Effects of Cage Stocking Density on Feeding Behaviors of Group-Housed Laying Hens

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Summary and Implications

Cage stocking density for laying hens has been one of the animal welfare issues that face the egg industry. This study investigated the effects of cage stocking density of 54, 60, 66, or 72 in^2 per hen on the feeding behavior of group-housed laying hens. The results revealed no significant difference in daily feeding behaviors of the hens subjected to the stocking density at thermoneutral conditions.

Introduction

Animal welfare debate has spawned governmental actions in Europe, and the issue has been brought to the fore in the US by recent welfare standards adopted by private companies such as McDonald's. International pressures have also increased US interest in these issues. The welfare guidelines established in 2000 by United Egg Producers and McDonald's made a significant impact on the housing and husbandry of laying hens. The UEP guidelines call for cage space increase from the US industry standard of 348 cm^2 (54 in^2) per bird to a range from 432 to 490 cm^2 (67 to 76 in^2). McDonald's Recommended Welfare Practices call for 465 cm^2 (72 in^2) of floor space per bird.

Cage floor space requirements for layers have been researched often in the past, but measuring animal welfare is a challenge. So how do we measure animal welfare as it relates to the stocking density of caged layers in a truly scientific manner? One indicator of potential stress or welfare in poultry is feeding behavior. Continuous, automated measurement of feeding behavior has proven to be a useful tool for differentiating and quantifying impacts of different environments or management practices on poultry while also proving to be less time consuming, tedious, costly, and error-prone than direct human observation or video analysis. Using this method allows an objective, quantitative, and non-invasive means to measure an indicator of animal welfare.

The objective of this study was to investigate the effect of cage stocking density of 54, 60, 66, or 72 in^2/hen on feeding behavior of group-housed laying hens.

Materials and Methods

Equipment and Set-up

This study was conducted in environmentally controlled testing rooms (23 deg C or 73 deg F, 51% ± 5% RH) at the Livestock Environment and Animal Physiology (LEAP) Lab II of Iowa State University (fig. 1). The testing room held four cages with a stocking density of 348 cm^2 (54 in^2) per bird (SD54), 387 cm^2 (60 in^2) per bird (SD60), 426 cm^2 (66 in^2) per bird (SD66), or 465 cm^2 (72 in^2) per bird (SD72). The cages had the same depth of 46 cm (18 in) and the same height of 40.6 cm (16 in). The difference among the cages was the width, being 46, 51, 56, and 61 cm (18, 20, 22, 24 in), respectively, for the SD54, SD60, SD66, and SD72 cages. This variation in width caused the feeder space to vary between cages at 7.6, 8.4, 9.4, and 10.2 cm (3, 3.3, 3.7, and 4 in) per hen for the SD54, SD60, SD66, SD72 cages, respectively.

Each cage held six hens and was equipped with two nipple drinkers and a feed trough spanning the front width of the cage. Each feed trough rested across two electronic balances (2200 ± 0.1 g) placed in front of the cage and was secured with Velcro strips. The balances had automatic response adjustment to compensate for vibration and drafts, and had an analog output of 0-2.2 VDC corresponding to the weighing capacity. The eight balances were connected to an electronic data logger.

Six access openings were available for feeding across the front of each cage, and each of these was equipped with an infrared (IR) sensor pair to detect the presence of a hen eating through a particular opening. These sensor pairs allowed the recording of the number of hens feeding at any given time. These sensor pairs consisted of an IR light emitting diode (LED) below the opening and an IR phototransistor above the opening. The 24 pairs of IR sensors were connected to the datalogger via a 32-channel multiplexer to record the output between 0-2.5 VDC. Both balance data and IR sensor data were recorded every two seconds. The data were automatically downloaded to a PC every ten minutes via the datalogger's associated software, and the files were retrieved and saved once every 24 hours.

One video camera was mounted directly above each cage to monitor the feeding behavior for the purposes of bird monitoring outside the testing room and validating the data acquisition system and the computational algorithm. The images from the four cameras were recorded during the lighting hours using a time-lapse videocassette recorder and were viewable on a color monitor simultaneously using a quad-system.

Experimental Birds

The experimental birds (24 hens per replicate with four replicates) were W-36 white leghorn hens between 32-40 weeks of age and approximately 1.5 kg (3.3 lbs.) in body weight at procurement. These birds had been housed at 348 cm^2 (54 in^2) per bird on the farm. The hens were housed in the testing room for 11-13 days, with the first 3 to 7 days being an acclimation period. The hens were checked and eggs were collected once per day during data collection. Feed troughs were refilled every other day with the same commercial diet the hens had been fed at the farm. Four days of stabilized feeding behavior data were analyzed from each replicate.

Analysis of Feeding Characteristics

Feeding behaviors of the laying hens and the effects of stocking density were evaluated by an analysis algorithm that was developed by adaptation from previous protocol used at ISU. The characterized feeding behaviors included average daily feed intake per hen, daily time spent feeding in hen-hours per cage and average hours per hen, number of meals per day, meal size, meal duration, ingestion rate, average number of hens feeding per meal, distribution of simultaneous feeding activity, and diurnal feeding patterns. To obtain these values, the start and end time of each feeding event had to be determined as well as the recorded feeder weights at these moments. The feed trough of each cage was spanned over two balances and the sum of balances' recorded values yielded the total feeder weight. The IR sensor signals were used to determine the presence of a hen feeding at a particular feeder opening. A high signal indicated the presence of a hen, with a high signal defined as any reading within 5% of the maximum reading for a particular sensor on a given day. Based on review of the video recordings, a hen fully obstructed the IR sensors to reach the feed trough, giving a full high reading during feeding. The readings that were in-between a full high or low signal seemed to be a result of partial obstruction of the sensors during other activities, such as a hen entering or exiting a feeder opening, tail feathers protruding from the opening when a hen turns around, etc.

Based on a trial-and-error optimization, a threshold change of 2 grams in feeder weight between two adjacent stabilized series of readings was chosen to represent a true feeding event, allowing one gram of variation in the signal from each balance during a period of no feeding activity. This resulted in the feed intake values as determined from the algorithm being 96.4% or better of the values obtained from the feeder weights at the beginning and ending of day. A time span of at least 16 seconds (8 readings) in which the feeder weight remained stable (<2 g in feeder weight change) was used to define the breaks between feeding events. Due to the absence of feeding activity during the dark hours of the day, the data from the dark period were excluded from the analysis of the feeding characteristics. All of the analyses were conducted on the pooled data from all four groups of birds with the exception of the SD54 cage. The loss of one bird in the SD54 cage during the first trial caused the change in stocking density and group size; thus, these data points were excluded from the analysis.

Results and Discussion

The feeding characteristics of the hens are summarized in Table 1, where the mean values and standard error are shown for each stocking density. The p-value shown corresponds to a "mixed procedure" analysis using SAS that included factors for the fixed effect of stocking density and the random effects of trial and day of data collection within each trial. A p-value of 0.05 or less would indicate a significant difference between the stocking densities for a parameter. From the data shown, it can be concluded that no significant differences exist between the stocking densities for any of the feeding behavior parameters recorded during these four trials.

Diurnal feeding patterns are shown in Figure 2. These points represent the percent of each hour spent feeding by a particular cage of hens throughout a 24-hour period, and were averaged over all days of data collection. Simultaneous feeding behavior data are shown in Figure 3 as the percentage of total feeding time that different numbers of birds were present at the feeder for each cage. The simultaneous feeding behavior is shown on a percentage basis rather than a frequency basis for comparison purposes since the SD54 cage is based on data from the last three trials only. This information is useful to determine whether more birds tend to eat simultaneously if space at the feeder is available. Inability to feed with the rest of the group due to lack of space at the feeder could be a stressor for the hens.

Conclusion

This experiment investigated the effects of cage stocking density on the feeding behavior of group-housed laying hens. The data revealed that daily feeding behaviors of hens subjected to stocking density of 54, 60, 66, or 72 in^2 per hen were not significantly different. Hence, from the standpoint of feeding behavior as an animal welfare indicator, the stocking densities examined in this study did not compromise the hens' welfare under thermoneutral conditions.

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Table 1. Feeding characteristics of laying hens subjected to cage stocking density of 54, 60, 66 or 72 in^2/hen

Feeding Characteristic	SD54		SD60		SD66		SD72		P-value
	Mean	***SE***	***Mean***	***SE***	***Mean***	***SE***	***Mean***	***SE***	
Daily feed intake per hen (g)	100	4	97	4	98	4	101	4	0.37
Daily hen-hrs spent feeding per cage	23.96	2.75	17.84	2.39	22.00	2.39	18.82	2.39	0.32
Average daily feeding time per hen (hours/hen-day)	4.00	0.46	2.97	0.40	3.67	0.40	3.14	0.40	0.32
Number of meals per day per cage	144	22	181	22	170	22	117	22	0.18
Average meal size (g/meal-hen)	1.9	0.4	1.9	0.3	1.6	0.3	2.6	0.3	0.09
Average meal duration (seconds/meal)	258	43	174	39	198	39	220	39	0.40
Average ingestion rate (g/min-hen)	0.47	0.08	0.63	0.07	0.50	0.07	0.77	0.07	0.06
Average number of hens feeding per meal	2.0	0.1	1.9	0.1	1.9	0.1	2.0	0.1	0.72

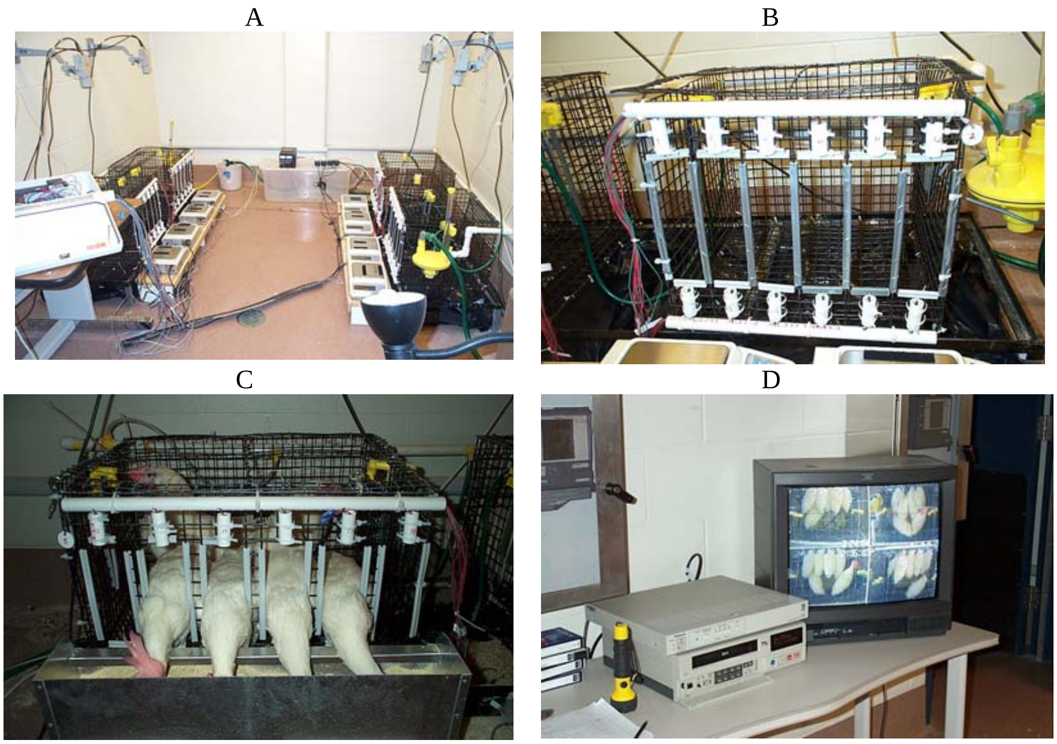

Figure 1. Photo views of the experimental setup: testing room (A); close-up view of feeder access openings with IR sensor pairs above and below each opening (B); hens feeding through instrumented feeder openings (C); video display and recording system (D).

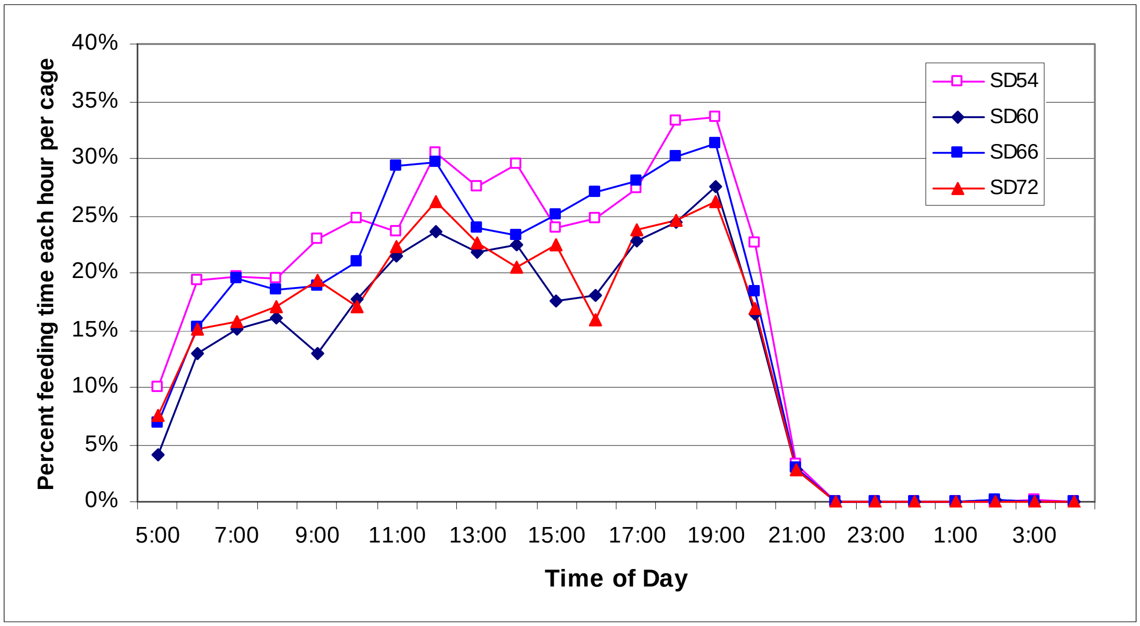

Figure 2. Diurnal feeding patterns of hens at four stocking densities (348, 387, 426, and 465 cm^2 per hen; 54, 60, 66, and 72 in^2 per hen). Chart displays average percent of time spent feeding in each hour. Based on averages from four days' feeding data from each group of 24 hens. Lighting schedule was 16h light (5:30AM-9:30PM) and 8h dark (9:30PM-5:30AM). Data for Group 1 SD54 omitted due to mortality.

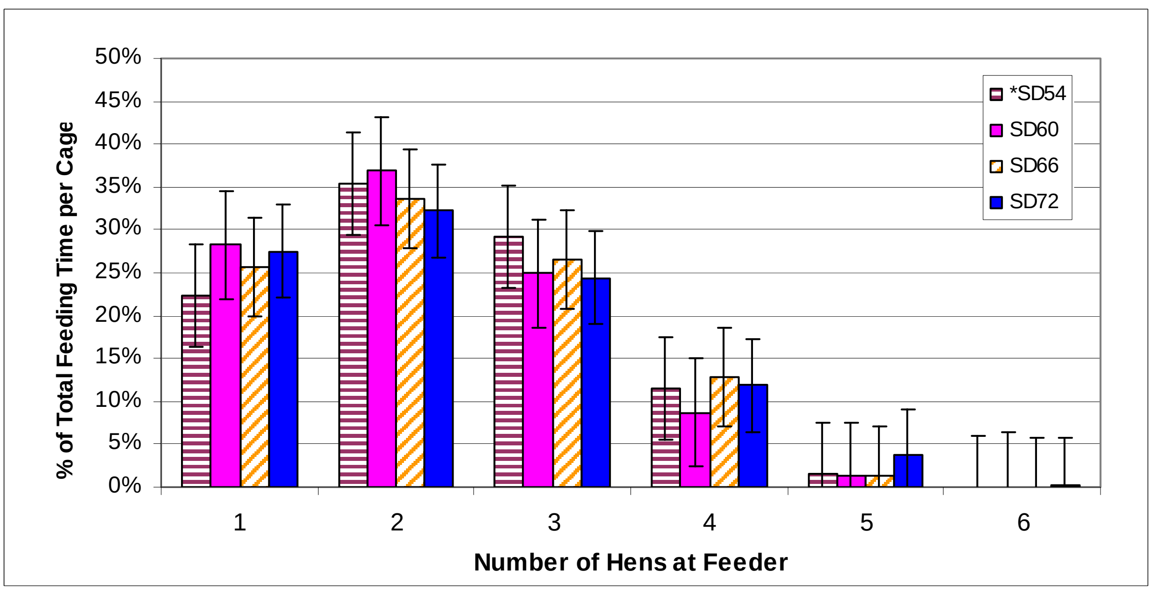

Figure 3. Distribution of simultaneous feeding behavior of hens under four stocking densities (348, 387, 426, and 465 cm^2 per hen; 54, 60, 66, and 72 in^2 per hen), expressed as the percentage of the total feeding time of the cage when a particular number of hens were at the feeder simultaneously. Standard error bars are indicated. Based on pooled data from four groups except Group 1 SD54 cage data omitted due to mortality.