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Case Report

Effective Strategies for Mitigating Feather Pecking and Cannibalism in Cage-Free W-36 Pullets

Ramesh Bahadur Bist, Sachin Subedi, Xiao Yang and Lilong Chai *

Department of Poultry Science, College of Agricultural and Environmental Sciences, University of Georgia, Athens, GA 30602, USA
* Correspondence: lchai@uga.edu

Abstract: Pecking is one of the most concerning poultry welfare issues in the layer houses, especially in the cage-free (CF) housing system. Pecking behavior may lead to severe feather pecking (SFP) and cannibalism when birds feel frustrated, stressed, and dominant over other birds. Since pecking is caused by multi-factorial problems (e.g., hormonal influence, environment, dietary composition, and genetic differences), it is very important to find optimal strategies for reducing pecking damage. The objective of this study was to evaluate the effects of pullet age and management practices on pecking behavior and to identify the optimal pecking mitigation strategy. Four climate-controlled rooms were used, each housing 200 Hy-Line W36 pullets, for a total of 800 pullets from 0 to 16 weeks of age (WOA). Pecking mitigation strategies were tested at different ages, including an isolated chamber (IC) at 14 WOA, an IC with lotion (water, aloe vera gel, tea tree oil, calendula, and methyl anthranilate), and a pecking block from 15 to 16 WOA. Data on severe feather pecking (SFP) and mortality were collected daily from 13 to 16 WOA during the pecking block, IC, and IC with lotion treatments and from 0 to 16 WOA for the entire pullet cycle of age treatment. Results show that the SFP significantly increased with the bird's age ($p < 0.01$). The SFP started with 5 WOA. About 16% of birds were found with severe peck damages by 16 WOA. In this study, pecking blocks did not show a reduction in pecking order, possibly due to pecking at alarming rates. Isolating birds with SFP damages into the IC and applying lotion resulted in a significant decrease in SFP ($p < 0.05$) and cannibalism ($p < 0.05$). This study provides a reference for commercial CF egg producers to develop on-farm management strategies for mitigating pecking damage and cannibalism.

Keywords: cage-free housing; animal welfare; feather pecking; cannibalism; management strategies

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1. Introduction

Feather pecking (FP) is a serious welfare issue in the poultry industry, associated with damage to the feathers, injury to body parts, and even death due to cannibalism [1–5]. Based on both the cause and its effects, FP is mainly categorized into five different types: (a) aggressive pecking (AP; pecking feathers aggressively but not necessarily resulting in injury or damage to the feather), (b) gentle FP (GFP; pecking the tips of feathers), (c) severe FP (SFP; forcefully and repeatedly pecking, pulling, and often removing feathers from other birds, causing skin damage or bleeding), (d) denuded area tissue pecking (DP), and (e) vent pecking (VP) [6,7]. The GFP is considered normal social behavior, while SFP may result in aggressive tissue pecking, leading to VP and cannibalism. The occurrence of SFP is mainly influenced by frustration [8] and stress in birds [4,9,10]. Thus, these behaviors have serious adverse effects on the health and welfare of the bird. In addition, pulling out feathers results in fewer feathers from birds causes economic losses for producers because birds with fewer feathers lose heat faster and require more feed consumption to stay warm [11]. In severe cases, pecking can lead to cannibalism, resulting in the victim bird's death [7,12].

Feather pecking is a multi-factorial problem and may be caused by four main factors: hormonal influence [13], environment [4,14], dietary composition [13], and genetic differences [14,15] (Figure 1). In addition, pecking behavior has been associated with the immune system, circadian rhythm, and foraging behavior [16]. Hughes and Duncan [1] found that pecking behavior (PB) was significantly influenced by light intensity, bird strain, and housing system, while group size and feed have a minor influence; however, brooding temperatures and population density did not significantly affect pecking damage. The GFP was approximately 20 times more frequent with a light intensity of 3 lux, while SFP was observed 2–3 times more frequently with a light intensity of 30 lux [17]. In addition, the pecking score was encountered significantly higher in the highest stocking density chicken [2,4,12,18,19]. Similarly, feather pecking differs according to the poultry housing system in which birds were raised. The prevalence of FP evaluation at various commercial scales found that the birds raised in a cage-free (CF) housing system have higher FP behaviors, between 40 and 80% [12]. The mortality rates due to pecking or cannibalism in different housing systems represented approximately one-third of all mortality rates, while the lowest mortality was found in the caged system compared to the CF housing system [12]. Therefore, the SFP needs to be stopped or reduced significantly to improve welfare and production by identifying the factor that causes SFP.

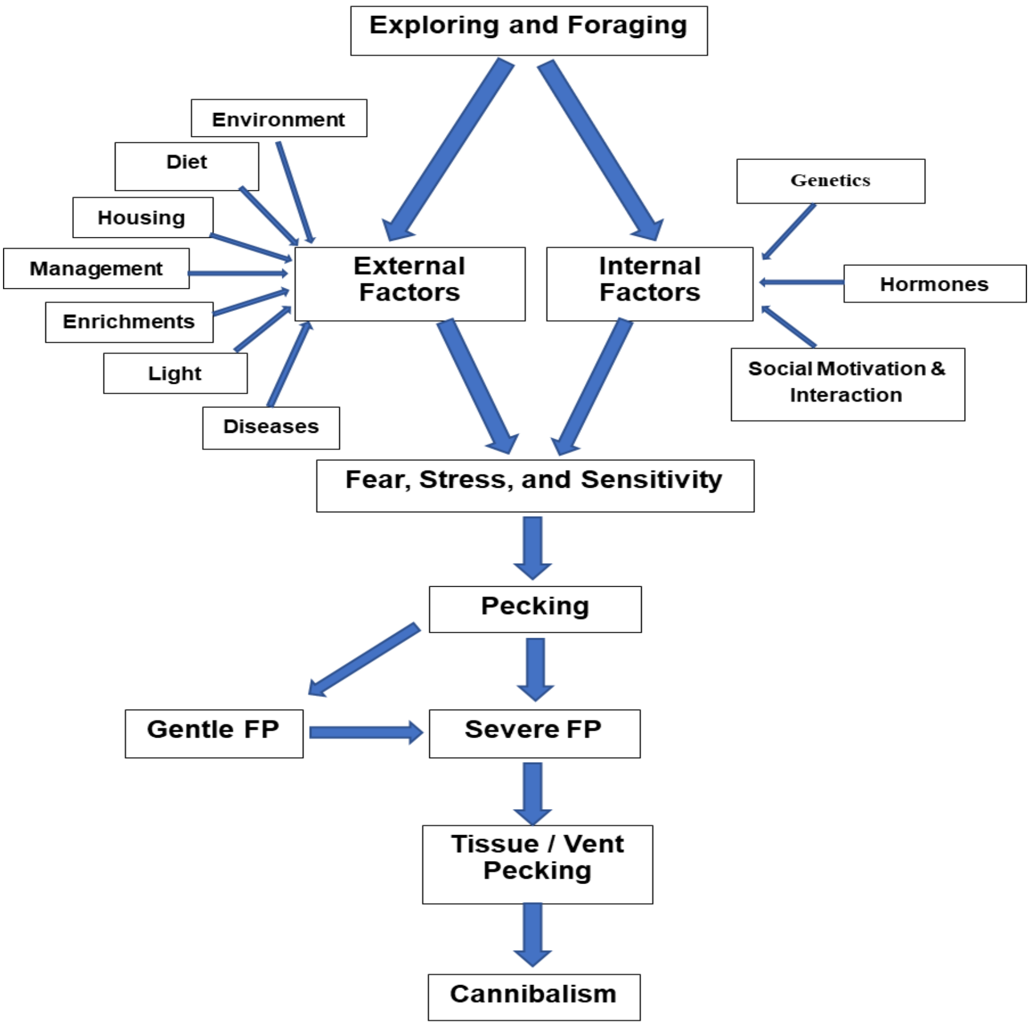

Figure 1. Multi-factorial factors affecting feather pecking and cannibalism.

To prevent pecking behavior in poultry, various measures were taken into consideration. These include providing enough space and ventilation in their living area [4,14], ensuring that they have access to clean water and a balanced diet [13], avoiding overcrowding [2,4,12], and implementing strategies to reduce stress [4,9,10]. These strategies can involve providing enrichment activities [20–22]. For example, a diet composed of pellets reveals a higher prevalence of SFP than a mashed-form diet [18,23]. Similarly, a dietary supplement with 20 g/kg of L-tryptophan found reduced FP compared to the control treatment (0 g/kg) [18]. According to Van Krimpen [24], FP was reduced by feeding high-fiber, roughage, and low-energy diets. In addition, the birds bred with suitable genotypes should be selected (minimal tendencies for FP) to reduce FP, especially in commercial housing systems [12]. Both now and in the past, laying hens' beaks are trimmed at 1 day of age to avoid SFP and negative consequences in poultry production. Beak trimming is widely used in the US to improve welfare and feather conditions by reducing pecking, feather pulling, cannibalism, fearfulness, nervousness, chronic stress, and mortality rates [25]. However, beak trimming also results in welfare concerns, including acute stress, pain (acute or chronic), reduced body weight, feed intake, and an impairment of beak-related behavior (feeding, drinking, preening, and pecking) due to the new beak shape and pain following beak trimming [11,25,26]. In addition, beak trimming can reduce FP and minimize resulting injuries but cannot remedy the cause. In Europe and the USA, beak trimming is currently highly criticized because of welfare issues and painful practices that occur while performing beak-related behaviors [27]. However, regular monitoring and intervention at the earliest sign of any issues can help prevent pecking behavior from becoming a serious problem.

Pecking behavior can be reduced or prevented through various mitigation measures. One effective approach is to ensure that birds have sufficient space to move around, explore, and engage in natural behaviors such as foraging [20]. Providing appropriate environmental enrichment, such as perches, nest boxes, and toys, can also help alleviate boredom [21,22] and reduce pecking [20]. Additionally, ensuring that birds have access to a nutritionally balanced diet and clean water can reduce the likelihood of aggressive pecking behavior [13]. Finally, monitoring the flock for signs of aggression or injury and promptly separating any birds that exhibit aggressive behavior can prevent the spread of pecking behavior. If pecking occurs inside the farm, taking immediate action and finding the factors affecting the pecking behavior is necessary. Quick action taken on time can save birds and help to maintain animal welfare inside the housing. This case study was also based on the immediate call to action to find the best management strategy to control FP and cannibalism. The objectives of this case study were to identify (i) the effects of a pullet's age on severe FP; (ii) the effect of introducing different mitigation strategies of pecking blocks, isolation cages, and body lotion on the prevention of FP; and (iii) the implementation of the best pecking mitigation management strategy.

2. Materials and Methods

2.1. Ethical Approval

The case study was conducted in four experimental CF floor-raised rooms at the University of Georgia (UGA). Before recording data, all the procedures were approved by UGA Institutional Animal Care and Use Committee (IACUC) (AUF#: A2020 08-014-A2).

2.2. Housing and Management

This case study was observed in four identical CF laying hen rooms (7.3 m L × 6.1 m W × 3.1 m H) at the University of Georgia Poultry Research Center (Athens, GA, USA). A total of 800 Hy-line W-36 pullets (non-beak-trimmed) were raised from 1 to 16 weeks of age (WOA) with a stocking density of 200 pullets per room (4.5 birds/m^2 or 5.4 kg/m^2). The stocking density of each bird was more than the recommended space of 0.12–0.14 m^2 $bird^{-1}$. The rationale behind the low stocking density was to promote animal welfare and natural behaviors by providing more space for each pullet. Another reason for using low stocking density was to potentially benefit future research on laying hens by requiring fewer hens for experimental designs. Furthermore, each room was provided with enrichment, such as an A-shaped perch (0.18 m $bird^{-1}$) and bedding material (pine shaving; depth 1 inch from concrete floor), from day one. In addition, this study provided 12.75 cm feeder space per pullet and one nipple per 10 pullets. The feed formulation was produced at the UGA feed mill based on the Hy-line W-36 commercial layer management guidelines (Hy-Line, 2020). Feeds provided during starter, grower, developer, and pre-lay were completely antibiotic-free diets.

The lighting system, room temperature, and ventilation rates were controlled and adjusted according to Hy-line W-36 commercial layer management guidelines with the help of the Chore-Tronics Model 8 controller (Chore-Time Group, Milford, IN, USA). As mentioned in previous research, the light system, temperature, and ventilation rates changed according to different pullet age stages [28,29]. The temperature and relative humidity data were recorded using an Onset HOBO CO_2 data logger (HOBO MX CO_2 Logger MX1102A, Bourne, MA, USA). Similarly, light intensity was checked using a light intensity meter (Dr. Meter, San Francisco, CA, USA), and the light intensity measured data was shown in Figure 2. Each room was equipped with two circulating fans (Vortex, Munter's Corporation, Mason, MI, USA) inside houses and two exhaust fans attached to the wall (8" small fan and 18" big fan; Vortex, Munter's Corporation, Mason, MI, USA). In addition, six cameras (Swann Company, Santa Fe Springs, CA, USA) were mounted in each room and recorded the birds' activities for 24 h daily during pullet rearing.

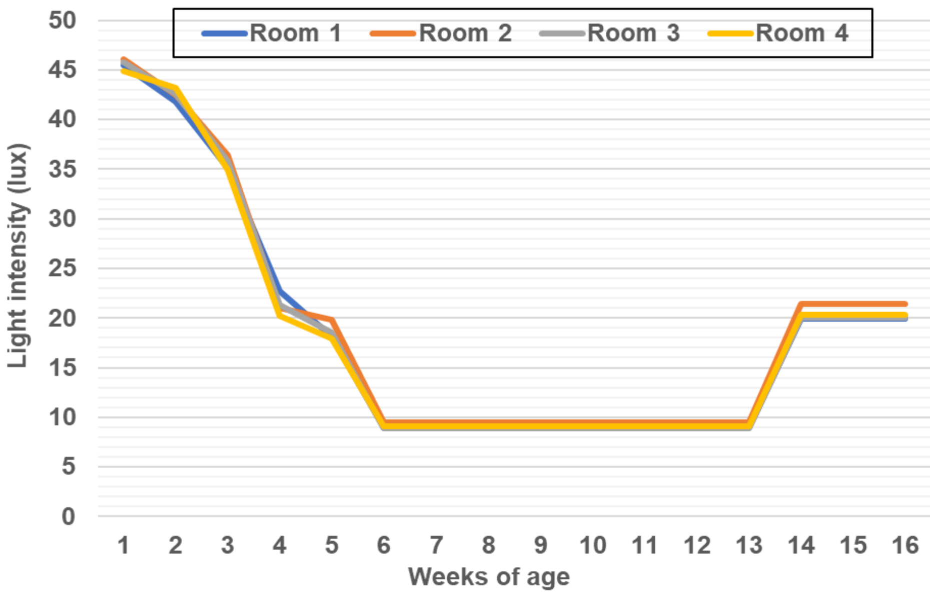

Figure 2. The light intensity in four CF floor-raised rooms during pullet rearing.

The study monitored the ammonia (NH3) levels in the center of four rooms where laying hens were kept from the time they hatched until they were 16 WOA. Ammonia level was measured with a device called the Drager DOL-53 NH_3 sensor (Dol-sensors A/S, Aarhus N, Denmark), which recorded the data every minute for 24 h a day with the help of Onset's HOBO RX3000 (Onset Computer Corporation, Bourne, MA, USA), and a Kitagawa NH_3 Sampling Pump (Kit AP-20, Kitagawa America LLC., Pompton Lakes, NJ, USA) to verify the readings once a week. The study found that the NH_3 levels in the rooms were consistently below 1 part per million (ppm), considered a normal level for laying hens. Although high levels of NH_3 can lead to behavioral changes in chickens [30], the study suggests that the low levels of NH_3 in these rooms were unlikely to have caused such behavior.

2.3. Behavioral and Clinical Signs

Feather condition inspection was performed regularly to identify SFP behavior in pullets. During pullet rearing, feather pecking was predominantly observed along the back, at the tail end, or over the wings. SFP behavior was identified by observing birds rigorously pecking, plucking feathers, and causing damage to other birds' tails, vents, feathers, or necks. The location of the pecked part on the bird depended on the position of the victim and the pecking bird. Abdominal pecking was highest when the bird was on the floor or ground, while neck and tail pecking was highest on perches or elevated structures. The SFP victims were observed to be aggressive toward or run away from the pecking birds. Forceful feather pulling caused severe plumage damage, resulting in the birds reacting to injury, crying out in pain, and looking for a way to escape from the pecking birds. Similarly, if the victim bird could not defend itself, it surrendered and fell into an ultimate immobility stage. Pecking birds were more attracted to the bloody parts of victim birds. The red color of blood on the feathers and open areas made the birds more aggressive and attracted to the victim, resulting in frequent and forceful pecking. Tissue damage in victim birds caused excessive blood loss (Figure 3) and increased mortality rates. Moreover, the salty taste and red color of blood attracted more birds towards the pecked bird, resulting in repeated and forceful pecking.

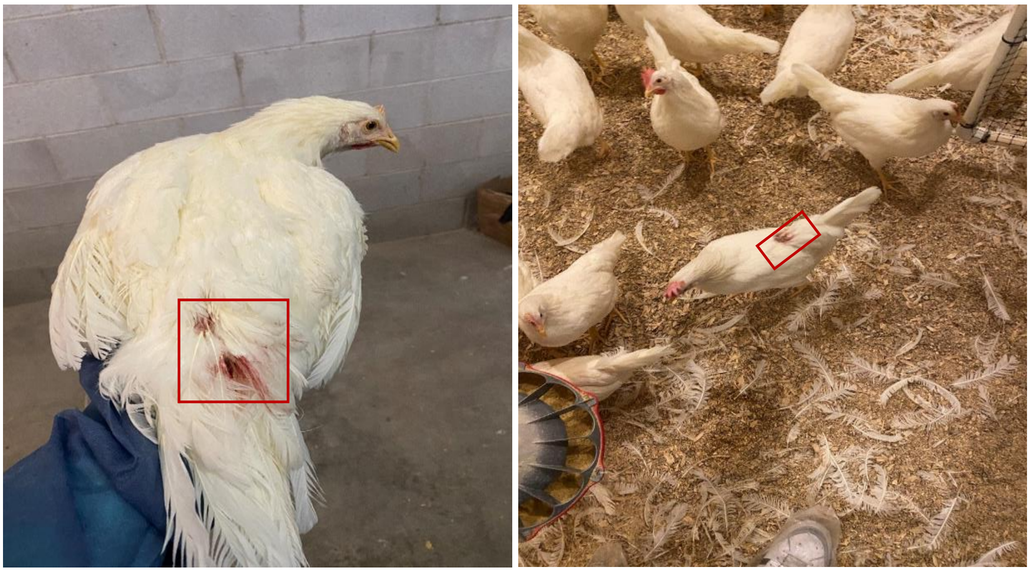

Figure 3. Severe feather PB showing pecked part near the tail with bloody color in the CF floor-raised housing system. The rectangle shape in the figure represents the severely pecked part.

2.4. Management Strategies Implementation

Pecking behavior is unpredictable and found to be highest in CF housing compared to other housing conditions. Gentle FP is not a point of our case study because it is a social behavior and did not cause any harm or welfare concern to birds. Instead, this study considered just SFP behaviors with bloody parts, leading to painful pecking and cannibalism. However, it did not matter whether SFP caused a visible wound, but there had to be some sign of blood in that area. Bloody parts, or a red color due to bleeding, is the birds' main attraction, which can lead to cannibalism. To prevent further SFP behaviors, we introduced an organic pecking block (Alltech, Inc., Nicholasville, KY, USA) in each room (outside of isolate chamber but placed within a room) from 15 to 16 WOA. However, birds experiencing SFP with bloody parts also needed to be protected from further pecking condition, which lead to cannibalism. This study introduced a closed, isolated chamber (IC; 2.4 m L × 1.2 m W × 0.8 m H) placed at the corner of each room to protect severely pecked birds from other aggressive birds from 14 WOA. Isolated chambers consisted of a litter floor with a nipple drinker, feeder, and perch (Figure 4). The study examined the SFP data by conducting two separate experiments: one involved introducing a pecking block outside the IC and within the room to reduce SFP in the room, while the other experiment used an IC to decrease severe FP in birds brought from the room into the IC.

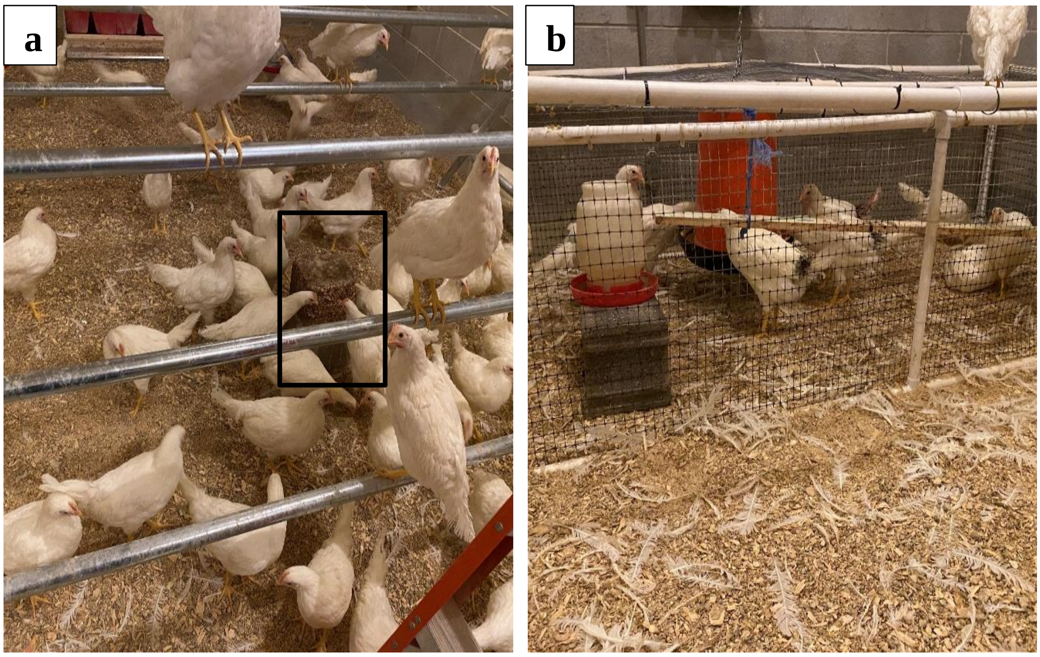

Figure 4. Prevention of SFP in Hy-Line W-36 pullets by (**a**) introducing a pecking block placed 15 cm high from the litter floor and (**b**) isolating pecked birds into the separate isolated chamber and providing them with a peck-no-more lotion. The rectangle box indicates the pecking block area.

SFP birds were placed inside the IC until severely pecked parts recovered. Unfortunately, placing them inside a separate IC did not work out, so we introduced Pick-No-More Cover-up lotion (Rooster Booster, TDL Industries, Inc., Fallon, NV, USA) from 15 to 16 WOA to cover wounds and stop further pecking. The number of pecked pullets and mortality were recorded daily.

2.5. Pecking Lotion Application Method

In order to catch severely pecked birds, the light inside the room was turned off, and the headlight with red light was used. When pecked pullets were discovered, the headlight was turned off to catch and handle the pullet safely. After catching severely pecked birds, the pecked parts with blood were covered using a peck-no-more lotion. Pick-No-More Cover-up lotion is all-natural, non-stinging, and safe to use, which helps to repel aggressive birds, heal wounds fast, and prevent cannibalism. The amount of lotion applied depends on the size of the pecked part. After applying lotion, pecked pullets were kept inside IC.

2.6. Statistical Analysis

The four identical CF floor-raised rooms were considered in this case study, and pecking data were recorded daily and evaluated weekly. Repetition of this study cannot be possible at this time, which is a limitation of this study. Pecking data over 16 weeks were first normalized using log10 transformation and later analyzed using two-way ANOVA, including week as the main effects and rooms as a block in JMP Pro-16 (SAS Institute Inc., Cary, NC, USA). Similarly, the pecking data collected before and after the introduction of pecking blocks and IC were analyzed using a paired *t*-test. Finally, pecking data obtained inside IC with and without lotion were normalized using square root transformation because of the skewed distribution of the data. After the data transformation, the data was analyzed using Paired *t*-test.

3. Results

3.1. Pecking Behavior by Weeks

This case study found that SFP increases with increasing bird age ($p < 0.01$; Figure 5). The SFP started at the early stage of the pullet from 5 WOA onward and increased and then decreased until it reached 13 WOA. The SFP behavior was recorded from 5 WOA and gradually increased at 6 WOA but decreased to no SFP at 8 WOA. After 8 WOA, there was a gradual increase in peaking behavior, and this peaked from 13 to 16 WOA, so it was very important to take quick action to control the increasing SFP. Similarly, the highest SFP was observed at 16 WOA. On average, 16% of the total birds per room were severely pecked until they reached 16 WOA. The 16% SFP rate was obtained after isolating pecked pullets from the normal or aggressive ones. If they were not isolated from the group, these rates might have increased, resulting in increased mortality rates due to cannibalism. Out of the 16% severely feather-pecked birds, an almost 6% mortality was recorded during pullet rearing before the treatments were applied.

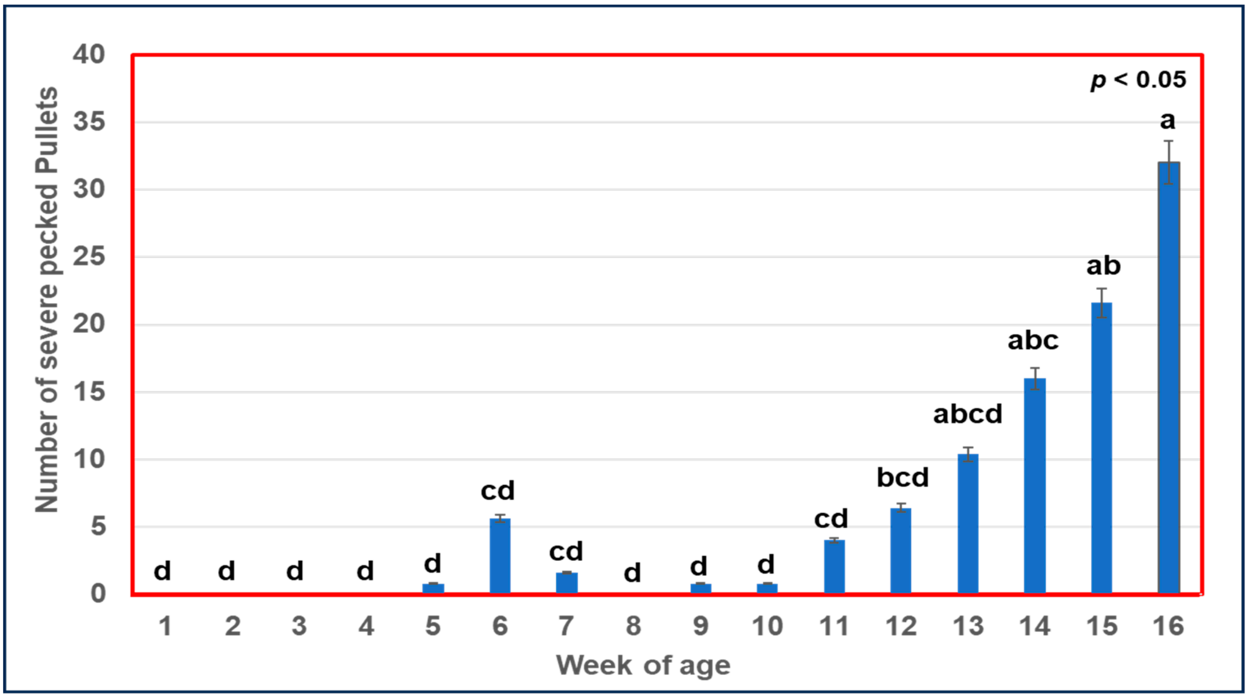

Figure 5. Number of severely pecked birds during pullet rearing in CF floor-raised housing from 1 WOA to 16 WOA. The different letters in the figure represent that the weeks of age are significantly different.

3.2. Pecking Behavior Variation between Rooms

The four rooms used in this case study were identical, but SFP was found to be different among rooms. The difference can be due to social interaction or the transmission of behaviors, which makes birds easy and fast to train by observation. Room 2 showed the highest SFP rates, while the lowest SFP rates were observed in Room 4, as shown in Figure 6.

3.3. Pecking Behavior between Treatments

3.3.1. Before and after Placing the Isolated Chamber

Severely pecked birds were put inside an IC to protect the pecked birds from pecker birds. However, the results showed no difference in SFP before and after placing IC ($p = 0.5772$; n = 4). Instead of reducing SFP, the prevalence of SFP still existed amongst the pecked birds inside the IC. When pecked birds were placed inside the IC, the red blood color attracted the birds to perform further SFP among pullets.

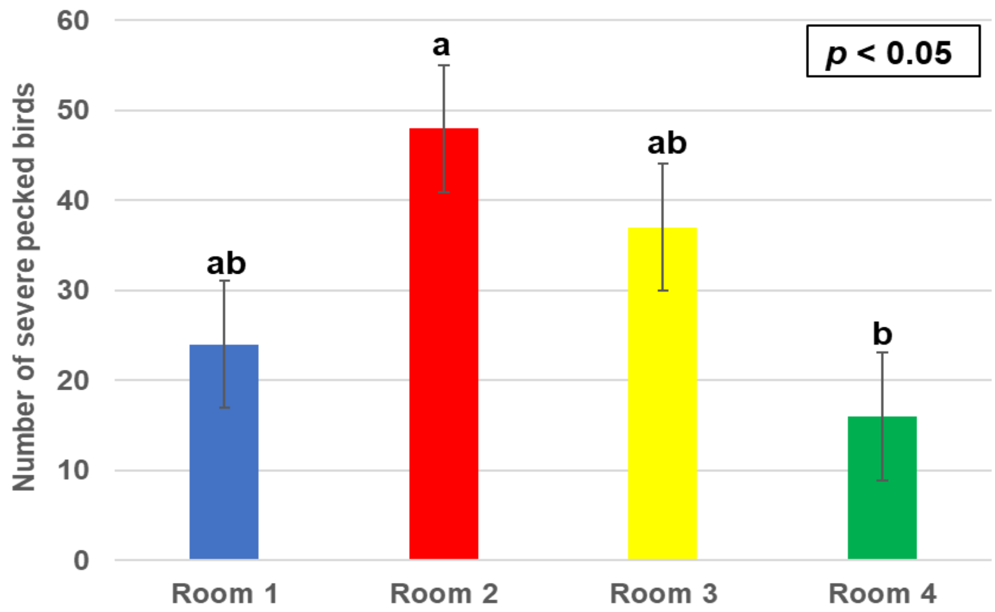

Figure 6. Severely feather-pecked birds per room over 16 weeks of pullet rearing in the CF housing system. The different letters in the figure represent that the rooms are significantly different.

3.3.2. Isolated Chamber with or without Pecking Lotions

The result shows that by introducing IC, SFP could not be controlled within the room or the IC chamber, but by integrating IC and peck-no-more lotion, the pecking rates were significantly reduced compared to treatment with just IC ($p = 0.0249$; n = 4). Depending on the wound size, after introducing lotion, it takes around 3 days to 2 weeks for the wound to recover or heal. After applying lotion, the birds recovered quickly instead of dying from cannibalism. Furthermore, the number of birds dying from cannibalism was found insignificant following the introduction of the lotion. Thus, an IC with lotion treatment reduced SFP significantly and stopped pullets dying from severe feather peaking, which leads to cannibalism.

3.3.3. Before and after Introducing the Pecking Block

After introducing the pecking block in this study, the result shows significant effects on increasing SFP ($p = 0.0313$; n = 4), which might be due to alarmingly high rates of pre-existing SFP. Although pullets like pecking-on-pecking blocks, the treatment could not reduce existing SFP. The observations from the camera recording show that pullets were attracted toward pecking blocks, but we were unable to quantify or track individual pullets because all pullets looked similar and were large in numbers.

4. Discussion

The current study evaluated pecking behaviors in pullets until 16 WOA and found that gentle PB was most common and frequently observed in the CF housing with perches and other enrichments. Furthermore, PB increased with bird age. A previous study on laying hens also reported increased SFP with age [31], and this varied with hen strain [16,31]. Similarly, SFP has been observed more near nest boxes [32]. However, the increase and decrease in SFP observed before 13 WOA were due to the unpredictable behavior of birds inside CF housing [33]. According to Nicol et al. [32], aggressive behavior was higher in a flock with higher stocking density because the birds resulted to non-social and non-aggressive behavior, while the case is just the opposite for larger flock sizes where birds seem to appear to create social hierarchies. However, we found that the pullets in each room had low stocking density but exhibited higher SFP, which might be due to other factors contributing to the development of SFP in this study. SFP can result in poor plumage conditions, which might worsen if SFP increases at a higher rate [6]. The birds with bad plumage conditions showed higher heat loss, ultimately increasing feed intake [11]. An increase in feed cost decreases the profitability of the producer.

The SFP data obtained from each room show the difference in SFP between the rooms. The room variation might be due to unpredictable PB during bird rearing [33]. Once pecking starts, the PB transfers through social interaction [34]. Social interaction, learning, and pecking behavior increase faster where PB already exists [35]. As PB increases and causes SFP, this might lead to the stage called cannibalism. Cannibalism in pullets leads to increased mortality. The mortality rates from cannibalism resulting from wounds (bleeding parts) represent 20%, and are higher in laying hens [12]. Isolating the pecked pullets in an IC away from other birds helps to reduce the higher mortality rates but is unable to stop mortality rates because of existing SFP and wounds with red blood. This red color makes the pullets more aggressive and increases SFP. When severely pecked birds were introduced to the IC with lotion, the pecking rates decreased to the lowest, and mortality rates were stopped. Pecking behavior was decreased due to the lotion's ingredients (water, aloe vera gel, tea tree oil, calendula, and methyl anthranilate) that repel aggressive birds and decrease further pecking. In addition, the lotion covers the color of bloody wounds and helps wounds to heal quickly and prevents further pecking. To heal wounds, it usually takes 2 to 14 days which depends on the size of the pecked part and the damage to pullets. Once wounds healed, the birds were put back into the room (out of IC). This might be the strategy to allow the severely pecked bird to recover and to control further loss and improve welfare. However, this preventive measure requires more labor, IC, and lotion, which is expensive. In addition, looking at each bird is time-consuming and very hard. That is why automatic detection of pecking behavior is required to find the pecking behavior and find the real cause of the pecking behavior [5].

Similarly, SFP in pullets can be decreased by providing enrichment such as a pecking block. These pecking blocks and enrichments help decrease the prevalence of SFP by 98.2% and aggressive behavior by 50% in birds [36], while this case study found that when SFP was at an alarming stage, the pecking block also did not help to control SFP. When comparing SFP before 13 WOA and after 13 WOA until 16 WOA, this study found that SFP increased by 300%, which might be due to the birds' quick learning behavior. Once the laying hens develop SFP, it may persist for their whole laying stage [15]. However, providing a pecking block at an early stage might help to reduce the SFP at a later stage [36]. Since the pecking block did not show any reduction in SFP because SFP was at alarming rates within the farm, separating pecked pullets and introducing IC with lotion treatment may be the alternative to reduce further pecking and prevent cannibalism amongst pullets and economic loss due to mortality.

Overall, this case study highlights the importance of action and reaction in controlling SFP in pullets to prevent mortality rates and improve animal welfare. To prevent SFP, detailed studies will be required to find the best solution to these problematic behaviors in hens. Therefore, further research is needed to identify the root causes and develop tailored strategies to tackle them. In addition, researchers must work closely with industry stakeholders and policymakers to prioritize animal welfare and sustainable production while implementing effective measures. A comprehensive approach that considers the biological, behavioral, and social factors contributing to pecking behavior is necessary to tackle this issue.

5. Conclusions

This case study showed that SFP increased with pullets' age. Introducing pecking blocks and a closed IC inside the room at a later stage of pullet growth and for pullets with pre-existing pecking damages did not reduce SFP. However, the integrated mitigation method, IC with lotion treatment, significantly reduced SFP and cannibalism. This case study provides a reference for the poultry industry to develop systematic prevention strategies for mitigating pecking damages and associated mortality in commercial cage-free houses.

Author Contributions: L.C. and R.B.B. developed the method; R.B.B., S.S., X.Y. and L.C. collected data; R.B.B. analyzed data; R.B.B. and L.C. wrote the original paper; L.C. provided resources. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: This case study was recorded in four CF floor-raised houses at the University of Georgia (UGA). Before recording data, all the procedures were approved by the UGA Institutional Animal Care and Use Committee (IACUC) (AUF#: A2020 08-014-A2).

Informed Consent Statement: Not applicable.

Data Availability Statement: The data are available on reasonable request from the corresponding author.

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Conflicts of Interest: The authors declare no conflict of interest.

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