Effects of Dietary Modification on Laying Hens in High-Rise Houses: Part II –Hen Production Performance

A.S. Leaflet R2451

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Summary and Implications

Dietary manipulation can substantially lower ammonia emissions from laying-hen manure. However, such dietary changes would be of little value if the changes cause inferior egg production and hen performance. Therefore, the objective of this study was to evaluate the effect of a diet containing EcoCal™ (gypsum and zeolite, at 3.5% inclusion rate), which has been shown to lower ammonia emission in laboratory-scale testing, on hen production performance as well as on gaseous emissions, in commercial high-rise laying-hen houses in Iowa. A companion paper (A.S. Leaflet R2450) describes the effect of the EcoCal diet on ammonia (NH_3), hydrogen sulfide (H_2S), and carbon dioxide (CO_2) emissions. Comparative data were collected from December 2006 to May 2007. The period was broken into 2-wk increments for data analyses. There were differences between the control and EcoCal regimens for some 2-wk periods but no responses were consistently different between the two treatments during the 16-week time interval evaluated. A new phase of the study is ongoing for 2 additional years and subsequent analyses will help determine if hen production performance differences exist between the dietary regimens.

Introduction

Ammonia (NH_3) emissions from animal feeding operations have been estimated to represent the largest portion of the national NH_3 emissions inventory in the United States. To improve the environmental stewardship and indoor air quality, the egg industry has been progressively looking for practical means to reduce NH_3 generation and/or emissions from the production facilities. Dietary manipulation is one promising method to lower NH3 emission from laying-hen facilities. One such method is the addition of EcoCal™ (a mixture of calcium sulfate and zeolite). The calcium sulfate serves to acidify the manure, thereby converting volatile NH_3 into NH_4^+, which is more water-soluble. Zeolite binds NH_3 to trap it in the manure and further minimize volatilization.

The objective of this field-scale study was to evaluate the effects of feeding laying hens a diet containing EcoCal (3.5% by weight) on NH_3, H_2S, and CO_2 emissions, production performance, and the economic returns for a commercial high-rise layer operation in Iowa. This paper reports the effects of the diet on hen production performance.

Materials and Methods

Two commercial high-rise houses, each containing approximately 255,000 white-leghorn (Hy-Line W-36) laying hens, were used for this research. Hens in one house were fed a diet that contained 3.5% EcoCal, while hens in the other house were fed a control diet (containing no EcoCal). All other ingredients were included in the proprietary commercial diet to supply nutrients to meet or exceed the NRC (1994) recommendations. Production performance was measured by staff at the farm and reported to the research group weekly. Egg production was also measured using a laser beam counter placed across the egg belt at the end of each house. The total number of eggs was measured each day and divided by the house populations, adjusted daily for mortality, to determine the percent egg production, then averaged by week. Each week, a representative case (30 dozens) of eggs were collected from each house and weighed. Individual egg weight was subsequently calculated and expressed as grams per egg. Egg mass was calculated as egg production multiplied by egg weight to show the daily egg output per hen. Mortalities were recorded daily and house population was calculated by subtracting each week's mortalities. Feed consumption was measured as feed disappearance from the two bins per house and expressed as grams of feed consumed per hen daily. Hen body weight (BW) was measured once per month by weighing the same 100 hens in each house. Air temperature was recorded at hen level at the 3rd tier height of 5 tiers in each house and averaged by week.

The control hens were 9 weeks older than the EcoCal hens; therefore, all data in this report are compared by hen age rather than by date. Data shown are from hens at 90 to 105 weeks of age, which corresponds to December 1, 2006 to March 22, 2007 for the control hens and February 1, 2007 to May 24 2007 for the EcoCal hens.

Statistical analyses were performed using JMP (version 6.0, SAS Institute, Inc., Cary, NC). Data were analyzed using a separate ANOVA analysis for each 2-wk period with each week considered an observation; *P*-values ≤ 0.05 were considered significant. The model included the effect of treatment: EcoCal or control diet. Because hen BW was measured once per month rather than once per week, BW data were analyzed over the entire 16-wk period.

Results and Discussion

Because the 2-wk periods were not from the same calendar month for the two treatments, house temperature was measured and compared to determine if differences in production, if any, could have been attributed to temperature differences. House temperature is shown in each of Figures 1 to 6. The collection periods did not coincide with the warm summer season, hence the temperature differences between the houses were rather small. When hens were 90 to 91 and 104 to 105 wk of age, the house temperature was 1.7 and 1.2ºC higher, respectively, in the EcoCal house compared to the control house.

Feed consumption is shown in Figure 1. The EcoCal hens consumed 8.5, 8.5, and 9.2 g/d more feed than the control hens for the periods of 100 to 101, 102 to 103, and 104 to 105 wk of age, respectively. Environmental temperature may affect feed consumption with lower temperatures causing higher feed consumption and vice versa (Leeson and Summers, 2005). However, of the three periods where feed consumption was greater for the EcoCal hens, house temperatures were only different for the final period (104 to 105 wk of age). Furthermore, air temperature was higher in the EcoCal house than in the control house, which would have led to a lower feed consumption rather than the higher consumption that was observed. The greater feed consumption of the EcoCal hens at higher house temperature indicates that temperature was likely not the cause of the differences in feed intake between the dietary regimens.

Egg production is shown in Figure 2. Egg production was lower for the EcoCal hens during 92 to 93 wk of age but was not different during the remainder of the observation periods. Egg weight and egg mass are shown in Figures 3 and 4, respectively. Egg weight was 0.6 g lower for the EcoCal hens during 96 to 97 wk of age. However, egg weight was numerically greater during the following period, indicating there were no long-lasting problems with egg weight. Egg mass was 2.8 g/d and 1.2 g/d lower from the EcoCal hens compared to the control for 92 to 93 wk of age and 96 to 97 wk of age, respectively. The lower egg mass during 92 to 93 wk of age was attributed to the lower egg production (fig. 2) during that time whereas the lower egg mass during 96 to 97 wk of age was attributed to the lower egg weight (fig 3) during that period.

Feed conversion (FC) was calculated as quantity (e.g., grams) of feed per quantity (e.g., gram) of egg mass and is shown in Figure 5. There were no differences in FC when hens were 90 to 99 or 104 to 105 wk of age; however, during 100 to 101 and 102 to 103 wk of age, the control hens had a better FC than the EcoCal hens. The difference in FC was due mainly to the greater feed consumption (fig. 1), as egg mass (fig. 4) was not different.
Monthly BW measurements were analyzed for the entire 16-wk period. The mean BW over this period was 1.74 and 1.64 ± 0.01 kg ($P < 0.0001$) for the EcoCal and control hens, respectively. At the onset of the data analysis period when hens were 90 wk of age, the mean BW of the EcoCal hens was 1.67 kg while the control hens weighed 1.63 kg. At the end of the data analysis period, the EcoCal hens averaged 1.75 kg while the control hens averaged 1.63 kg. This result indicates that the EcoCal hens seemed to gain weight at a faster rate (80 g weight gain over the 16-wk period) than the control hens (0 g weight gain). The EcoCal hens also consumed more feed during the last 8 wk of the 16-wk data analysis period. The increased feed consumption may have led to the larger BW for the EcoCal hens. The greater BW would, in turn, require somewhat higher energy intake for metabolic maintenance. Mortality, expressed as percentage per week, is shown in Figure 6. During the period of 92 to 93 wk and 100 to 105 wk the control flock experienced a higher mortality compared to the EcoCal flock. However, it is difficult to say with certainty if the differences in the observed flock mortality were linked to the dietary treatment. Further test data are expected to help elucidate.

Conclusions

Dietary EcoCal was evaluated for its efficacy as an ammonia-lowering feed ingredient in a commercial egg-production operation (reported in A.S. Leaflet R2450) and its effects on hen production performance are reported here. Data to date show few differences in egg production, egg weight, or egg mass (output) for hens fed 3.5% EcoCal compared to hens fed a control (EcoCal-free) diet. Compared with the control hens, the EcoCal hens consumed more feed and had a lower mortality rate during 100 to 105 wk of age, and had a less favorable feed conversion during 100 to 103 wk of age. Additionally, the EcoCal hens tended to have a larger body weight. A new phase of the field research is ongoing, and future analyses should help better determine if the observed differences were due to the dietary treatment.

Acknowledgments

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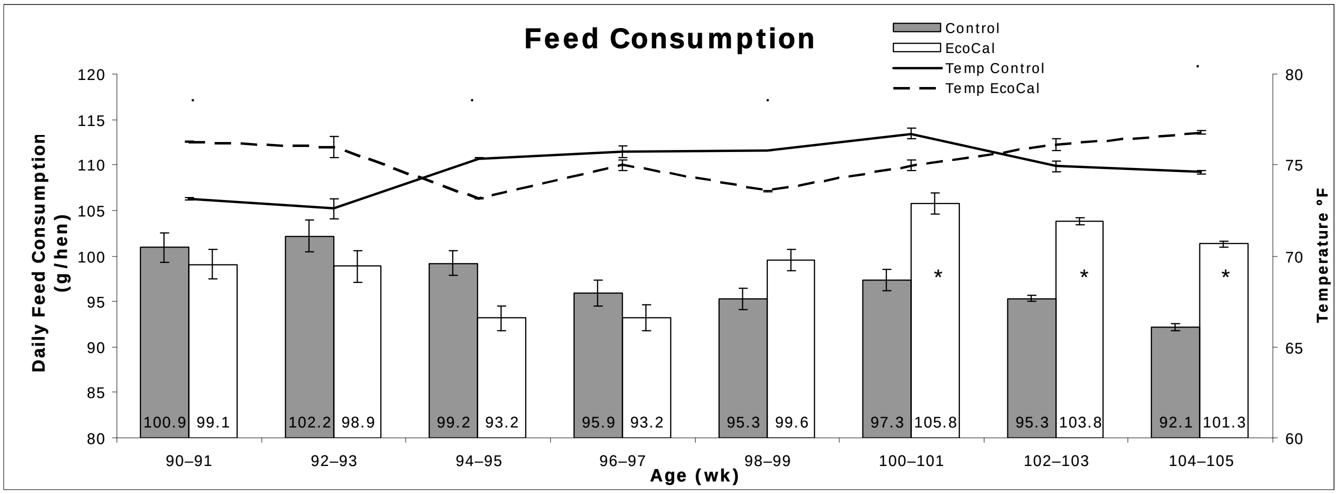

Figure 1. Bi-weekly mean house temperature and daily feed consumption of laying hens fed either a diet containing 3.5% EcoCal or a control diet containing 0% EcoCal. × denotes significant difference in house temperature ($P \leq 0.05$); * denotes significant difference in feed consumption ($P \leq 0.05$) between the EcoCal and control dietary regimens.

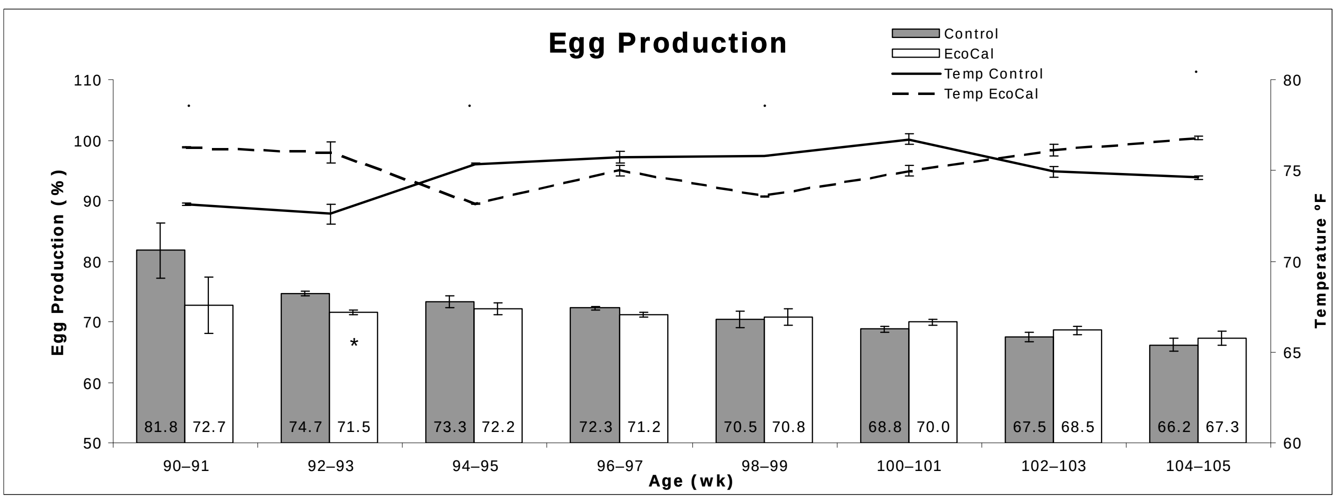

Figure 2. Bi-weekly mean house temperature and egg production of laying hens fed either a diet containing 3.5% EcoCal or a control diet containing 0% EcoCal. × denotes significant difference in house temperature ($P \leq 0.05$) between the EcoCal and control dietary regimens.

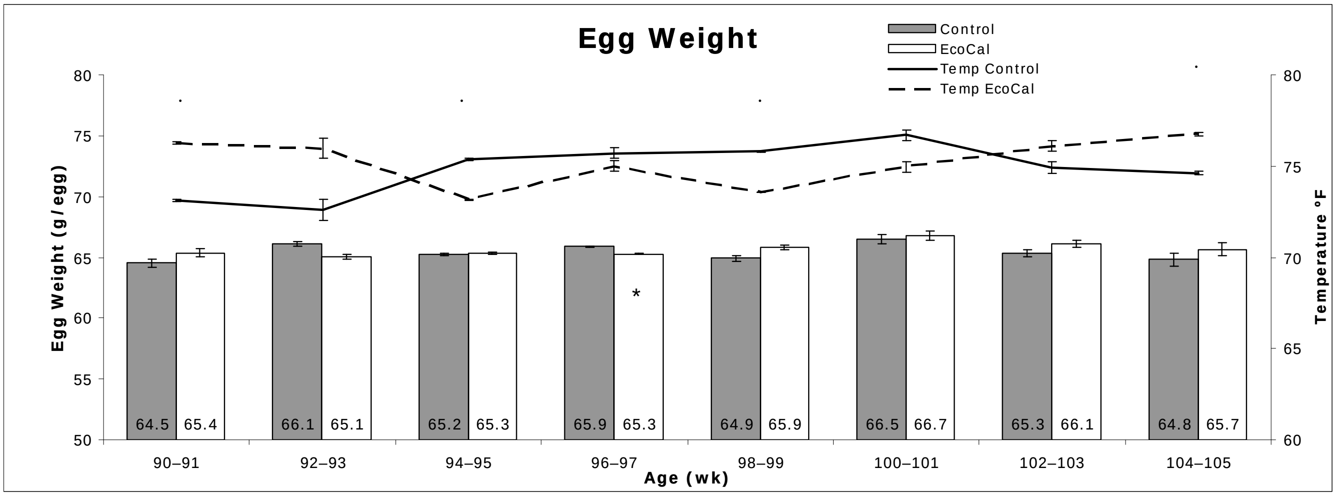

Figure 3. Bi-weekly mean house temperature and egg weight of laying hens fed either a diet containing 3.5% EcoCal or a control diet containing 0% EcoCal. × denotes significant difference in house temperature ($P \leq 0.05$) between the EcoCal and control dietary regimens.

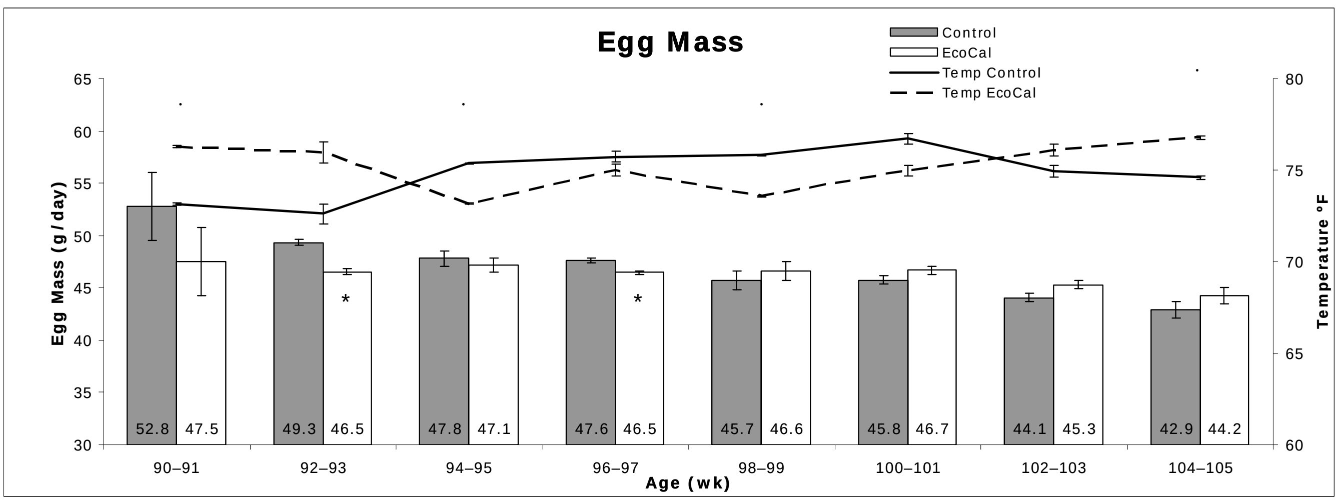

Figure 4. Bi-weekly mean house temperature and egg mass of laying hens fed either a diet containing 3.5% EcoCal or a control diet containing 0% EcoCal. × denotes significant difference in house temperature ($P \leq 0.05$) between the EcoCal and control dietary regimens.

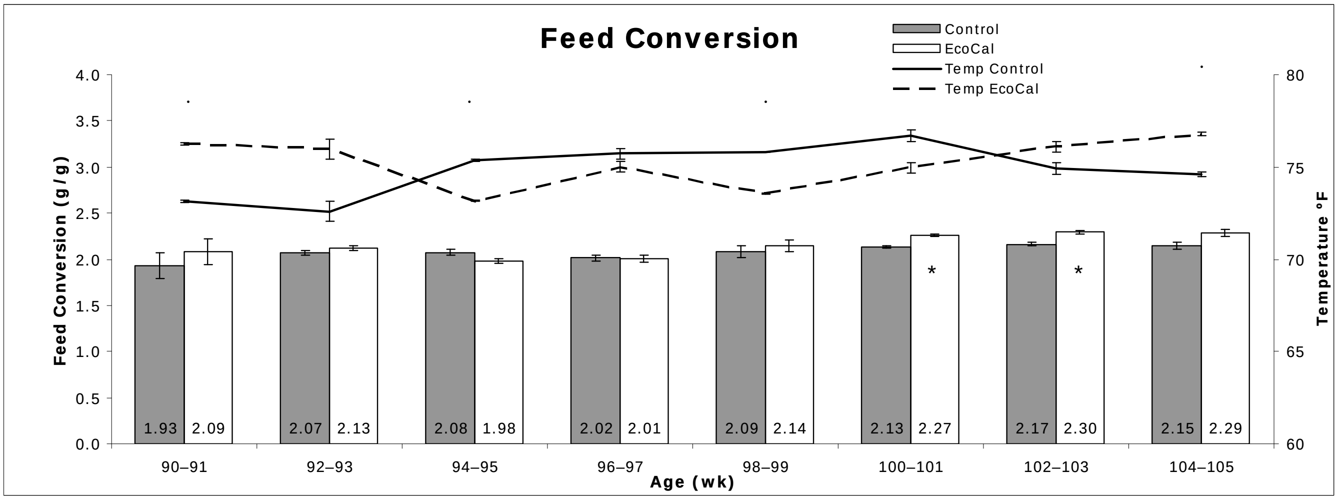

Figure 5. Bi-weekly mean house temperature and feed conversion of laying hens fed either a diet containing 3.5% EcoCal or a control diet containing 0% EcoCal. × denotes significant difference in house temperature ($P \leq 0.05$). * denotes significant difference in feed conversion ($P \leq 0.05$) between the EcoCal and control dietary regimens.

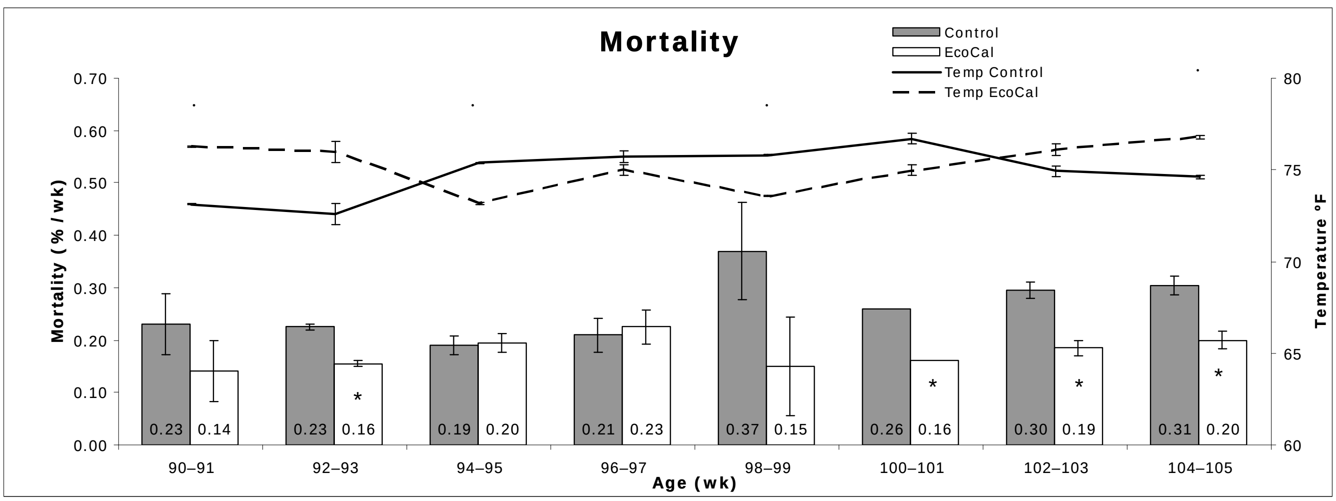

Figure 6. Bi-weekly mean house temperature and flock mortality of laying hens fed either a diet containing 3.5% EcoCal or a control diet containing 0% EcoCal. × denotes significant difference in house temperature ($P \leq 0.05$); * denotes significant difference in mortality rate ($P \leq 0.05$) between the EcoCal and control dietary regimens.