INTRODUCTION

Beak trimming is a common practice in the egg industry to reduce injury, pain, and stress associated with feather pecking and aggression among birds. The practice of beak trimming, however, has come under great scrutiny from animal welfare advocates and the public for being a source of stress and pain to the trimmed birds. Traditionally, beak trimming has been performed by the hot blade (HB) method. The conventional HB technique is usually performed within the first 10 d of life and uses a guillotine-style blade heated to upwards of 750°C that cuts and cauterizes the beak tissue simultaneously (Jendral and Robinson, 2004). Although some automated HB systems exist, the traditional method is still commonly performed by hand. Trained personnel place the chick’s beak through a hole in a safety guard. The superheated blade on the other side of the safety guard is then used to trim the beak tip. In this procedure, the skill and consistency of personnel is a major factor in the efficacy and variability of treatment. More recently, an automated infrared beak treatment system has been developed (Nova-Tech Engineering Inc., Willmar, MN). The procedure is performed at the hatchery. Chicks are placed in holders that secure the beak through a short sheath with guard plates protecting all but the beak tip, while mechanical fingers hold the head still. A short burst from an infrared lamp is focused onto the beak tip. The treated beak tip will slowly soften and erode away within 2 wk. Infrared beak treatment (IR) provides many seemingly beneficial aspects, which suggest that this may provide a more welfare-friendly means of beak trimming. Some benefits of the IR are 1) birds can be trimmed at the hatchery simultaneously with vaccinations, reducing the catching and handling stress and the age at which birds will be trimmed, 2) the automation provides less...
room for human error, rough handling, or variability of results. 3) in IR trimming, the beak tip slowly erodes away, giving the bird an adjustment phase in which to alter behaviors such as feeding, and 4) the elimination of open wounds that contribute to bleeding, inflammation, and pain. Previous analysis of IR- and HB-trimmed birds showed that HB birds spent more time eating but weighed less than IR-trimmed birds, suggesting a reduction in feeding efficiency in HB birds (Dennis and Cheng, 2010a). However, in an earlier study in our lab, we found no differences in eating or drinking behaviors (Dennis et al., 2009). The present study was designed to determine if differences in IR protocols could have different effects on behavior as well as physiology.

The infrared beak-trimming process is flexible with interchangeable guard plates and adjustable infrared intensity settings that can allow for the use of multiple protocols. However, the effects of individual protocols on bird health has not been studied. The objective of the study was to examine the long-term effects of different IR protocols on bird productivity and well-being through investigation of growth rate, morphology, and regrowth of beak stumps, feather condition, feed waste, and behavior. To develop an optimized IR protocol, in the present study, we used 2 guard plates: 25 or 27 mm length × 23 mm height (25/23C or 27/23C). Each guard plate was used at 3 different infrared lamp intensity settings: high (52), moderate (48), and low (44). This design provided 6 IR protocols, each tested against one another and against the conventional HB protocol, performed at 7 d of age.

MATERIALS AND METHODS

Experimental Design

Eight hundred forty W-36 white laying chicks were beak-trimmed by either HB or one of 6 IR methods (described below in Beak Trimming Treatment section; 120 chicks in each of 7 total beak-trimming treatments). As per the industry standard, IR methods were performed on d 1 of age at the hatchery, whereas HB-treated birds were trimmed on d 7 of age at the grower facility.

Chicks were moved directly from the hatchery to an industry growing facility in Indiana. Chicks were maintained in 10 cages per treatment of 12 chicks per cage. Two chicks per cage were selected at random and tagged with numbered wing bands for individual identification. The 20 wing-banded focal birds were used throughout the study for repeated measures analysis over time.

At 16 wk of age, birds were transported to a laying facility in Indiana. Chicks were redistributed at a density of 5 birds per cage. Ten cages per treatment were used (a total of 50 birds per treatment), consisting of 2 wing-banded focal birds (a total of 20 focal birds per treatment) and 3 unmarked birds all of the same treatment and from the same grower cage. Remaining unmarked birds were maintained at the layer facility in separate cages but were no longer used on the present study.

The wing-banded focal birds were used to take beak length, BW, and feather score measures at 5, 10, 20, and 30 wk of age. Behavioral measures and feed waste were taken at the cage level from the 10 cages per treatment. Due to the design of the feeders in the grower cages, feed waste measures were not possible at 5 and 10 wk of age.

Layer Room

Each layer cage had a dimension of 40.64 × 50.80 cm to give a cage density of 412.90 cm² per bird. Cages were wire bottom and were arranged in tiers 5 cages high and each cage row was 136.54 m. The layer room had a total of 30,150 cages with a potential capacity of 150,750 hens. Using automated trough-style feeders and nipple drinkers, feed and water were provided ad libitum. Overhead lights were on daily from 0400 until 2000 h (16L:8D).

All procedures were approved by Purdue Animal Care and Use Committee (PACUC protocol number 00–008–09).

Beak-Trimming Treatments

Hot blade beak trimming was conducted on the farm when the birds were 7 to 10 d old by a trained team. Infrared beak treatment was performed at the hatchery (Centurion Poultry MidAmerica Hatchery, WI) using equipment developed by Nova-Tech Engineering (MN). Infrared trimming was performed by an automated system. First, the chick’s beak is placed through a hole with guard plates protecting the portion of the beak not to be trimmed. The chick’s head is then held into place by mechanical fingers, while the tip of the beak (portion not protected by the guard plate) is exposed to infrared light. Infrared trimming treatments were arranged in a 2 × 3 factorial design, using 2 guard-plate treatments, 25/23C (more severe) and 27/23C (less severe), and 3 energy settings, 44 (low), 48 (medium), and 52 (high).

BW and Feather Score

Body weights were collected from the 20 focal birds per treatment when they were 5, 10, 20, and 30 wk of age. Feather scoring was used to assess the quality of feather coverage of each chicken at 20 and 30 wk of age. Feathers were scored on a 0-to-5 scale, with the best score at 0 and the worst score at 5 (Table 1; 0 = full feathering and 5 = large bare spots; Dennis et al., 2009). Seven body regions were assessed and an average of these was taken as the total average feather score for
each bird. Feather score data collection was conducted by the same trained person to eliminate interobserver variations.

**Test Feather**

Feather scoring is not an effective measure for young birds because incoming adult feathers can obscure results. Therefore, at 5 and 10 wk of age, a test feather was tied to the front of the cage for 2 h. Scan sample observations were performed every 3 min for a 60-min period to determine the number of birds pecking at the feather. Following the 2-h period, a damage score was determined for each feather (0–5; 0 = smooth and seemingly untouched feather, 1 = ruffled barbs, 2 = small bare spots, 3 = large bare spots, 4 = almost completely bare, and 5 = completely stripped with broken rachis).

**Beak Morphology**

A digital image of each beak was recorded using the same method and equipment outlined by Marchant-Forde et al. (2008). Briefly, images of each beak were captured with a 5.1 megapixel Nikon digital camera (Nikon Inc., Melville, NY). Beak dimensions were determined using MCID Imaging Software (V4.0, Imaging Research Inc., Ontario, Canada) to examine length of the upper and lower mandibles at several points along the mandibles. To achieve this, images were imported into MCID before being individually calibrated (number of pixel per horizontal and vertical centimeter) using a background reference scale incorporated into each image.

**Feed Waste**

At 20 and 30 wk of age, feed waste was measured from 10 cages per treatment over a 4-h period to avoid any interference with daily operations. For this test, the production trough feeder was covered and an individual trough feeder was presented to each test cage containing 120 g of feed (approximately 1/3 full). A tray was affixed under each cage to collect waste. Following a 4-h feeding period, the trough feeders and waste trays were removed and the remaining feed in both the trough feeders and waste trays was weighed following the removal of any foreign or fecal matter.

**Behavior Data**

Direct scan sample observations were taken of number of birds eating, drinking, and walking for every 3 min for an hour (a total of 20 scan samples). Numbers were converted into percentage of the total number of birds per cage to correct for variations in number of birds per cage at a given time. Therefore, figures are represented as the mean of the percent of the total number of birds eating, drinking, or walking at each time point.

**Statistical Analysis**

Statistical analysis was performed using SAS v9.1 software (SAS Institute Inc., Cary, NC). All data were checked for normality with the aid of histograms, Q-Q plots, and formal statistical tests with the UNIVARIATE procedure, including Shapiro-Wilk and Kolmogorov-Smirnov tests. Body weight and upper and lower beak length data were normally distributed.

Behavior and Feather Score Data. Behavior data exhibited a nonnormal distribution; therefore, data was log-transformed for analysis for the fixed effect of beak treatment by ANOVA using proc MIXED. Original untransformed means are shown in tables and figures. Feather score data were ranked and then analyzed using a mixed model. The data were analyzed by ANOVA using the MIXED procedure of SAS.

**BW and Beak Length Data.** Birds were tagged with numbered wing bands for identification. Tagged birds were weighed and the upper and lower beak length was measured and analyzed using repeated measures with bird ID as the subject. Repeated measures was used to compare overall growth curves over the 25-wk period (from 5 to 30 wk of age).

Main effects of beak trim method (HB and IR treatments) and age of birds as well as the interactions were considered for the repeated measures analyses. Additional factors such as area of the room (front, middle, and back) and row (top or bottom) were also analyzed.

Table 1. Upper beak length at 5, 10, 20, and 30 wk of age following 7 different beak-trimming protocols (n = 20; F = 5.59; P < 0.0001)\(^1\)

<table>
<thead>
<tr>
<th>Beak trim protocol</th>
<th>5 wk</th>
<th>10 wk</th>
<th>20 wk</th>
<th>30 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot blade abc</td>
<td>1.09 (0.03)(^a)</td>
<td>1.59 (0.03)abc</td>
<td>1.74 (0.04)(^a)</td>
<td>1.74 (0.04)(^ab)</td>
</tr>
<tr>
<td>Infrared 27/23C</td>
<td>1.21 (0.03)(^a)</td>
<td>1.61 (0.03)bc</td>
<td>1.80 (0.03)(^a)</td>
<td>1.86 (0.03)(^b)</td>
</tr>
<tr>
<td>44(^d)</td>
<td>1.21 (0.03)(^a)</td>
<td>1.63 (0.03)c</td>
<td>1.77 (0.03)(^a)</td>
<td>1.78 (0.04)(^ab)</td>
</tr>
<tr>
<td>52(^bcd)</td>
<td>1.19 (0.03)(^a)</td>
<td>1.54 (0.03)abc</td>
<td>1.76 (0.04)(^a)</td>
<td>1.78 (0.04)(^ab)</td>
</tr>
<tr>
<td>25/23C</td>
<td>1.12 (0.03)(^a)</td>
<td>1.51 (0.03)abc</td>
<td>1.72 (0.04)(^a)</td>
<td>1.73 (0.04)(^ab)</td>
</tr>
<tr>
<td>48(^a)</td>
<td>1.10 (0.03)(^a)</td>
<td>1.48 (0.03)ab</td>
<td>1.71 (0.03)(^a)</td>
<td>1.73 (0.03)(^ab)</td>
</tr>
<tr>
<td>52(^a)</td>
<td>1.09 (0.03)(^a)</td>
<td>1.48 (0.03)(^a)</td>
<td>1.69 (0.04)(^a)</td>
<td>1.67 (0.04)(^a)</td>
</tr>
</tbody>
</table>

\(^a\)–\(^d\)Means within a column are significantly different (P < 0.05). Superscripts in the “Beak trim protocol” column denote differences between treatments over all time periods as determined in a repeated measures analysis.

\(^1\)Results displayed as least squares means (SEM). 27/23C and 25/23C = guard plates at 27 or 25 × 23 mm height, respectively.
to account for the effect of microenvironment within the house; no significant effect or interaction of microenvironmet was found. Interactions with to account for the effect of microenvironment within the house; no significant effect or interaction of microenvironment was found. Interactions with P-values greater than 0.50 were removed from the model.

RESULTS AND DISCUSSION

Beak regrowth measures followed a predictable growth curve based on guard-plate length and energy setting. Birds trimmed using the shorter plate (25/23C) had shorter upper and lower beaks compared with those trimmed with the longer (27/23C) plate, as more beak tissue was exposed to the infrared energy (P < 0.001; Tables 1 and 2). The greater the energy level used, the shorter the upper, and generally, lower beak length. However, a difference in BW based on beak-trimming protocol was unexpected (P < 0.001; Table 3). Although differences in BW were rarely significant at each given sample time, repeated measures analysis of body BW showed differences across all time periods. Previous studies have shown alterations in feeding behavior and BW of trimmed birds (Gentle, 1986; Hester and Shea-Moore, 2003). These differences are generally no longer detectable by sexual maturity (Cunningham, 1999). Hens trimmed with 27/23 (48) had the greatest BW overall, whereas hens of 25/23 (44) protocol had the lowest. Reductions in BW have been suggested to be associated with the pain of beak trimming and changes in the beak morphology that alter the bird’s ability to perform natural feeding behaviors (Gentle et al., 1982). Previous studies of pain and HB trimming suggest that beak trimming-associated pain is more common at young ages (Jendral and Robinson, 2004). Therefore, the effect of BW is most likely due, at least in part, to changes in beak morphology. Our data suggest that infrared trimming protocols can be optimized for longer beak length and improved BW compared with conventionally trimmed hens.

The frequency of feeding behaviors did not differ between beak-trimming treatments for any age observed in the present study (P = 0.78). However, our analysis of feed waste noted that hens trimmed with both plates using the moderate energy setting (48) and the 25/23 (52) protocol tended to waste less feed compared with HB hens (P = 0.089; Figure 1). Using only two 4-h periods (4 h at both 20 and 30 wk of age) to collect feed waste data resulted in a high degree of variability, ultimately reducing our power to determine significant differences between the beak-trimming protocols. However, it did give us an initial view of how feeding efficiency might change through differences in feed wastage based on beak-trimming protocols. These data suggest that energy level used for IR trimming may be a more important factor when considering feed waste than plate length. However, our data also show the need for further study into the effects of different beak-trimming protocols on feed waste.

Reduction in overall activity level has been seen in trimmed birds and is suggested to be an indicator of their reduced overall well-being (Hughes and Gentle, 1982).

Table 2. Lower beak length at 5, 10, 20, and 30 wk of age following 7 different beak-trimming protocols (n = 20; F = 9.64; P < 0.0001)\(^1\)

<table>
<thead>
<tr>
<th>Beak trim protocol</th>
<th>5 wk</th>
<th>10 wk</th>
<th>20 wk</th>
<th>30 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot blade(^a)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27/23C</td>
<td>0.66 (0.03)(^{bc})</td>
<td>0.72 (0.03)(^{b})</td>
<td>0.73 (0.03)(^{b})</td>
<td>0.73 (0.03)(^{b})</td>
</tr>
<tr>
<td>48</td>
<td>0.65 (0.03)(^{ab})</td>
<td>0.96 (0.03)(^{ab})</td>
<td>0.96 (0.03)(^{ab})</td>
<td>0.90 (0.03)(^{a})</td>
</tr>
<tr>
<td>52</td>
<td>0.57 (0.03)(^{a})</td>
<td>0.96 (0.03)(^{ab})</td>
<td>1.03 (0.04)(^{a})</td>
<td>1.01 (0.04)(^{a})</td>
</tr>
<tr>
<td>25/23C</td>
<td>0.57 (0.03)(^{a})</td>
<td>0.84 (0.02)(^{a})</td>
<td>1.11 (0.04)(^{a})</td>
<td>1.19 (0.04)(^{a})</td>
</tr>
</tbody>
</table>

\(^{a}\)Means within a column are significantly different (P < 0.05). Superscripts in the “Beak trim protocol” column denote differences between treatments over all time periods as determined in a repeated measures analysis.

\(^{b}\)Results displayed as least squares means (SEM). 27/23C and 25/23C = guard plates at 27 or 25 × 23 mm height, respectively.

Table 3. Body weight at 5, 10, 20, and 30 wk of age following 7 different beak-trimming protocols (n = 20; F = 3.98; P < 0.001)\(^1\)

<table>
<thead>
<tr>
<th>Beak trim protocol</th>
<th>5 wk</th>
<th>10 wk</th>
<th>20 wk</th>
<th>30 wk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot blade(^b)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>27/23C</td>
<td>0.34 (0.02)(^{a})</td>
<td>0.83 (0.02)(^{a})</td>
<td>1.56 (0.02)(^{ab})</td>
<td>1.62 (0.02)(^{a})</td>
</tr>
<tr>
<td>48</td>
<td>0.35 (0.02)(^{a})</td>
<td>0.86 (0.02)(^{a})</td>
<td>1.16 (0.02)(^{a})</td>
<td>1.08 (0.02)(^{a})</td>
</tr>
<tr>
<td>52</td>
<td>0.35 (0.02)(^{a})</td>
<td>0.85 (0.02)(^{a})</td>
<td>1.55 (0.03)(^{b})</td>
<td>1.65 (0.03)(^{a})</td>
</tr>
<tr>
<td>25/23C</td>
<td>0.34 (0.02)(^{a})</td>
<td>0.81 (0.02)(^{a})</td>
<td>1.46 (0.03)(^{b})</td>
<td>1.58 (0.03)(^{a})</td>
</tr>
</tbody>
</table>

\(^{a,b}\)Means within column are significantly different (P < 0.05). Superscripts in the “Beak trim protocol” column denote differences between treatments over all time periods as determined in a repeated measures analysis.

\(^{1}\)Results displayed as least squares means (SEM). 27/23C and 25/23C = guard plates at 27 or 25 × 23 mm height, respectively.
Previous studies have suggested that increased activity levels or time spent walking is an indicator of superior well-being (Bizeray et al., 2002; Pohle and Cheng, 2009). Lower activity levels can be a sign of pain or discomfort in mammals and birds, including pain associated with beak trimming (Marchant-Forde et al., 2008; Marchant-Forde and Cheng, 2010). In the present study, we observed the amount of walking performed by these birds as indicators of activity level. An increase in walking at 5 wk of age was evident in birds of 27/23°C (less severe) protocols ($P < 0.049$; Figure 2) compared with traditional HB trimming or birds trimmed with 25/23°C (more severe). However, from 10 to 30 wk of age, there were no longer discernible differences in walking behavior between the beak-trim treatments ($P > 0.97$). This finding is in agreement with previous studies that found reduced activity due to HB trimming in early life but no difference in activity at later time periods following beak trimming (Hughes and Gentle, 1995). These findings suggest the potential for some short-term pain that persists to 5 wk of age but is reduced in 27/23°C (less severe)-treated birds.

Drinking, as a distinct behavior, is expected to be altered by beak trimming separately from eating behaviors (Kuenzel, 2007). Birds in the present study were provided with nipple drinkers that they must peck to drink; therefore, beak pain or discomfort may cause a change in motivation to drink. Here we saw a distinct pattern of drinking behavior at 5 wk (Figure 3). Frequency of drinking increased with decreasing infrared energy and with increased guard-plate length. Hot blade birds were observed drinking less often than birds of 27/23°C protocols or 25/23°C (44) ($P < 0.042$). This pattern suggests an increase in pain at the beak tip with increased energy usage. The HB birds spent significantly less time drinking than birds in 4 of the IR treatments, suggesting that the use of an optimized IR protocol can improve the motivation to drink compared with the current conventional beak-trimming method. The reduction in drinking behavior seen in HB birds is no longer evident by 10 wk of age. This is similar to results from previous studies that have noted differences in feeding and pecking behaviors at a young age, which disappear before sexual maturity (Cunningham, 1992). A reduction in drinking is still noticeable at 10 wk of age.
age in birds trimmed with 25/23C (more severe) plates with 48 and 52 energy settings ($P < 0.034$). This may suggest a prolonged period of pain or discomfort from these protocols.

The primary function of beak trimming is to reduce the potential for injury or cannibalism as a result of pecking. Feather pecking and aggressive pecking behaviors, in untrimmed flocks, lead to a severe reduction in feathering, open wounds, and ultimately cannibalism. To investigate the effect of multiple beak-trimming protocols on their potential to prevent damage, the birds were feather-scored (0–5; Dennis et al., 2009) at 20 and 30 wk of age. Feather scores in body regions associated with feather-pecking damage (tail, abdomen, head, and neck) were not different between these treatments ($P = 0.98$). All protocols of IR used in this study perform as well as the traditional HB method at reducing the damage caused by feather pecking and aggressive pecking. At 30 wk, breast feather scores were reduced in hens trimmed with 27/23C (less severe) protocols ($P < 0.05$).

![Figure 4](image_url)

**Figure 4.** Percent of birds per cage pecking at a “test” feather 5 wk of age from 7 beak-trimming protocols, including 6 infrared protocols (27/23C guard plate with energy settings of 44, 48, and 52, and 25/23C guard plate with energy settings of 44, 48, and 52) and traditional hot blade (HB) beak trimming ($n = 10$; $F = 2.30$; $P < 0.037$) presented as least squares means ± SEM. *Significantly different from HB ($P < 0.05$).

![Figure 5](image_url)

**Figure 5.** The damage score (0–5) for the “test” feather from 7 beak-trimming protocols, including 6 infrared protocols (27/23C guard plate with energy settings of 44, 48, and 52) and traditional hot blade (HB) beak trimming ($n = 10$; $F = 2.12$; $P < 0.047$) presented as least squares means ± SEM. *Significantly different from HB ($P < 0.05$). †Different from HB ($P < 0.10$).

<table>
<thead>
<tr>
<th>Wk</th>
<th>Trim protocol</th>
<th>Head</th>
<th>Neck</th>
<th>Abdomen</th>
<th>Breast</th>
<th>Back</th>
<th>Wing</th>
<th>Tail</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Hot blade</td>
<td>0.40 (0.11)</td>
<td>0.50 (0.15)</td>
<td>0.10 (0.06)</td>
<td>2.00 (0.18)</td>
<td>0.90 (0.09)</td>
<td>1.1 (0.11)</td>
<td>1.60 (0.17)</td>
</tr>
<tr>
<td></td>
<td>Infrared 27/23C</td>
<td>0.06 (0.09)</td>
<td>0.50 (0.12)</td>
<td>0.06 (0.05)</td>
<td>1.56 (0.14)</td>
<td>0.94 (0.07)</td>
<td>0.88 (0.08)</td>
<td>1.31 (0.13)</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>0.06 (0.09)</td>
<td>0.75 (0.12)</td>
<td>0.00 (0.05)</td>
<td>1.44 (0.14)</td>
<td>0.81 (0.07)</td>
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<td></td>
<td>48</td>
<td>0.07 (0.09)</td>
<td>0.73 (0.12)</td>
<td>0.00 (0.05)</td>
<td>1.53 (0.15)</td>
<td>0.93 (0.08)</td>
<td>1.07 (0.09)</td>
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<td>1.81 (0.14)</td>
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<td>48</td>
<td>0.27 (0.09)</td>
<td>0.80 (0.12)</td>
<td>0.13 (0.05)</td>
<td>1.93 (0.15)</td>
<td>1.00 (0.08)</td>
<td>1.20 (0.09)</td>
<td>1.80 (0.14)</td>
</tr>
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<td>30</td>
<td>Hot blade</td>
<td>0.45 (0.15)</td>
<td>0.82 (0.26)</td>
<td>1.82 (0.23)</td>
<td>2.09 (0.23)</td>
<td>0.91 (0.17)</td>
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<td>1.82 (0.13)</td>
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<tr>
<td></td>
<td>Infrared 27/23C</td>
<td>0.63 (0.13)</td>
<td>0.94 (0.22)</td>
<td>1.50 (0.19)</td>
<td>1.75 (0.19)</td>
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<td>1.13 (0.12)</td>
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<td>1.69 (0.21)</td>
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<td>1.23 (0.24)</td>
<td>1.85 (0.21)</td>
<td>2.23 (0.21)</td>
<td>1.00 (0.15)</td>
<td>1.23 (0.13)</td>
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</tr>
<tr>
<td></td>
<td>48</td>
<td>0.63 (0.13)</td>
<td>1.19 (0.22)</td>
<td>2.06 (0.19)</td>
<td>2.00 (0.19)</td>
<td>1.31 (0.14)</td>
<td>1.25 (0.12)</td>
<td>2.00 (0.11)</td>
</tr>
<tr>
<td></td>
<td>52</td>
<td>0.60 (0.13)</td>
<td>1.20 (0.22)</td>
<td>1.80 (0.20)</td>
<td>1.47 (0.20)</td>
<td>0.73 (0.14)</td>
<td>1.33 (0.12)</td>
<td>1.67 (0.11)</td>
</tr>
</tbody>
</table>

*abMeans within a column are significantly different ($P < 0.05$).
†Results displayed as least squares means (SEM). 27/23C and 25/23C = guard plates at 27 or 25 × 23 mm height, respectively.
< 0.0496; Table 4) and appeared to be reduced in hens trimmed with 25/23C (52) protocol. Feather damage in the breast is less often associated with feather pecking, as damage can often be done from the cage bars during feeding. Such damage could be a result of birds that spend more time engaging in behaviors that cause them to rub against the cage walls, including feeding, social behaviors with birds in adjacent cages, or preferentially lying against the cage walls.

Feather scoring is a useful measure in older birds; however, at younger ages, feather scores can be obscured by incoming adult feathers. For this reason, birds at 5 and 10 wk of age were presented with a test feather, which was affixed to the front of the cage for 2 h. Birds from 27/23C (44 and 48) were found to peck at the novel feather more frequently than birds from HB or other treatments (P < 0.037; Figure 4). However, the HB birds and IR birds treated with high energy did the greatest amount of damage to the feather in the time provided as measured by the damage score (P < 0.047; Figure 5). This suggests that trimming performed with HB or IR high energy alters the ability of these birds to perform fine manipulations with their beaks, possibly due to reduced sensitivity from the higher-energy trauma. Reduced sensitivity could be due to a reduction in sensory input from mechanoreceptors in the beak that were lost during trimming or by an alteration in the brain’s ability to map these sensory inputs across the altered beak surface. Reduced sensitivity, as seen in human patients following hand trauma, can alter the ability to perform fine motor manipulations (Svens and Rosen, 2009). Interference with fine motor skills of the birds could alter the feed efficiency (as seen in higher feed waste) as well as in their ability to perform natural grooming behaviors.

Our study provides evidence that guard-plate length and intensity of the infrared lamp can be adjusted to optimize beak length as well as production parameters and animal well-being. Animal well-being can be improved by reducing pain and preserving normal beak sensitivity and fine motor capabilities for the performance of more natural behaviors. However, recommendations of IR protocols may be made more precise by adapting them to the specific strain and size of chicks to be trimmed. For W-36 chicks used here, 27/23C (48) protocol optimizes both production-relevant parameters, such as BW and feed waste, while safeguarding against animal pain, discomfort, or the alteration of normal behaviors.

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**REFERENCES**


