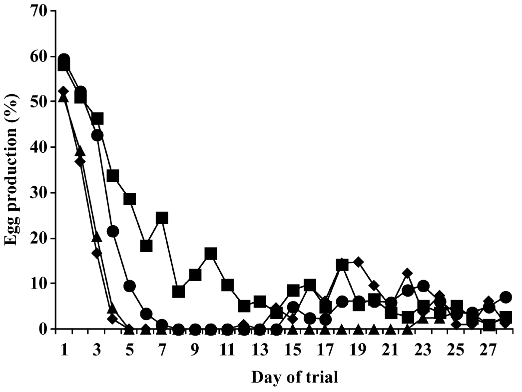

Figure 1. Hen-day egg production for d 1 to 28 (Study 1). Treatement 1 (■) fed corn molt diet; treatment 2 (●) fed wheat middlings diet; treatment 3 (◆) feed withdrawn for 4 d; treatment 4 (▲) feed withdrawn for 10 d.

RESULTS AND DISCUSSION

Study 1

In the first study, DeKalb White strain hens at 60 wk of age were used [11]. They were subjected to 1 of 4 treatments: 1) continually fed a corn diet, 2) continually fed a wheat middlings diet, 3) fasted for 4 d, then fed a corn diet, or 4) fasted for 10 d, then fed a corn diet (Table 1). The results of this study showed that feeding a high wheat middlings diet produced a reduction in egg production by d 8 and the hens stayed out of production until d 15 (Figure 1). The return to egg production after the initiation of feeding the layer diet is summarized in Table 2. Postmolt egg production was generally higher for those hens fed the wheat middlings molt diet and the 10-d feed removal treatments than for the continuous corn and 4-d feed removal treatments. Hens fed the wheat middlings molt diet reached 50% egg production the soonest with peak egg production being 89.6 and 90.7% for the 10-d feed removal treatment. Postmolt hen-day egg production was significantly greater for hens deprived of feed for 10 d compared with those fed the corn molt diet and deprived of feed for 4 d during wk 5 to 44 (Table 2). In addition, egg production was not significantly different for hens fed the wheat middlings molt diet and those deprived of feed for 10 d. There were no differences in postmolt mortality between any of the treatments during wk 5 to 44 (data not shown). These results indicated that postmolt egg production of hens fed a high wheat middlings molt diet equaled that for hens that were deprived of feed for 10 d.

Finally, Table 3 depicts the effect of the molt treatments on postmolt egg income minus feed costs for wk 1 to 44. Egg income minus feed costs was compared using the total number of eggs produced and total feed (molt plus layer) consumed for all hens in each treatment. Egg income was based on a price of $0.70 per dozen [13]. As noted in Table 3, the hens that were deprived of feed for 10 d had the highest egg income minus feed costs, with hens fed the wheat middlings molt diet producing the second highest profit. Thus, this study indicated that feeding a diet that was high in wheat middlings would induce hens to molt and that postmolt performance was nearly equal to a program that utilized a conventional feed withdrawal molting technique.

Study 2

After discovering that a nonwithdrawal feeding program using wheat middlings would work, we decided to use other feed ingredients

Table 2. Effect of nonwithdrawal vs. feed withdrawal molting methods on subsequent egg production (Study 1)

Treatment	Days to 50% production	Peak hen-day production (%) (wk)	Egg production (% hen-day)	
			Wk 5 to 44	Wk 1 to 44
Corn	49	84.3 (12)	66^{b}	61^{b}
Wheat middlings	43	89.6 (14)	74^{ab}	68^{ab}
4-d feed withdrawal, then corn	50	85.4 (15)	68^{b}	62^{ab}
10-d feed withdrawal, then corn	47	90.7 (14)	77^{a}	70^{a}
Pooled SEM	—	—	1.6	1.7

^{a,b}Means within a column with no superscript differ significantly ($P < 0.05$).

Table 3. Effect of nonwithdrawal vs. feed withdrawal molting methods on egg income minus feed costs (wk 1 to 44; Study 1)

Treatment	Egg income[1]	Feed cost	Profit	Profit per hen-housed
	($)			
Corn	838.72	330.14	508.58	6.05
Wheat middlings	991.78	343.52	648.26	7.72
4-d feed withdrawal, then corn	880.02	337.76	542.26	6.46
10-d feed withdrawal, then corn	1,016.69	351.33	665.36	7.92

[1]Based on $0.70 per dozen produced (Urner Barry Price Current, Midwest grade A large white eggs) [13].

and combinations. In this study, we tested the feeding of wheat middlings, corn, corn gluten feed, corn distillers grain, and combinations of wheat middlings and corn [14]. Again, we fed hens the molt diets that were low in energy, and the combinations of wheat middlings and corn were implemented to improve flowability in a commercial feeding system. The composition of the molt diet treatments used in this study is depicted in Table 4.

Table 5 shows the molt period and overall egg production from wk 5 to 44 following the molt period. The hens that were without feed for 10 d, then fed a 16% protein corn-soybean diet had the highest egg production from wk 5 to 44, whereas those fed the 71%:23% wheat middlings:corn diet had slightly lower egg production. For hen-housed egg production, the hens that were subjected to feed withdrawal for 10 d, and then fed a 16% protein diet produced the most eggs per hen housed (200), followed by those hens fed the 71%:23% wheat middlings:corn diet (194) (data not shown).

Table 6 depicts the economic comparisons between treatments for egg income minus feed costs for wk 1 to 44 [15]. These results indicate

Table 4. Composition of experimental molt diets (Study 2)

Ingredients and analysis	Corn	Wheat middlings	Corn gluten feed	Distillers dried grains	71% WM: 23% corn	47% WM: 47% corn
	(%)					
Corn	93.68	—	—	—	22.99	47.05
Wheat middlings (WM)	—	94.34	—	—	71.25	47.00
Corn gluten feed	—	—	95.00	—	—	—
DDGS[1]	—	—	—	94.46	—	—
Limestone	4.67	4.87	4.20	4.84	4.96	4.87
Dicalcium phosphate	—	0.38	0.10	—	0.10	0.38
Iodized salt	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
Vitamin mix[3]	0.20	0.20	0.20	0.20	0.20	0.20
Insecticide[4]	0.05	0.05	0.05	0.05	0.05	0.05
Calculated analysis[5]						
CP (%)	8.0	14.2	20.0	25.9	12.6	11.1
ME_n (kcal/kg)	3,138	1,887	1,663	2,343	2,195	2,516
Calcium (%)	2.0	2.0	2.0	2.0	2.0	2.0
Available phosphorus (%)	0.25	0.28	0.25	0.37	0.25	0.25

[1]DDGS = distillers dried grains with solubles.
[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, 0.75 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; vitamine E from α-tocopherol acetate, 11 IU; vitamin B_{12}, 0.011 mg; riboflavin, 4.4 mg; D-pantothenic acid, 10 mg; niacin, 22 mg; menadione sodium bisulfite complex, 2.33 mg.
[4]Commercially available insecticide.
[5]Based on NRC (1994) feed composition tables [17].

Table 5. Effect of nonwithdrawal vs. feed withdrawal molting treatments on hen-day egg production during the 4-wk molt period and 40 wk postmolt (Study 2)

Treatment	Week 1	2	3	4	1 to 4	5 to 44
	(% hen-day)					
10-d feed withdrawal, 16% CP	25[d]	0[d]	0[d]	9[bc]	8[e]	71[a]
10-d feed withdrawal, corn	25[d]	0[d]	0[d]	0[d]	6[e]	68[a]
Corn	55[a]	20[b]	7[c]	5[cd]	22[bc]	64[a]
Wheat middlings (WM)	37[c]	7[cd]	11[bc]	11[bc]	16[d]	67[a]
71% WM:23% corn	44[b]	13[bc]	11[bc]	16[b]	21[bcd]	70[a]
47% WM:47% corn	52[a]	19[b]	14[b]	12[bc]	24[b]	62[a]
Corn gluten feed	44[b]	9[c]	8[c]	11[bc]	18[cd]	67[a]
DDGS[1]	58[a]	31[a]	27[a]	29[a]	36[a]	64[a]
Pooled SEM	2.2	2.9	1.8	2.6	1.8	2.4

[a–e]Means within a column with no common superscript differ significantly ($P < 0.05$).
[1]DDGS = distillers dried grains with solubles.

that the most profitable molting program occurred for those hens that had feed withdrawn for 10 d, and were then fed the 16% corn-soybean meal molt diet. The next best profitable program was that in which hens were continuously fed the 71%:23% wheat middlings:corn molt diet.

Study 3

After examining the results of the previous studies, we noticed that using a nonwithdrawal feeding program using wheat middlings, soybean hulls, and various combinations of those with corn, we could not induce the hens to go completely out of production. This would in turn affect production and eggshell quality late in the postmolt production period, although it was difficult to observe this in our previous work. Therefore, in an ongoing study, we are evaluating 6 treatments that include feeding wheat middlings and corn combinations, and soybean hulls and corn combinations compared with a conventional 10-d fasting treatment (10-d fast). In the 6 diet combinations, 2 of them are full-fed (corn:wheat middlings and corn:soybean hulls), 2 combinations are fed at a rate of 12 lb/100 hens daily for 28 d (corn:wheat middlings limit and corn:soybean hulls limit), and 2 combinations are full-fed the first 7 d, then fed at a rate of 12 lb/100 hens daily for d 8 to 28 (corn:wheat middlings combo and corn:soybean hulls combo). All the combination diets are 47% corn with 47% wheat middlings or with 47% soybean hulls, plus vitamins

Table 6. Effect of nonwithdrawal vs. feed withdrawal molting methods on egg income minus feed costs (wk 1 to 44; Study 2)

Treatment	Egg income[1]	Feed cost[2]	Profit	Profit per hen housed
	($)			
Corn	662.90	286.98	375.92	5.22
Wheat middlings (WM)	690.25	277.67	412.58	5.73
WM:corn (47:47%)	624.10	285.81	338.29	4.70
WM:corn (71:23%)	718.95	282.10	436.85	6.07
Corn gluten feed	682.55	264.66	417.89	5.80
DDGS[3]	676.35	275.26	401.09	5.57
10-d feed withdrawal, then 16% corn-soybean	719.00	281.61	437.39	6.08
10-d feed withdrawal, then 8% corn	650.75	277.07	373.68	5.19

[1]Based on $0.60 per dozen produced (Urner Barry Price Current, Midwest grade A large white eggs [15]).
[2]Molt plus layer feed costs.
[3]DDGS = distillers dried grains with solubles.

and minerals. The preliminary results of this study shows that the hens that were limit-fed the corn:soybean hulls combination diets went out of production the soonest (data not shown).

How to Use a Nonwithdrawal Molt

Based on our work and that of others, the use of nonwithdrawal feeding programs has merit in the commercial laying hen industry. It is important to note that commercial producers who adopt such a molting program need to adapt it to their own situation and conditions. For example, different results would probably be obtained depending on the strain of birds used, the time of year the molt is done, and many other factors. The price and availability of feed ingredients would also be a factor. However, in every situation, a standard type molting protocol should be followed. Thus, the following recommendations or guidelines are provided. On d −7, the lights should be increased to 24 h/d; on that day, approximately 100 to 125 hens from different locations in the house should be tagged and weighed. On d 0, all previously fed layer feed should be removed from the feed troughs and the photoperiod reduced to 8 h/d. The molt feed diets should then be fed. On d +7 and d +14, the 100 to 125 hens should be weighed. On d 21, the lights should be increased to 12 h/d, and then on d 28, the hens should be switched from the molt feed to a layer diet. Hens on this program should still lose about 15% of their starting BW and egg production should approach between 0 and 5% during this period. Two example molt diets that might be considered in a nonwithdrawal feeding program are depicted in Table 7.

Examples of Using a Nonwithdrawal Feeding Program in Industry

From direct conversations with several egg production companies, different techniques have been implemented depending on their conditions. The first company fed a premolt diet 1 wk before starting; then on d 1 they switched to feeding 57% corn and 40% wheat middlings at a rate of 10 to 12 lb per 100 hens for 28 d. With this program they achieved good postmolt performance results. The second producer fed a 60% wheat middlings:40% corn molt diet. They commented that postmolt egg production was similar to using a fasting method and mortality was lower than with the fasting method. However, they commented that reduced eggshell quality occurred during the last 10 wk of the second cycle. This company plans to initiate their molting program at an earlier age.

Commercial Application of Nonwithdrawal Feeding Programs

In summer 2004, the UEP conducted a survey of 46 companies to determine what type of molting program they were using (Table 8) [16]. Of those surveyed, 22 said that they used a feed withdrawal program and 24 said they used a nonwithdrawal feeding program. Of those producers who have tried a nonwithdrawal molt program, about 80% said they would continue using some type of nonwithdrawal feeding program. Most of the producers using the nonwithdrawal feeding program adapted their program using some variation of the methods developed by us and others. Most of the programs used a combination of wheat middlings, soybean hulls, and corn as the molt diets. In general, most companies reported that slightly lower egg production occurred with a nonwithdrawal feeding program compared with a feed withdrawal program; however, the nonwithdrawal program produced lower mortality with comparable eggshell quality.

Table 7. Example molt diets for a nonwithdrawal feeding program

	Molt diets	
	Wheat middlings/corn (71:23%)	Soybean hulls/corn (47:47%)
Ingredients	(lb/ton)	
Corn	460	942
Wheat middlings	1,425	—
Soybean hulls	—	942
Limestone	99	82
Dicalcium phosphate	2	20
Salt	6	6
Mineral mix	3	3
Vitamin mix	4	4
Insecticide[1]	1	1

[1]Commercialy available insecticide.

Table 8. United Egg Producers molt survey (summer 2004)

Parameter	Frequency of response[1]		
	Higher	Lower	Same
	(% of total companies)		
Mortality	4.2	54.2	41.7
Egg production	8.3	41.7	50.0
	Better	Worse	Same
Egg quality	8.3	20.8	70.8

[1]Responses come from commercial egg companies and independent egg producers and represent the evaluation of nonwithdrawal feeding methods compared with a conventional feed withdrawal molting technique [16].

UEP Molting Guidelines

Due to the egg industry's adoption of our findings and those of other university research projects for nonwithdrawal feeding programs, the UEP's scientific advisory committee modified their recommended molting guidelines in February 2005. Based upon those guidelines, the UEP amended the *Animal Husbandry Guidelines for US Egg Laying Flocks*, as listed below:

1. Only nonfeed-withdrawal molt methods will be permitted after January 1, 2006.
2. The hens should be able to consume nutritionally adequate and palatable feed suitable for a nonproducing hen.
3. Body weight loss should be sufficient so as not to compromise hen welfare.
4. Mortality during the molt should not substantially exceed normal flock mortality.
5. Water must be available at all times.
6. Reduce light period to no less than 8 h in closed houses or to natural day length in open houses for the duration of the rest period. When the flock is placed back on a layer diet, lights should be returned to the normal layer program.

It is interesting to note that the failure of an Animal Care Certified egg production company to meet the above guidelines will result in a failed audit in audit year 2007. It is also interesting to note that these guidelines will apply to approximately 82% of the US egg industry.

CONCLUSIONS AND APPLICATIONS

1. Based on experiments evaluating nonwithdrawal molting techniques, it is apparent that using molt diets containing wheat middlings or soybean hulls in combination with corn would be feasible as an alternative molting program compared with using a feed withdrawal program.
2. The exact combination of wheat middlings or soybean hulls with corn has not yet been firmly established.
3. Based on the 2004 UEP molt survey, egg production companies have successfully adapted the nonwithdrawal feeding programs that researchers have developed to their own specific circumstances.

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