Effects of Feeding Babcock B300 Laying Hens Conventional Sanfandila Layer Diets Compared to Diets Containing 10% Norgold DDGS on Performance and Egg Quality

Introduction

Corn distiller's dried grains with solubles (DDGS) is a co-product of the dry mill ethanol industry. Norgold is a trademark for corn DDGS obtained from selected ethanol plants in Minnesota, South Dakota, and Iowa in the U.S.

University of Minnesota research has shown that corn DDGS can be used as a partial substitute for grain, soybean meal, and dicalcium phosphate in swine and poultry diets. Recent studies have been conducted with turkeys, but little information is available on feeding "new generation" DDGS to laying hens. Results from research studies involving feeding DDGS to laying hens and broilers conducted 20 to 30 years ago do not reflect the quality improvements in DDGS or performance of modern poultry production systems and genetic lines used today. Based upon recent research results evaluating the nutritional value of Norgold DDGS for swine and poultry, the recommended inclusion rate of DDGS in poultry diets is 10 %.

One of the objectives of the Minnesota Corn Growers Association and the ethanol plants that produce Norgold, is to demonstrate that this co-product is high quality ingredient that can be used effectively in laying hen diets used in Mexico to provide excellent performance and egg quality when replacing a portion of the grain, soybean meal, and dicalcium phosphate. Based upon the working agreements between Sanfandila, the Minnesota Department of Agriculture, the Minnesota Corn Growers Association, and ethanol plants producing Norgold, a commercial layer trial was conducted. The objective was to evaluate performance and egg quality of laying hens fed conventional Sanfandila layer diets compared to similar diets containing 10% Norgold for the hens that were the same age and in the same phase of production. The nutrient profile of the conventional and Norgold diets were the same in each phase of production during the 12-week trial.

Hypothesis

Production performance and egg quality of hens fed the control Sanfandila diets and the Norgold diets will not be different throughout a 12-week egg production period.

Material and Methods

1. Facilities

The trial was conducted in buildings 3, 4, 5, and 6 of the "Las Liebres" farm. These buildings were selected from the 10 buildings available at this location because past production performance was not statistically significantly different among these buildings, and because of the close proximity of these buildings to feed storage bins capable of accommodating the two experimental diets. Hens housed in buildings 3 and 6 were fed the Norgold diets and hens housed in buildings 4 and 5 were fed the control diets. The same management procedures were used in all buildings.

The buildings were older, more traditional layer facilities common throughout Mexico. The building dimensions are: 120 m long x 10 m wide. Each building had 4 pyramids of cages with 4 lines per pyramid. Each pyramid served as an experimental unit to provide 8 replications per dietary treatment (2 buildings per diet, 4 pyramids/building). Each pyramid was supported by a metallic structure, to provide alleys that were 85 cm wide. Each line had 372 cages and 186 water cup drinkers. The maximum capacity was 1,116 hens per line with 3 hens per cage. The average space allowance provided was 405 square cm per hen. The maximum capacity was 4,464 hens per pyramid and 17, 856 hens per building. Trough (channel) feeders were located in the front of each line of cages and provided 30 cm of feeder space per cage. Feed was added manually to feed troughs once per day, and spoiled feed was removed at least 5 times each day to stimulate feed consumption. A stationary scale was used to weigh the portable feed cart containing the experimental diets before adding feed to the assigned to feed troughs. The amount of feed added to feeders in each pyramid was recorded each time feed was added. Feeders were lightly cleaned once per day, and were thoroughly cleaned once per week to remove feathers and other contamination. Two buildings shared one feed storage bin that had capacity for 9 metric tons. One bin was used to store the control diets while another adjacent bin was used to store the Norgold diets during the trial.

2. Animals

Commercial Babcock B-300 hens were used. The average age at the beginning of the trial was 68 weeks. The hens that were used were subjected to an early molt at 60 weeks of age. The "California Type" molting system was used. This system involved restricting water, light, and feed for approximately 4 weeks at the end of the previous production cycle, until hens came back into egg production again.

Before the starting the trial, attempts were made to standardize the number, condition, and health status of the hens in each pyramid to provide approximately 4000 hens per pyramid, 16,000 hens per building, and 32,000 per dietary treatment group. The feeding trial began on 11/8/02, and was completed 12 weeks later on approximately 1/31/03. The original plan was to conduct the trial over the entire 36-week production period to collect information on production performance at the beginning, peak, and late lay portion of the production curve. However, due to health problems with the hens in this trial and lack of adequate supply of DDGS to complete an entire 36-week production cycle, the trial was conducted during the beginning and peak of production only.

3. Hen management

Hens were managed equally in each barn, regardless of dietary treatment, using standard commercial production practices. Hens were vaccinated via the drinking water for infectious bronchitis and Newcastle diseases. The same standardized protocol used by Sanfandila in all of their layer operations was used during this trial. Management procedures included using only daylight during the first two weeks of the molting process to re-initiate laying, followed by increasing the lighting period 30 minutes each subsequent week until 16 hours of light was provided per day during the production cycle. Building sanitation was carried out daily and litter removal was done twice per week. Ad libitum access to water via one water cup for every two cages was provided.

4. *Feeding program*

Hens were fed using a conventional Sanfandila protocol based on the age and production phase. A two phase feeding program was used for control and Norgold diets. Nutrient content of the control and Norgold diets were the same (see attached diet composition and nutrient analysis of Phase 2 and Phase 3 experimental diets). The nutrient profile for Norgold used in the diet formulations was obtained from Dr. Shurson at the University of Minnesota. He provided current nutrient analysis and true amino acid digestibility values for DDGS produced at Chippewa Valley Ethanol Company, Benson, MN (the DDGS source used in this trial). The following tables include diet composition and calculated nutrient analysis of all diets used in the trial.

Agropecuaria Sanfandila S.A., de C.V.

Formula: 101 Phase 2 Unica, 66 to 78 weeks
Date: October 15, 2002
Formulator: MVZ Martin Audiffred Pinedo
Use: Phase 2 Unica Original Control Diet for Norgold Trial

Diet Composition

Code	Ingredient	Amount	Actual Price
003	Sorghum, 9%	650.60	1.50
133	Soybean meal, 48%	213.00	2.47
190	Calcium carbonate, 38%	99.00	0.25
246	Acidified oil	13.00	2.90
187	Dicalcium phosphate, 21%/17%	13.00	3.20
195	Salt	3.50	0.90
669	Neosil (mycotoxin binder)	3.00	4.00
445	Pixafil postura (pigment)	1.25	29.75
221	D, L Methionine, 98%	0.85	19.00
416	Na bicarbonate	1.00	2.87
*NR	Trace mineral premix	1.00	4.60
*NR	Vitamin premix	0.50	40.00
556	Ronozyme/Postura/180 (enzyme)	0.18	53.00
*NR	Santiox (mold inhibitor)	0.12	12.00
		1000.00	1,717.08

Nutrient Analysis

Nutrient	Amount
Moisture, %	10.53
ME, kcal/kg	2797
Crude fat, %	3.24
Linoleic acid, %	1.42
Crude fiber, %	1.94
Crude protein, %	16.20
Lysine, %	0.82
Methionine, %	0.35
Met + cys, %	0.63
Threonine, %	0.60
Tryptophan, %	0.19
Calcium, %	4.17
Phosphorus, %	0.70
Available phosphorus, %	0.46
Sodium, %	0.19
Ash, %	14.03
Xanthophyll, mg/kg	8.75
Choline, mg/kg	917

Formula: 220 Phase 2 Unica, 66 to 78 weeks
Date: October 15, 2002
Formulator: MVZ Martin Audiffred Pinedo
Use: Phase 2 Unica DDGS Diet for Norgold Trial

Diet Composition

Code	Ingredient	Amount	Actual Price
003	Sorghum, 9%	595.76	1.50
133	Soybean meal, 48%	163.00	2.47
190	Calcium carbonate, 38%	100.00	0.25
673	Norgold DDGS	100.00	1.65
246	Acidified oil	18.00	2.90
187	Dicalcium phosphate, 21%/17%	10.00	3.20
195	Salt	3.50	0.90
669	Neosil (mycotoxin binder)	3.00	4.00
570	Biolys 60 (lysine)	1.85	8.70
445	Pixafil postura (pigment)	1.25	29.75
221	D, L Methionine, 98%	0.84	19.00
416	Na bicarbonate	1.00	2.87
*NR	Trace mineral premix	1.00	4.60
*NR	Vitamin premix	0.50	40.00
556	Ronozyme/Postura/180 (enzyme)	0.18	53.00
*NR	Santiox (mold inhibitor)	0.12	12.00
		1000.00	1,697.33

Nutrient Analysis

Nutrient	Amount
Moisture, %	10.37
ME, kcal/kg	2800
Crude fat, %	4.51
Linoleic acid, %	2.02
Crude fiber, %	2.50
Crude protein, %	16.20
Lysine, %	0.82
Methionine, %	0.35
Met + cys, %	0.63
Threonine, %	0.59
Tryptophan, %	0.18
Calcium, %	4.14
Phosphorus, %	0.67
Available phosphorus, %	0.46
Sodium, %	0.21
Ash, %	14.03
Xanthophyll, mg/kg	8.75
Choline, mg/kg	767

Formula: 101 Phase 3 Unica, 79 to 88 weeks
Date: October 15, 2002
Formulator: MVZ Martin Audiffred Pinedo
Use: Phase 3 Unica Original Control Diet for Norgold Trial

Diet Composition

Code	Ingredient	Amount	Actual Price
003	Sorghum, 9%	685.71	1.50
133	Soybean meal, 48%	191.00	2.47
190	Calcium carbonate, 38%	102.00	0.25
246	Acidified oil	3.00	2.90
187	Dicalcium phosphate, 21%/17%	10.00	3.20
195	Salt	3.50	0.90
669	Neosil (mycotoxin binder)	0.00	4.00
445	Pixafil postura (pigment)	1.25	29.75
221	D, L Methionine, 98%	0.74	19.00
416	Na bicarbonate	1.00	2.87
*NR	Trace mineral premix	1.00	4.60
*NR	Vitamin premix	0.50	40.00
556	Ronozyme/Postura/180 (enzyme)	0.18	53.00
*NR	Santiox (mold inhibitor)	0.12	12.00
		1000.00	1,662.93

Nutrient Analysis

Nutrient	Amount
Moisture, %	10.73
ME, kcal/kg	2781
Crude fat, %	2.33
Linoleic acid, %	0.99
Crude fiber, %	1.94
Crude protein, %	15.44
Lysine, %	0.76
Methionine, %	0.33
Met + cys, %	0.59
Threonine, %	0.57
Tryptophan, %	0.18
Calcium, %	4.23
Phosphorus, %	0.63
Available phosphorus, %	0.39
Sodium, %	0.19
Ash, %	13.67
Xanthophyll, mg/kg	8.75
Choline, mg/kg	891

Formula: 221 Phase 3 Unica, 79 to 88 weeks
Date: October 15, 2002
Formulator: MVZ Martin Audiffred Pinedo
Use: Phase 3 Unica DDGS Diet for Norgold Trial

Diet Composition

Code	Ingredient	Amount	Actual Price
003	Sorghum, 9%	629.14	1.50
133	Soybean meal, 48%	143.00	2.47
190	Calcium carbonate, 38%	103.00	0.25
673	Norgold DDGS	100.00	1.65
246	Acidified oil	7.00	2.90
187	Dicalcium phosphate, 21%/17%	8.00	3.20
195	Salt	3.50	0.90
669	Neosil (mycotoxin binder)	0.00	4.00
570	Biolys 60 (lysine)	1.61	8.70
445	Pixafil postura (pigment)	1.25	29.75
221	D, L Methionine, 98%	0.70	19.00
416	Na bicarbonate	1.00	2.87
*NR	Trace mineral premix	1.00	4.60
*NR	Vitamin premix	0.50	40.00
556	Ronozyme/Postura/180 (enzyme)	0.18	53.00
*NR	Santiox (mold inhibitor)	0.12	12.00
		1000.00	1,643.02

Nutrient Analysis

Nutrient	Amount
Moisture, %	10.58
ME, kcal/kg	2774
Crude fat, %	3.50
Linoleic acid, %	1.55
Crude fiber, %	2.51
Crude protein, %	15.51
Lysine, %	0.75
Methionine, %	0.33
Met + cys, %	0.60
Threonine, %	0.56
Tryptophan, %	0.17
Calcium, %	4.22
Phosphorus, %	0.63
Available phosphorus, %	0.41
Sodium, %	0.21
Ash, %	13.77
Xanthophyll, mg/kg	8.75
Choline, mg/kg	744

5. *Data collection*

Each pyramid within each barn served as an experimental unit. The following production data were collected for each pyramid:

- number of hens per day
- % production
- daily mortality
- number of first quality eggs
- number of broken eggs
- number of double yolk eggs
- number of shell-less eggs
- amount of feed provided per day

Weekly feed adjustments were made based on the number of hens in each pyramid and dietary phase changes were made at the same time for both experimental diets. A weekly data summary was provided to Dr. Shurson for review and analysis.

Egg quality was also evaluated using 30 randomly selected eggs from each group for the following characteristics:

A. Haugh units – a measure of albumin (egg white) density.
B. Specific gravity – measure of egg shell quality determined by weighing eggs in different concentrations of saline solution
C. Yolk pigmentation - using Minolta photo-colorimeter

Feed samples from each experimental diet were collected weekly and analyzed for crude protein, crude fat, crude fiber, calcium, phosphorus, and salt. Samples were also analyzed for mycotoxins including aflatoxin, ochratoxin, T-2 toxin, citrinin, fumonisin, and zearalenone.

6. DDGS stability

A random sample of Norgold will be obtained weekly from storage at the Sanfandila feed mill and analyzed for moisture (dry matter), mycotoxins (aflatoxin, ochratoxin, T-2 toxin, citrinin, fumonisin, and zearalenone), and a measure of fat oxidation (rancidity).

7. Data Analysis

All data were statistically analyzed using the GLM Procedures of SAS with repeated measures in time. The model included time, dietary treatment, and time x treatment interactions.

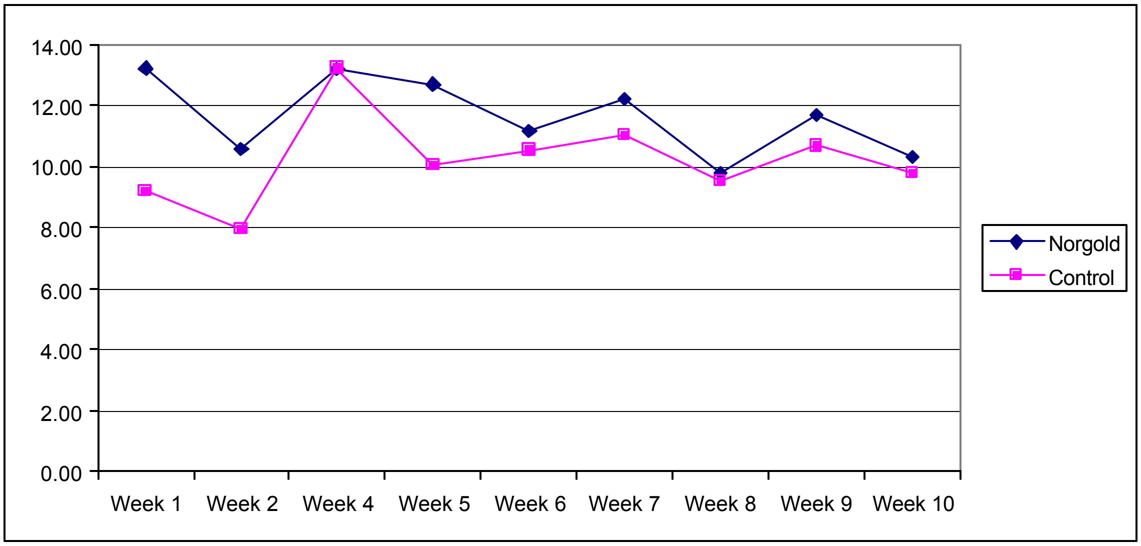
Results and Discussion

As shown in Table 1, there were no overall differences in dry matter, crude protein, crude fat, ash, calcium, and phosphorus content between the control and Norgold diets ($P > 0.1$). The crude fiber content was similar (2.84 vs. 2.74%) between the control and Norgold diets, respectively. However, the addition of 10% Norgold DDGS provided significantly more xantohphyll to the Norgold diet than the control diet (Table 1), and the difference in xanthophylls content of the experimental diets tended to be the greatest during the first four weeks of the trial (Figure 1). Xanthophyll content of the Norgold diets appeared to decline during the trials which reflects the expected loss of xanthophyll content of Norgold during the 16 week storage period (4 weeks prior to starting the trial plus the 12 week trial). Norgold was also tested for rancidity during the 16-week storage period and no rancidity was detected. Furthermore, Norgold was tested and was devoid of mycotoxins.

Table 1. Average Nutrient Analysis of Experimental Diets During the 12-Week Norgold Layer Trial

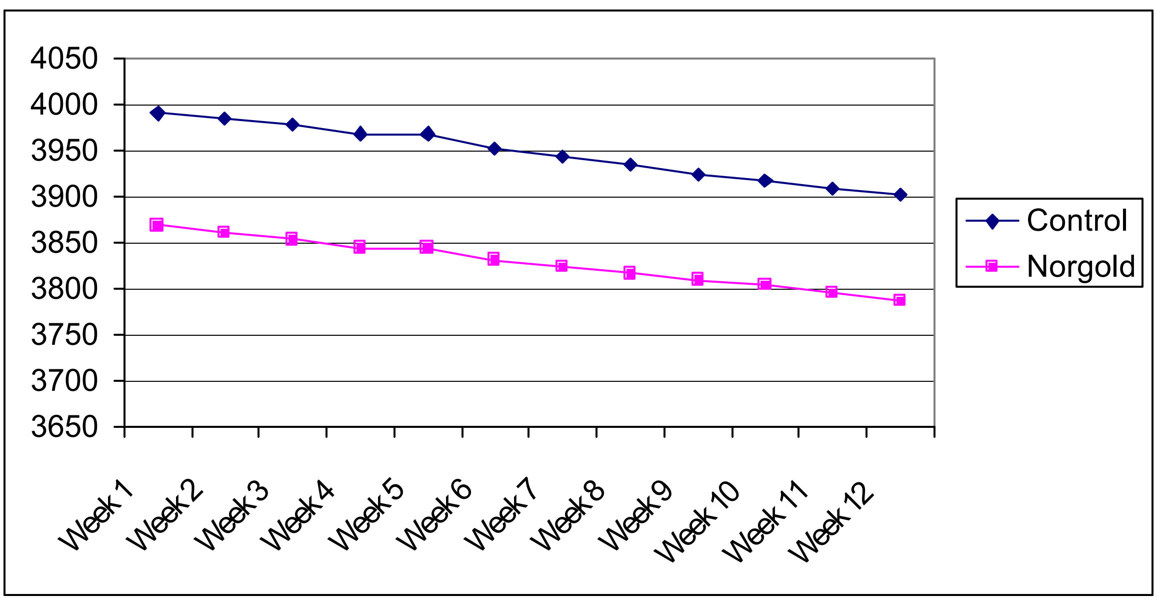
Nutrient	Control	Norgold	SE	P value
Dry matter, %	88.7	89.0	0.17	0.19
Crude protein, %	16.1	16.2	0.17	0.50
Crude fat, %	2.71	3.25	0.27	0.17
Ash, %	12.1	11.7	0.47	0.62
Calcium, %	4.16	4.22	0.09	0.61
Phosphorus, %	0.54	0.54	0.02	0.81
Xanthophyll, ppm	10.2	11.8	0.44	0.02

Figure 1. Xanthophyll Content of Control and Norgold Diets During the 12-Week Layer Trial



There tended to be more (P > .10) total hens fed the control diet than those allotted to the Norgold diets throughout the entire 12-week feeding period (Figure 2). As a result, many performance measures are presented on a percentage basis to account for differences in the number hens allotted to the control and Norgold dietary treatments. Average environmental temperature during the 12-week feeding period was 17.0° C, and ranged from an average low of 9.3° C to an average high temperature of 24.7° C.

Figure 2. Average Number of Hens per Replicate at the Beginning of Each Week for Control and Norgold Dietary Treatments During the 12-week Norgold Layer Trial.



Average hen body weight was higher for hens fed the Norgold diet compared to hens fed the control diet ($P < .002$; Figure 3). There was also a time x treatment interaction ($P < .0001$) indicating that there was no difference in body weight of hens fed either the control or Norgold during the first two weeks of the trial, but hens fed the Norgold diets weighed consistently more than hens fed the control diet for the duration of the trial. This suggests that the energy content of the Norgold diet was higher than the control diet because average weekly feed consumption was not different between hens fed the control and Norgold diets (Figure 4).

As shown in Figure 5, average percentage of production was higher for layers fed the Norgold diets during the entire 12-week trial ($P > .03$). There was also a time x treatment interaction ($P < .01$) indicating that % production was similar between hens fed the control and Norgold diets during the first weeks of the trial, but then increased for hens fed the Norgold diets for the duration of the trial. These results suggest that feeding layer diets containing 10% Norgold will result in an increase in egg production compared to feeding a common control diet used in Jalisco, Mexico. The decrease in percentage of production that occurred during week 9 was a result of an outbreak of Newcastle and influenza, along with feeding mycotoxin contaminated sorghum during this time period. Layers fed the Norgold diet appeared to return to a high percentage of production more quickly than hens fed the control diet.

Figure 3. Average Hen Body Weight (kg) during the 12-week Norgold Trial.

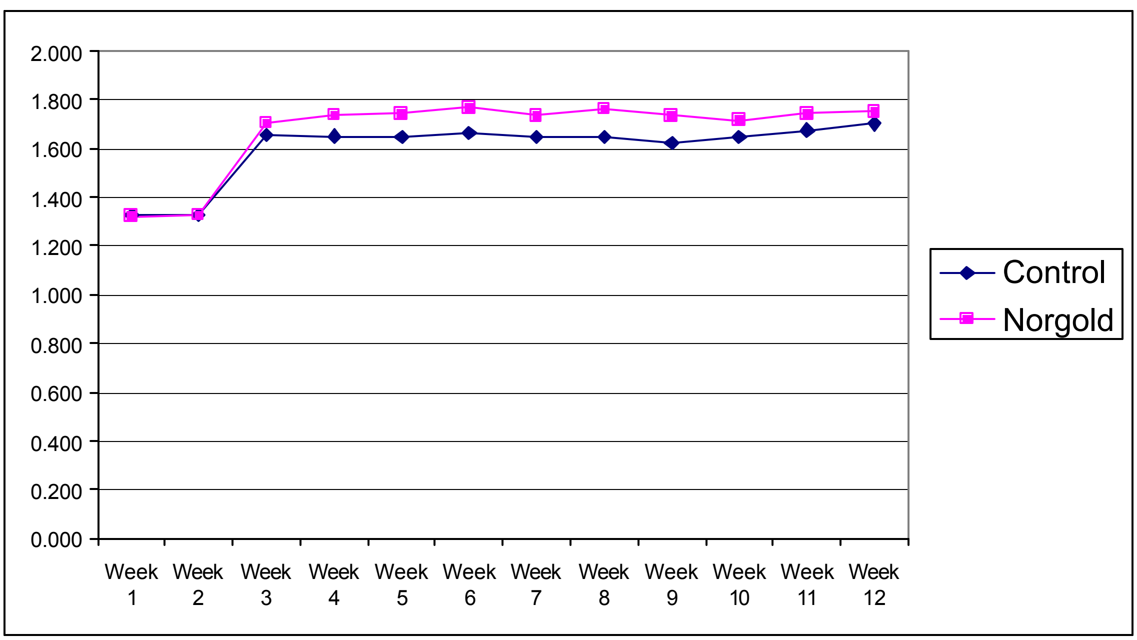


Figure 4. Average Weekly Feed Consumption (kg) per Replicate of Hens Fed Control and Norgold Diets.

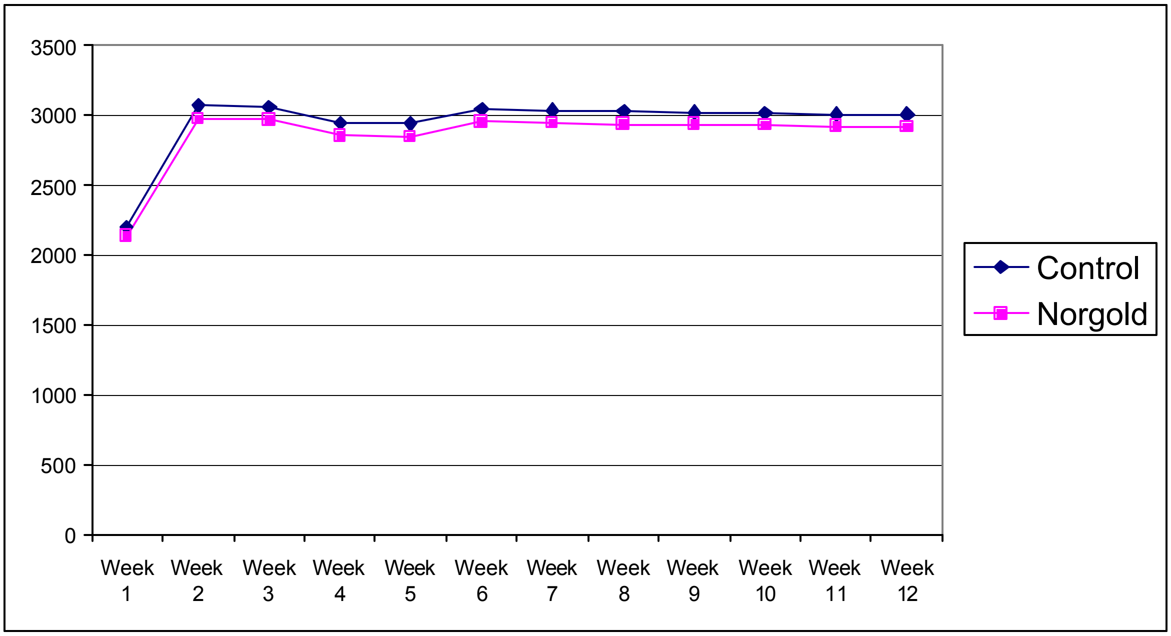
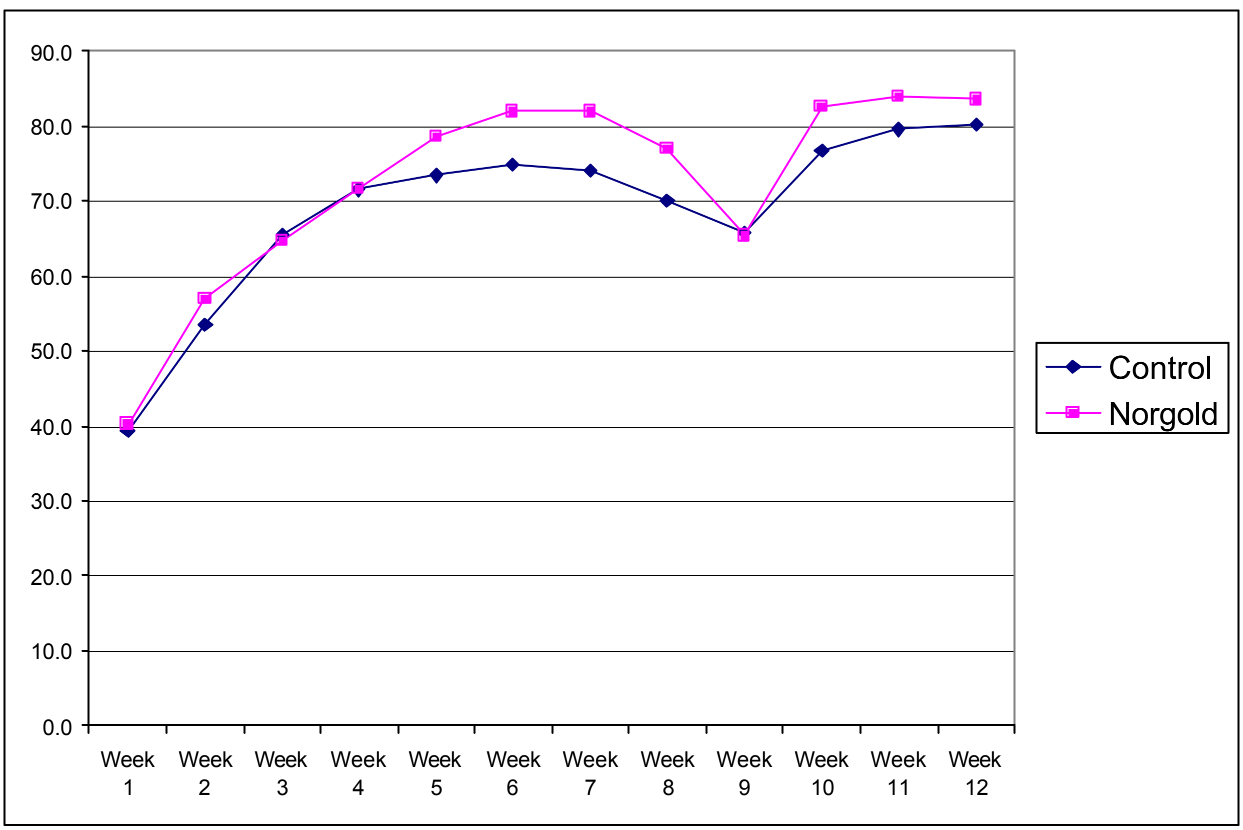


Figure 5. Average Percentage of Production by Week for Layers Fed Control and Norgold Diets



The average number of hens/pyramid/week tended (P > .12) to be greater for the control diet compared to the Norgold diet. As a result, several production measures were calculated as percentages of the total number of hens or eggs to account for unequal number in each dietary treatment. As shown in Table 2, there were no overall differences in % mortality and % prolapsed hens between layers fed the control and Norgold diets (P > .1). During the 12-week feeding period, the percentage production of first class eggs tended to be higher (P < .1) for hens fed the Norgold diet compared to hens fed the control diet. Hens fed the Norgold diet produced an average of 3.7 more eggs (P < .02) during the 12-week feeding period compared to hens fed the control diet. Furthermore, hens fed the Norgold diets tended (P < .11) to produce more kilograms of eggs per week than hens fed the control diet. However, the percentage of first class eggs of the total eggs produced was lower for layers fed the Norgold diet (P < .003). The lower percentage of first class eggs of total eggs produced for hens fed the Norgold diet was due to the higher percentage of broken eggs (1.22 vs. 0.75%; P < .0001), no shell eggs (0.02 vs. 0.01%; P < .006), dirty eggs (2.18 vs. 1.37%; P < .002), and double yolk eggs (0.12 vs. 0.08%; P < .003). Although there were significant dietary treatment differences for no shell eggs and double yolk eggs, the percentage of the total eggs produced was extremely low and is not of great importance. It is unclear why feeding the Norgold diet in this experiment resulted in an increase in the percentage of broken and dirty eggs compared to eggs from hens fed the control diet.

Table 2. Effect of Feeding a Layer Diet Containing Norgold on Hen Mortality and Prolapses, and Egg Production and Quality

Response variable	Control	Norgold	SE	P value
Average number hens/wk/pyramid	3948	3828	51.2	0.12
% hen mortality	1.99	1.80	0.13	0.30
% prolapsed hens	0.49	0.52	0.07	0.76
% production of first class eggs	66.2	68.9	1.09	0.10
Total number of eggs produced	224,533	229,294	2324	0.17
Average % production	68.7	72.4	1.01	0.02
Egg weight produced/pyramid, kg	14,576	14,659	158.2	0.72
Average egg weight produced/hen/wk, kg	0.308	0.320	0.005	0.11
Total number of first class eggs	219,565	221,156	2338	0.64
% first class eggs	97.8	96.5	0.20	0.003
Total number of broken eggs	1683	2806	116	0.0001
% broken eggs	0.75	1.22	0.05	0.0001
Total number of no shell eggs	26.3	48.4	4.45	0.003
% no shell eggs	0.01	0.02	0.002	0.006
Total number of dirty eggs	3073	4999	341	0.001
% dirty eggs	1.37	2.18	0.15	0.002
Total number of double yolk eggs	185	284	16.9	0.001
% double yolk eggs	0.08	0.12	0.008	0.003
Average egg Haugh units	92.6	93.2	0.46	0.45
Average egg specific gravity	7.41	7.34	0.06	0.51
Average yolk color	10.63	10.81	0.02	0.02

There were no overall differences in egg albumin quality (measured as Haugh units; Table 2), egg shell quality (measured as specific gravity; Table 2), or average egg weight (Figure 6) between dietary treatment groups (P > .1). Furthermore, hens fed the Norgold diet produced eggs with a darker colored egg yolk (P , .02), which is very desirable to the Mexican consumer, compared to feeding the control diet (Table 2). However, as shown in Figure 7, these differences egg yolk color were greater during the early weeks of the production cycle compared to the later portion of the feeding trial and this pattern corresponds with the declining level of xanthophyll content of DDGS as shown in Figure 1.

Figure 6. Average Egg Weight (g) by Week for Layers Fed Control and Norgold Diets.

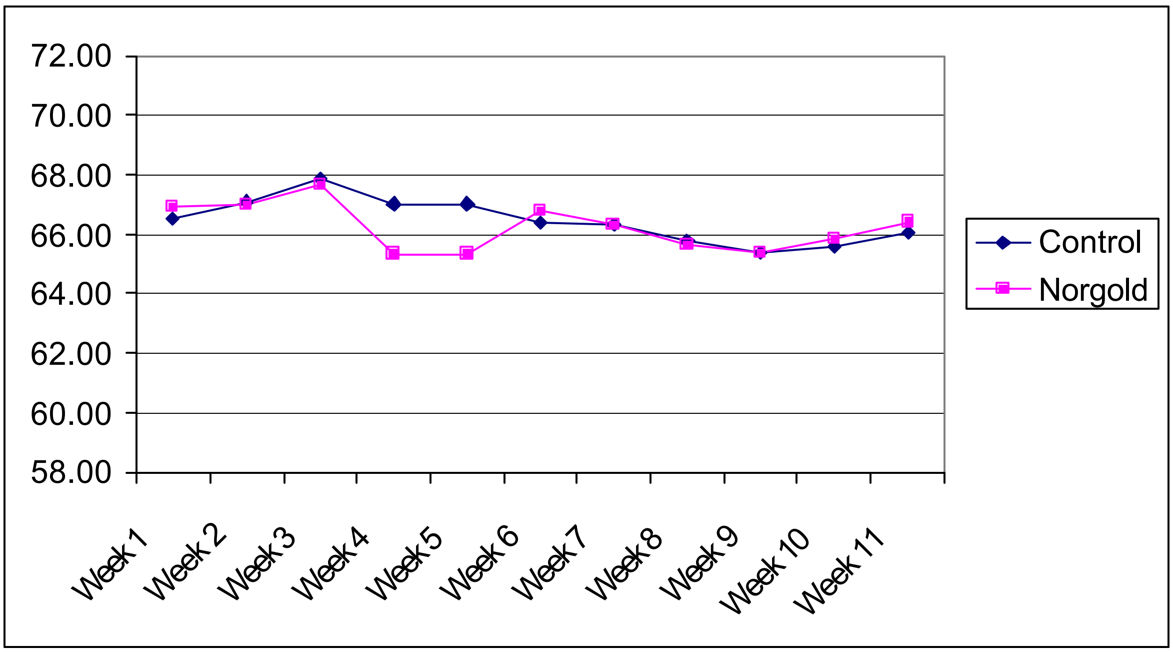
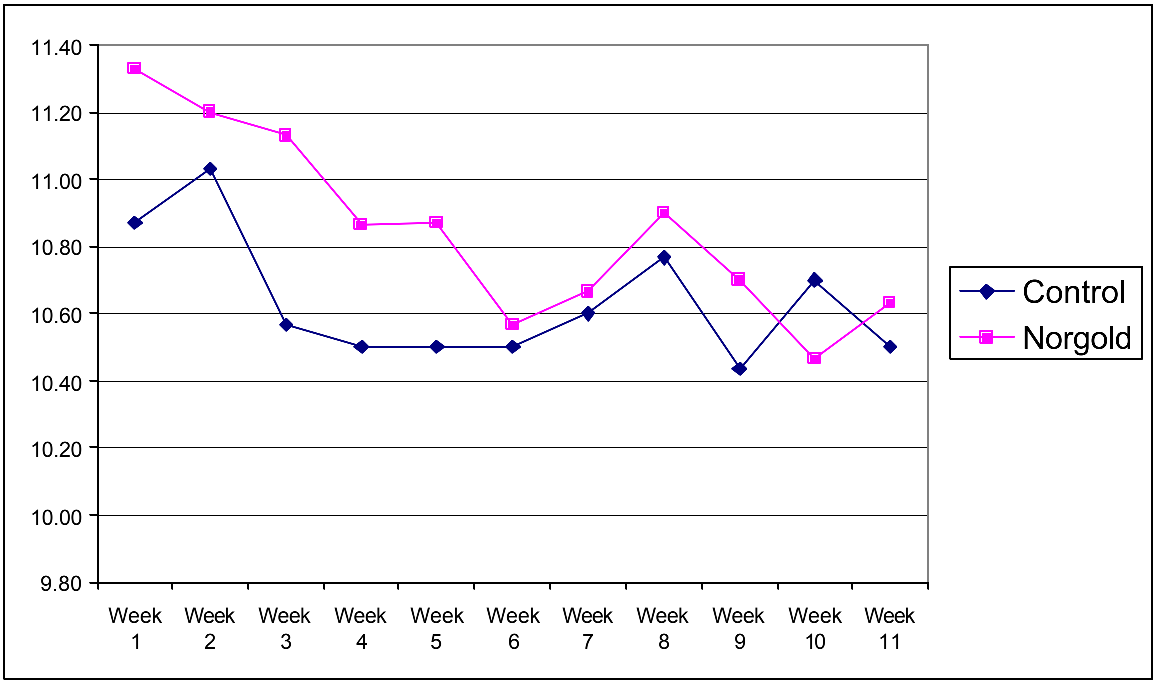


Figure 7. Differences in Yolk Color (Roche Units) in Eggs Produced by Layers Fed Control and DDGS Diets.



Summary

Results from this study show that adding 10% Norgold DDGS to practical layer diets used in Jalisco, Mexico can provide a significant improvement in % production and egg yolk color compared to typical control diets routinely used. This represents a significant economic advantage in favor of using Norgold in layer diets. However, the percentage of broken and dirty eggs may increase when feeding layer diets containing 10% Norgold. There were no differences between hens fed the Norgold diets compared to the control diets for mortality, prolapses, egg albumin quality, and egg shell quality. Potential reasons for an increase in the number of broken and dirty eggs for hens fed the Norgold diet are unknown, but may have been due to slightly different management conditions among the test barns used in this study.