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Infrared beak trimming protocols as an alternative to hot blade in commercial laying hens

Verônica Letícia da Silva[1], **Lilian Francisco Arantes de Souza**[2]*, **Rafael Victor Nunes Lima**[2], **Diogo Tsuyoshi Ito**[3], **Gustavo do Valle Polycarpo**[1]

[1] Universidade Estadual Paulista, Faculdade de Ciências Agrárias e Tecnológicas, Departamento de Produção Animal, Dracena, SP, Brasil.
[2] Universidade Federal Rural de Pernambuco, Departamento de Zootecnia, Recife, PE, Brasil.
[3] Hendrix Genetics, São Paulo, SP, Brasil.

***Corresponding author:**
lilian.arantes@ufrpe.br

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ABSTRACT - This study aimed to compare hot blade with infrared beak trimming with different protocols on performance, beak length, digestive system organ biometry, intestinal histomorphometry, and egg quality in white laying hens. One hundred and twenty chicks were distributed in a completely randomized design in three beak trimming methods/protocols with five repetitions. Hot blade (HB) trimming was carried out at day 7, and infrared beak trimming was carried out at day 1, using light (LIR: 26/23 protection plate and 38 nm intensity) and moderate (MIR: 24/23 protection plate and 40 nm intensity) protocols. The birds were assessed up to 33 weeks. Up to 18 weeks, weight gain (WG), feed intake (FI), feed conversion (FC), breeding viability (BV), uniformity (UN), beak length (BL), digestive system biometry, and intestinal histomorphometry were evaluated. Between 18 and 33 weeks, age at sexual maturity, egg production, and quality were assessed. Hot blade trimming worsened initial performance with a reduction in FI, WG, and UN ($P<0.05$). On the other hand, lower BV was observed with the MIR beak treatment ($P = 0.026$). Beak length was shorter with the HB method ($P<0.001$). Hot blade trimming resulted in greater gizzard weight ($P = 0.004$) with no effect on intestinal histomorphometry ($P>0.05$). During the laying phase, there was no effect of beak trimming on age at sexual maturity, egg production, and egg quality ($P>0.05$), except eggshell thickness, which was lower with HB trimming ($P = 0.025$). Beak treatment using the light infrared radiation protocol could be a viable alternative to the hot blade.

Keywords: beak length, beak treatment, debeaking, digestive system, performance

1. Introduction

Beak trimming is a common procedure adopted in the production of laying hens with the main objective of preventing cannibalism (Schwean-Lardner et al., 2016), as well as avoiding damage to the plumage and pecking of eggs, consequently reducing mortality, benefiting feed efficiency and egg quality (Gentle et al., 1997; Cruvinel et al., 2022). Although it is a beneficial practice from a production point of view, in the current production model and strong pressure from the consumer market, beak trimming generates discussions about the practices adopted in poultry farming that should be reviewed in terms of animal welfare. Currently, beak trimming is mainly performed using hot blade (HB) or infrared radiation (IR) techniques.

Although efficient in relation to the objectives of beak trimming, the conventional HB methodology subjects the birds to stress. The HB protocol involves cutting the beak with a blade at a temperature of around 700 °C, creating an open lesion, increasing the sensitivity of the beak, and altering the behavior of the birds. In addition, it must be performed by people trained in the operation to avoid the formation of neuromas or non-standardization of cuts (Glatz, 2000; Li et al., 2020). In addition, performing this procedure requires trained labor, and with the reduction in labor availability in rural areas, the constant need for training so that people can perform this management has become increasingly constant and difficult. In addition, when outsourced teams are used to perform this procedure, additional biosafety precautions are required related to the movement of people and equipment that are not part of the daily routine of a farm.

With greater attention to the welfare of laying hens, the search for alternative methods to conventional ones is growing (Grün et al., 2021; Struthers et al., 2022). Among the alternative methods, IR beak treatment emerged as an alternative, being carried out in hatcheries with equipment that avoids human handling, in which part of the beak is exposed to IR, generating subsequent necrosis of the region subjected to radiation, consequently not generating open lesions or hemorrhages (Struthers et al., 2022). However, despite the benefits of IR beak treatment, attention should be paid to the different protocols that can be used, such as the size of the protective plate and the intensity of the radiation applied, as well as the adaptation to the lineage and size of the chicks, factors still little explored in scientific research (Dennis and Cheng, 2012; Petrolli et al., 2017; Pelicia et al., 2019), and this gap will be explored in this research.

This study aimed to compare beak trimming by IR radiation with different beak exposure protocols and radiation intensity (light and moderate) to the hot blade on performance up to 33 weeks, beak length, development of digestive system organs, intestinal histomorphometry, and egg quality in light-laying hens, offering a practical and applicable solution for the industry that prioritizes animal welfare.

2. Material and methods

All the procedures carried out on the animals were approved by the Institutional Animal Use Ethics Committee (process number 5807/2019). The experiment was conducted on a commercial farm in Regente Feijó, São Paulo, Brazil (22°12'44.5" S and 51°20'57.3" W).

One hundred and twenty one-day-old Dekalb White chicks from 27-week-old breeders with an average weight of 33 ± 0.58 g were used. The birds were allocated to three treatments (beak trimming methods and protocols) with five replicates of eight birds each. The experimental period lasted until 33 weeks of age.

Partial beak removal was carried out using the HB and IR methods. The HB method was carried out by cutting and cauterizing in a “v” shape on the seventh day of life using a Verschuuren® pecker at 750 °C, at 1 mm from the nostril. Infrared beak trimming was carried out in the hatchery on the first day of life with the Poultry Service Processor® (Nova-Tech Engineering, LLC, Willmar, MN) using the light protocol (LIR: 26/23 protection plate and 38 nm intensity) and the moderate protocol (MIR: 24/23 protection plate and 40 nm intensity), both using a Mid Wrap mirror for reflection on the underside of the beak. The numbering of the protection plate (guide size) and the angulation of the beak determine how much of the beak was exposed to infrared radiation. In this study, the variation occurred about the size of the guide, with the larger guide resulting in less exposure of the beak to radiation and vice versa, with no variations in beak angulation.

The chicks were housed in metal cages (50 × 50 cm) containing trough-type feeders and cup-type drinkers, with a housing density of 312.5 cm^2/bird from 1 to 17 weeks and 416 cm^2/bird between 18 and 33 weeks.

Feed and water were provided *ad libitum*, and diets were offered to meet the nutritional needs of the birds, according to the strain manual. The diets were pre-starter (1 to 10 days), starter (11 to 49 days), grower (50 to 112 days), pre-layer (113 to 126 days), and layer (127 to 231 days).

The light program used was 23 h of artificial light until the third week, 12 h of natural light between 4 and 17 weeks, and 16 h of light (natural and artificial) from 18 to 33 weeks.

Up to 18 weeks, performance was assessed using feed intake, body weight gain, feed conversion (ratio between feed intake and weight gain), uniformity (percentage of birds within ±10% of average weight), and viability (percentage of live birds). Period performance was divided into one to six weeks, 7 to 12 weeks, 13 to 18 weeks, and a total period of 1 to 18 weeks.

Beak length was assessed at 6, 12, and 18 weeks, comprising the distance between the nostril and the tip of the beak, using a 150-mm digital caliper (Mtx with precision of 0.1 mm).

The biometry of the digestive system organs was assessed at 18 weeks of age, after a 12-h food fasting, in two randomly selected birds per repetition. The digestive system was separated into proventriculus, gizzard, intestine, and liver, and each organ was washed and weighed individually. The relative weight (%) of each organ in the digestive system was obtained from the ratio between the organ weights and the bird's body weight × 100.

Samples of the duodenum were taken from the proximal descending portion of the duodenal loop in the same birds used to assess the biometry of the digestive system. The samples were immediately fixed in formaldehyde solution for 24 h. They were then washed in 70% alcohol, dehydrated in an increasing series of ethanol (70, 80, 90, and 100%), diaphanized in xylene, and embedded in paraffin. Five histological sections were made per sample, measuring 5 µm each, and stained with hematoxylin and eosin. The images of the histological sections were obtained using an image capture system. The analyses were carried out using the Image J® program. The height of the villi (VH), the width of the villi (VW), the depth of the crypts (DC), the villus:crypt ratio (V:C), and the surface area of the villi were measured. Thirty readings were taken per intestinal segment. The villus:crypt ratio was determined using the ratio between the height of the villi and the depth of the crypts, and the surface area of the villi (SAV) was calculated according to Sakamoto et al. (2000).

Between 19 and 33 weeks, the age at sexual maturity (50% laying) and egg production (ratio between the number of eggs produced and the number of birds) were assessed.

Egg quality was assessed at 21, 25, 29, and 33 weeks in all the eggs produced in each experimental plot. The eggs were collected, weighed, and broken, and the yolks were separated by hand and weighed individually. The eggshells were washed, dried at air temperature for 24 h, and weighed. The weight of the albumen was obtained from the difference between the weight of the whole egg and the weight of the yolk and eggshell. The relative weight of the yolk, albumen, and eggshell was determined by the individual weight of each egg. Albumen height, yolk color, and Haugh unit (HU) were evaluated using the EggAnalyzer® (OKRA), shell strength was determined using the Egg Force Reader (OKRA), and shell thickness was determined using ultrasound on the EggShell Thickness Gauge (OKRA).

The data was previously analyzed for normality using the Cramer Von Mises test, and for homogeneity of variances using the Levene test. The data was subjected to analysis of variance, and if there was a significant effect, the means were compared using Tukey's test (5%). The SAS® software (Statistical Analysis System, OnDemand for Academics) was used. The data were analyzed according to the statistical model:

$$Y_{ij} = \mu + T_i + e_{ij},$$

in which Y_{ij} = observed value of the variables studied relative to each experimental unit receiving treatment i in repetition j; T_i = effect of the beak treatment method and protocol, in which i = 1....3; and e_{ij} = random error associated with each observation.

3. Results

Regarding the performance of the birds before the start of laying (Table 1), the HB method resulted in lower feed intake compared with the MIR protocol in the periods from 1 to 6, 7 to 12, 13 to 18 weeks and in the total period from 1 to 18 weeks (P<0.05). In addition, there was a reduction in weight gain in the periods from 1 to 6 and 13 to 18 weeks with HB compared to IR trimming (P<0.05), regardless of the protocol. The effects of the beak treatment methods and protocols on feed intake and weight gain resulted in better feed conversion for birds subjected to HB compared with MIR from 7 to 12 weeks and in the total period from 1 to 18 weeks (P<0.05). In addition, better viability was observed with HB compared with MIR in the periods 1 to 6 and 1 to 18 weeks (P<0.05).

At 18 weeks of age, a worse body weight uniformity was observed with the HB method (P<0.05; Table 2). Hot blade trimming resulted in shorter beak lengths compared with the IR method (P<0.05), regardless of the protocol at 6, 12, and 18 weeks (Table 2).

Table 1 - Mean values and standard deviation of feed intake, weight gain, feed conversion and breeding viability of white pullets according to the beak trimming method and protocol from 1 to 6 weeks, 7 to 12 weeks, 13 to 18 weeks, and 1 to 18 weeks

Performance	Beak trimming[1]			P-value
	HB	LIR	MIR	
		1 to 6 weeks		
FI (g)	21.08±1.84b	22.07±1.62ab	24.13±1.46a	0.035
WG (g/bird/day)	9.17±0.24b	9.97±0.37a	9.68±0.12a	0.002
FC (g/g)	2.30±0.21	2.21±0.12	2.49±0.16	0.053
BV (%)	97.86±2.55a	96.92±2.04ab	92.82±3.33b	0.026
		7 to 12 weeks		
FI (g)	61.93±4.67b	69.50±5.15a	73.75±2.62a	0.003
WG (g/bird/day)	11.19±0.53	11.13±0.63	11.09±0.27	0.945
FC (g/g)	3.52±0.29a	4.00±0.37ab	4.31±0.31b	0.004
BV (%)	100.00±0.00	100.00±0.00	100.00±0.00	-
		13 to 18 weeks		
FI (g)	72.24±4.19b	78.46±3.34ab	81.69±4.25a	0.008
WG (g/bid/day)	6.90±0.62b	7.87±0.63a	7.96±0.29a	0.046
FC (g/g)	10.51±0.28	10.07±1.12	10.28±0.74	0.772
BV (%)	100.00±0.00	100.00±0.00	100.00±0.00	-
		1 to 18 weeks		
FI (g)	51.75±2.92b	56.67±1.98a	59.85a±2.22a	0.001
WG (g/bird/day)	10.52±0.46	10.93±0.27	10.86±0.12	0.132
FC (g/g)	4.21±0.18a	4.43±0.22ab	4.71±0.20b	0.006
BV (%)	97.86±2.55a	96.92±2.04ab	92.82±3.33b	0.026

[1] HB - hot blade method; LIR - infrared radiation with 26/23 protection plate and 38 nm intensity; MIR - infrared radiation with 24/23 protection plate and 40 nm intensity; FI - feed intake; WG - weight gain; FC - feed conversion; BV - breeding viability.
a,b - Means followed by different letters in the rows differ from each other using Tukey's test (P<0.05).

Table 2 - Mean values and standard deviation of body weight uniformity (%) and beak length (mm) of white pullets at 6, 12, and 18 weeks, according to the beak trimming method and protocol

	Beak trimming[1]			P-value
	HB	LIR	MIR	
Uniformity (%)				
6 weeks	92.50±6.85	80.00±18.96	77.50±22.37	0.375
12 weeks	92.50±11.18	90.00±10.46	87.50±12.50	0.792
18 weeks	76.67±1.26b	96.67±7.46a	96.00±8.94a	0.008
Beak length (mm)				
6 weeks	6.15±0.32b	9.85±0.16a	9.66±0.43a	<0.0001
12 weeks	8.63±0.43b	12.71±0.36a	13.05±0.91a	<0.0001
18 weeks	8.49±0.40b	12.91±0.14a	12.90±0.63a	<0.0001

[1] HB - hot blade method; LIR - infrared radiation with 26/23 protection plate and 38 nm intensity; MIR - infrared radiation with 24/23 protection plate and 40 nm intensity.
a,b - Means followed by different letters in the rows differ from each other using Tukey's test (P<0.05).

Concerning the biometrics of the digestive system organs, HB trimming resulted in a higher relative weight of the gizzard compared with the IR method (P<0.05), regardless of the protocol used (Table 3).

There was no significant effect of the beak trimming methods and protocols evaluated on the VW, VH, CD, V:C, and VSA of the duodenum (P>0.05; Table 4).

The beak trimming methods and protocols used did not significantly influence the birds' age at sexual maturity and egg production (Table 5).

Regarding egg quality, only shell thickness was significantly affected by the beak trimming methods and protocols evaluated (Table 6). Hot blade trimming resulted in lower eggshell thickness compared with the LIR and MIR methods (P<0.05).

Table 3 - Mean values and standard deviation of relative weight of the organs of the digestive system (%) of white layers according to the beak trimming method and protocol

Organ	Beak trimming[1]			P-value
	HB	LIR	MIR	
Liver	2.05±0.318	1.99±0.136	1.70±0.216	0.079
Proventriculus	0.30±0.048	0.28±0.038	0.29±0.033	0.465
Gizzard	1.72±0.063a	1.49±0.064b	1.49±0.148b	0.004
Intestine	3.03±0.201	2.94±0.242	2.93±0.386	0.847

[1] HB - hot blade method; LIR - infrared radiation with 26/23 protection plate and 38 nm intensity; MIR - infrared radiation with 24/23 protection plate and 40 nm intensity.
a,b - Means followed by different letters in the row differ from each other using Tukey's test (P<0.05).

Table 4 - Mean values and standard deviation of villus width (VW), villus height (VH), crypt depth (CD), villus:crypt ratio (V:C), and villus surface area (SAV) of the duodenum of white layers according to the beak trimming method and protocol

Measurement	Beak trimming[1]			P-value
	HB	LIR	MIR	
VW (μm)	1183.9±71.70	1219.9±147.74	1172.5±148.74	0.832
VH (μm)	305.55±46.76	319.52±91.76	366.19±78.55	0.565
CD (μm)	369.53±60.80	218.87±73.28	285.97±95.26	0.174
V:C	3.29±0.66	4.60±1.33	4.47±1.54	0.144
SAV (μm^2)	1,133,881±1,621	1,210,809±3,204	1,351,128±3,259	0.513

[1] HB - hot blade method; LIR - infrared radiation with 26/23 protection plate and 38 nm intensity; MIR - infrared radiation with 24/23 protection plate and 40 nm intensity.

Table 5 - Mean values and standard deviation of age at sexual maturity (days) and egg production rate (%) of white layers according to the beak trimming method and protocol

Performance	Beak trimming[1]			P-value
	HB	LIR	MIR	
Sexual maturity	126.0±2.00	127.8±3.83	124.4±2.61	0.223
Egg production[2]	88.43±3.77	88.20±4.25	88.93±3.42	0.955

[1] HB - hot blade method; LIR - infrared radiation with 26/23 protection plate and 38 nm intensity; MIR - infrared radiation with 24/23 protection plate and 40 nm intensity.
[2] Egg production of laying hens between 19 and 33 weeks.

Table 6 - Mean values and standard deviation of egg weight (g), albumen height (mm), yolk color, Haugh unit, shell strength (kgf), shell thickness (mm), and percentage of yolk, albumen, and eggshell (%) of eggs from white layers according to the beak trimming method and protocol

Egg quality[1]	Beak trimming[2]			P-value
	HB	LIR	MIR	
Egg weight	48.91±0.55	49.73±1.12	48.01±1.42	0.083
Albumen height	9.00±0.27	9.13±0.20	8.99±0.15	0.528
Yolk color	4.81±0.05	4.77±0.22	4.62±0.23	0.290
Haugh unity	95.49±2.48	96.48±1.70	96.26±1.03	0.677
Shell strength	4.55±0.21	4.64±0.14	4.54±0.14	0.628
Shell thickness	0.408±0.010b	0.428±0.004a	0.426±0.013a	0.025
Yolk percentage	25.52±1.04	25.81±1.21	25.35±1.28	0.577
Albumen percentage	64.08±1.02	63.37±1.33	64.15±1.16	0.280
Eggshell percentage	10.40±0.29	10.82±0.12	10.49±0.34	0.390

[1] Assessments performed at 21, 25, 29, and 33 weeks of age.
[2] HB - hot blade method; LIR - infrared radiation with 26/23 protection plate and 38 nm intensity; MIR - infrared radiation with 24/23 protection plate and 40 nm intensity.
a,b - Means followed by different letters in the row differ from each other using Tukey's test (P<0.05).

4. Discussion

In general, HB trimming was detrimental to bird performance during the initial phase, especially in relation to feed intake, with a negative effect on chick weight gain when compared with the use of infrared radiation. However, better feed conversion was observed for the birds subjected to the HB protocol in the rearing periods before the laying phase, and despite the negative effect on feed intake, the flock's weight gain was compensated for from seven weeks of age onwards, without influencing age at sexual maturity and the productivity of the birds from 18 weeks onwards. Guarnieri et al. (2020) compared HB and IR beak treatment in white and brown layers and also observed higher feed intake and weight gain in birds subjected to the IR method, as well as better feed conversion with HB trimming. Similar results were described by Marchant-Forde and Cheng (2010), who reported lower feed intake in birds subjected to HB trimming. Beak recovery time is shorter after beak treatment with IR than with HB, and there is better patterning of the cut, resulting in regular natural feed intake and capture behavior (Marchant-Forde et al., 2008).

The lower weight gain of the birds subjected to HB trimming is a reflection of the lower feed intake in the days following the procedure because it is carried out at a greater depth of cut, as observed by the shorter beak length at 6, 12, and 18 weeks, and the birds' more sleepy and apathetic behavior probably due to the pain caused by the procedure. Birds treated with HB showed no reinnervation of the beak after six weeks of treatment, while birds subjected to the IR protocol showed repopulation of nerve cells, with a direct effect on the growth and formation of new mechanoreceptors at the tip of the beak, from four weeks of treatment (McKeegan and Philbey, 2012; Gentle et al., 1997).

Performance in the production phase depends on flock uniformity in the early stages of rearing. As feed intake and weight gain were higher in the birds subjected to the beak treatment with IR in both protocols, 20% greater uniformity was observed at 18 weeks of age compared with the birds treated by HB.

The beak is an important structure in the digestive system of birds and is used for ingesting food and water, as well as performing social behaviors and interacting with the environment (Boleli and Thimotheo, 2017). The use of the HB method results in the cutting and cauterization of the beak tissue, requiring skilled labor to carry out the procedure correctly (Gentle et al., 1997; Cheng, 2006). Thus, beak treatment with IR represents a beneficial alternative to HB, as it guarantees better standardization of the beak cut since the system is controlled by the equipment and computers (Avila et al., 2008).

In addition, beak treatment with IR reduces the chances of the flock being subjected to a second cut, which is possibly more stressful as it occurs at an older age, as is usually the case with HB trimming (Glatz and Bourke, 2006; Struthers et al., 2019). Another advantage of IR beak trimming is that it does not cause immediate loss of the region of the beak subjected to radiation. Struthers et al. (2019) showed that before the necrotic tissue of the beak detaches from the healthy tissue, the epithelium regenerates, forming a scarred barrier, not forming a sensitive lesion, avoiding possible bacterial contamination and not having a negative effect on the birds' social behaviors. Therefore, the effects of the beak trimming methods on body weight, feed intake, and uniformity can be attributed to changes in beak morphology and the trauma of the open lesion caused by the HB method.

Despite the few studies evaluating the effect of beak trimming methods on water intake, due to the sensitivity caused by the HB method or due to the change in beak shape by the IR method, the form of water supply can play an important role in the development of animals (Gentle and McKeegan, 2007; Marchant-Forde et al., 2008). According to Swenson and van Gulijk (2014), for birds subjected to IR beak trimming, water supply through pacifier or cup-type drinkers resulted in higher body weight compared with nipple-type drinkers. In both broilers and layers, feed and water intake are positively correlated, so water restriction caused by nipple drinkers, albeit in the short term, can reduce the body weight of laying pullets and may consequently delay their sexual maturity. Delayed sexual maturity was not observed in this study, suggesting that beak shape had no negative impact on overall growth.

Despite the benefits offered by the IR beak trimming, in this study, MIR caused higher mortality of the birds in the initial rearing phase, resulting in higher mortality for the period from 1 to 18 weeks, contrary to the results of Pelicia et al. (2019), who reported lower mortality with the IR protocol. The birds in this study came from young breeders (27 weeks) and had reduced body weight and beak length, making them more sensitive to the moderate IR protocol. As described by Glatz (2005), infrared radiation beak trimming has three basic components for adjustment: the protection plate, the mirror, and the intensity. All the components must be adjusted according to the weight of the chick, the species of bird, and its age, allowing a safe and precise procedure to be carried out. The severity of the treatment or the size of the tissue removed can have effects on the behavior, welfare, physiology, and production of commercial birds (Gentle et al., 1997; Lunam, 2005). Dennis and Cheng (2012), studying the effects of different sizes of protection plates and different intensities of infrared radiation, observed a higher body weight in birds treated with a less severe protection plate (27/23C) and low intensity (44 nm), and a reduction in body weight when the birds were subjected to protocols with a more severe protection plate (25/23C). This agrees with the present study, demonstrating that the proper adjustment of the IR beak trimming protocol is extremely important, since the high mortality observed shows that all the benefits of IR beak trimming can be lost if the protocol is not properly adjusted to the weight and size of the birds.

The development of the organs of the digestive system and the intestinal mucosa can benefit the performance and health of the birds. The different beak treatment methods and protocols did not influence the relative weight of the organs of the digestive system in laying hens at 18 weeks of age, except for the gizzard, which was heavier in the birds subjected to the HB protocol. The development of birds' visceral organs is influenced during the first few weeks of life and correlates positively with feed intake and physical appearance. As it is only carried out from seven days of age, HB trimming favors regular feed intake in the first days of the birds' lives, providing greater mechanical force to the gizzard, resulting in muscle hypertrophy and, consequently, greater relative weight in the organ, when compared with IR (García et al., 2019).

Despite the effect of HB trimming on the gizzard, feed intake, weight gain, and beak length, intestinal histomorphometry was not influenced by the beak trimming methods and protocols evaluated in this study. The development of the intestinal mucosa is related to the digestion and absorption of nutrients. Thus, greater VH is an indication of greater luminal absorption surface area (Boleli et al., 2002; Lv et al., 2015; Sirsat et al., 2018); therefore, regardless of the beak trimming method, the birds began their productive lives with the same intestinal morphology characteristics. The main factors that can modify the structure of the intestinal mucosa are the physical form of the feed, nutritional composition, and stress, as demonstrated by Mazzoni et al. (2022), who observed a reduction in the thickness of the muscle layer and the height of the villi in broilers subjected to caloric stress.

Despite the stress caused by lower feed intake in the initial phase (0 to 4 weeks), the HB protocol did not affect the development of the intestinal mucosa. Measurements of crypt and villus morphometric variables, such as the V:C, provide a better understanding of cytological changes in the organism, since a reduction in CD is indicative of lower cell proliferation and lower demand for tissue synthesis (Xia et al., 2004), as is an increase in the V:C, which is evidence of better nutrient absorption activity.

The internal quality of the eggs was not influenced by the beak trimming methods. However, eggshell thickness was lower in the birds subjected to HB, which is attributed to lower feed intake and, consequently, lower intake of nutrients such as calcium and phosphorus. The intake of these minerals in the early stages is directly related to bone metabolism. When they reach the production phase, bones are an important source of calcium for eggshell formation through the activity of the enzyme carbonic anhydrase (Whitehead, 2004; Zhang et al., 2017; Yu et al., 2020). Considering that eggshell thickness is one of the main attributes that determine the external quality of eggs, the result suggests that the IR method does not negatively affect the quality of eggs. Canhaço et al. (2023) described that infrared radiation is an alternative to the hot blade method since it does not influence the internal and external quality of 30-week-old layers, as reported by Cruvinel et al. (2022) with Japanese quail. In addition, the results of this study show the negative effects of HB beak trimming on the external quality of eggs.

5. Conclusions

The light infrared protocol can be a viable alternative to the hot blade, as it does not harm the performance, organs of the digestive system, and intestinal mucosa of birds in the rearing phases before the production phase and provides greater eggshell thickness.

Data availability

The dataset supporting the findings of this study is not publicly available but will be made available upon request to the corresponding author.

Author contributions

Conceptualization: Silva, V. L.; Souza, L. F. A.; Ito, D. T. and Polycarpo, G. V. **Data curation:** Souza, L. F. A. **Formal analysis:** Silva, V. L. and Souza, L. F. A. **Funding acquisition:** Silva, V. L. **Investigation:** Silva, V. L. **Methodology:** Silva, V. L.; Souza, L. F. A.; Ito, D. T. and Polycarpo, G. V. **Project administration:** Silva, V. L. **Supervision:** Souza, L. F. A. and Polycarpo, G. V. **Writing – original draft:** Souza, L. F. A.; Lima, R. V. N. and Ito, D. T. **Writing – review & editing:** Souza, L. F. A.

Conflict of interest

The authors declare no conflict of interest.

References

Avila, V. S.; Roll, V. F. B. and Catalan, A. A. S. 2008. Alternativas e consequências de debicagem em galinhas reprodutoras e poedeiras comerciais. Embrapa Suínos e Aves, Concórdia.

Boleli, I. C. and Thimotheo, M. 2017. Estrutura funcional do trato gastrointestinal: da percepção à absorção. p.137-170. In: Fisiologia das aves comerciais. Macari, M. and Maiorka, A., eds. FUNEP, Jaboticabal.

Boleli, I. C.; Maiorka, A. and Macari, M. 2002. Estrutura funcional do trato digestório. p.113-123. In: Fisiologia aviária aplicada a frangos de corte. Macari, M.; Furlan, R. L. and Gonzales, E., eds. FUNEP, Jaboticabal.

Canhaço, K. C. S. E. P.; Paula, S. C. S. E.; Silva, L. M.; Pastore, S. M. and Oliveira, W. P. 2023. Qualidade dos ovos: influência de diferentes métodos de debicagem das aves. Contribuciones a las Ciencias Sociales 16:23055-23062. https://doi.org/10.55905/revconv.16n.10-257

Cheng, H. 2006. Morphopathological changes and pain in beak trimmed laying hens. World's Poultry Science Journal 62:41-52. https://doi.org/10.1079/WPS200583

Cruvinel, J. M.; Montenegro, A. T.; Ouros, C. C.; Alves, K. S.; Ribeiro, G. C.; Santos, T. S.; Molino, A. B. and Garcia, E. A. 2022. Beak trimming in Japanese quails at initial phase is an alternative to reduce the negative effects of feather pecking. Acta Scientiarum. Animal Sciences 44:e54129. https://doi.org/10.4025/actascianimsci.v44i1.54129

Dennis, R. L. and Cheng, H. W. 2012. Effects of different infrared beak treatment protocols on chicken welfare and physiology. Poultry Science 91:1499-1505. https://doi.org/10.3382/ps.2011-01651

García, J.; Mandalawi, H. A.; Fondevila, G. and Mateos, G. G. 2019. Influence of beak trimming and inclusion of sodium butyrate in the diet on growth performance and digestive tract traits of brown-egg pullets differing in initial body weight. Poultry Science 98:3937-3949. https://doi.org/10.3382/ps/pez129

Gentle, M. J.; Hughes, B. O.; Fox, A. and Waddington, D. 1997. Behavioural and anatomical consequences of two beak trimming methods in 1 and 10-d-old domestic chicks. British Poultry Science 38:453-463. https://doi.org/10.1080/00071669708418022

Gentle, M. J. and McKeegan, D. E. F. 2007. Evaluation of the effects of infrared beak trimming in broiler breeder chicks. The Veterinary Record 160:145-148. https://doi.org/10.1136/vr.160.5.145

Glatz, P. C. 2000. Beak trimming methods – Review. Asian-Australasian Journal of Animal Science 13:1619-1693.

Glatz, P. C. 2005. What is beak-trimming and why are birds trimmed? p.1-17. In: Poultry Welfare Issues: Beak trimming. Nottingham University Press, Nottingham.

Glatz, P. C. and Bourke, M. 2006. Beak trimming handbook for egg producers: best practice for minimising cannibalism in poultry. Landlinks Press, Collingwood.

Grün, S.; Damme, K.; Müller, M.; Sommer, M. F.; Schmidt, P.; Erhard, M. and Bergmann, S. 2021. Welfare and performance of three turkey breeds—comparison between infrared beak treatment and natural beak abrasion by pecking on a screed grinding wheel. Animals 11:2395. https://doi.org/10.3390/ani11082395

Guarnieri, P. C.; Pagnussatt, H.; Aniecevski, E.; Dal Santo, A.; Leite, F.; Valentini, F. D. A.; Facchi, C. S.; Zaccaron, G.;Bosetti, G. E.; Rossatto, G.; Boiago, M. M.; Tavernari, F. C.; Artoni, S. M. B. and Petrolli, T. G. 2020. Comparison between infrared and hot-blade beak trimming methods in white and brown pullets: performance, organ, and bone development. Arquivo Brasileiro de Medicina Veterinária e Zootecnia 72:2373-2380. https://doi.org/10.1590/1678-4162-11964

Li, J.; Chen, H.; Dai, C.; Sa, R.; Wang, Z.; Wang, J.; Su, H.; He, X.; Guo, X. and Jiang, R. 2020. Effects of beak trimming on the performance, beak length, behavior, and carcass traits of a local broiler breed reared in battery cages. Animal Science Journal 91:e13405. https://doi.org/10.1111/asj.13405

Lunam, C. A. 2005. The anatomy and innervation of the chicken beak: effects of trimming and re-trimming. p.51-68. In: Poultry Welfare Issues: Beak trimming. Nottingham University Press, Nottingham.

Lv, M.; Yan, L.; Wang, Z.; An, S.; Wu, M. and Lv, Z. 2015. Effects of feed form and feed particle size on growth performance, carcass characteristics and digestive tract development of broilers. Animal Nutrition 1:252-256. https://doi.org/10.1016/j.aninu.2015.06.001

Marchant-Forde, R. M. and Cheng, H. W. 2010. Different effects of infrared and one-half hot blade beak trimming on beak topography and growth. Poultry Science 89:2559-2564. https://doi.org/10.3382/ps.2010-00890

Marchant-Forde, R. M.; Fahey, A. G. and Cheng, H. W. 2008. Comparative effects of infrared and one-third hot-blade trimming on beak topography, behavior, and growth. Poultry Science 87:1474-1483. https://doi.org/10.3382/ps.2006-00360

Mazzoni, M.; Zampiga, M.; Clavenzani, P.; Lattanzio, G.; Tagliavia, C. and Sirri, F. 2022. Effect of chronic heat stress on gastrointestinal histology and expression of feed intake-regulatory hormones in broiler chickens. Animal 16:100600. https://doi.org/10.1016/j.animal.2022.100600

McKeegan, D. E. F. and Philbey, A. W. 2012. Chronic neurophysiological and anatomical changes associated with infrared beak treatment and their implications for laying hen welfare. Animal Welfare 21:207-217. https://doi.org/10.7120/09627286.21.2.207

Pelicia, K.; Garcia, E. A.; Santos, T. A.; Santos, G. C.; Vieira Filho, J. A.; Silva, A. P.; Moreira, J.; Rabello, C. B. V. and Garcia, R. G. 2019. Beak trimming by infrared radiation of layers. Brazilian Journal of Poultry Science 21:eRBCA-2019-0618. https://doi.org/10.1590/1806-9061-2017-0618

Petrolli, T. G.; Petrolli, O. J.; Girardini, L. K.; Zotti, M.; Baggio, R. A. and Junqueira, O. M. 2017. Effects of laser beak trimming on the development of brown layer pullets. Brazilian Journal of Poultry Science 19:123-128. https://doi.org/10.1590/1806-9061-2016-0307

Sakamoto, K.; Hirose, H.; Onizuka, A.; Hayashi, M.; Futamura, N.; Kawamura, Y. and Ezaki, T. 2000. Quantitative study of changes in intestinal morphology and mucus gel on total parenteral nutrition in rats. Journal of Surgical Research 94:99-106. https://doi.org/10.1006/jsre.2000.5937

Schwean-Lardner, K.; Annett-Christianson, C. B.; Rajendram, J. and Classen, H. L. 2016. Does age of hot-blade trimming impact the performance and welfare of 2 strains of White Leghorn hens. Journal of Applied Poultry Research 25:547-560. https://doi.org/10.3382/japr/pfw037

Sirsat, S. D.; Chaithrashree, A. R.; Ramteke, B. N. and Shirsat, S. D. 2018. Early post hatch feeding in chicks and practical constrains - A review. Agricultural Reviews 39:226-233. https://doi.org/10.18805/ag.R-1763

Struthers, S.; Buchynski, K.; Chew, J.; Gomis, S.; Herwig, E.; Shynkaruk, T. and Schwean-Lardner, K. 2022. Specialized beak blunting feeders and their potential as an alternative to current beak treatment methods in leghorn pullets. Journal of Applied Poultry Research 31:100285. https://doi.org/10.1016/j.japr.2022.100285

Struthers, S.; Gupta, A.; Gomis, S.; Herwig, E. and Schwean-Lardner, K. 2019. Understanding how infrared beak treatment affects the beak tissue and the healing response of brown and white feathered layer pullets. Animals 9:665. https://doi.org/10.3390/ani9090665

Swenson, G. R. and van Gulijk, G. H. E. 2014. The effect of water delivery on beak treated layer chicks. International Hatchery Practice 28:15-17.

Whitehead, C. C. 2004. Overview of bone biology in the egg-laying hen. Poultry Science 83:193-199. https://doi.org/10.1093/ps/83.2.193

Xia, M. S.; Hu, C. H. and Xu, Z. R. 2004. Effects of copper-bearing montmorillonite on growth performance, digestive enzyme activities, and intestinal microflora and morphology of male broilers. Poultry Science 83:1868-1875. https://doi.org/10.1093/ps/83.11.1868

Yu, Q.; Liu, H.; Yang, K.; Tang, X.; Chen, S.; Ajuwon, K. M.; Degen, A. and Fang, R. 2020. Effect of the level and source of supplementary dietary zinc on egg production, quality, and zinc content and on serum antioxidant parameters and zinc concentration in laying hens. Poultry Science 99:6233-6238. https://doi.org/10.1016/j.psj.2020.06.029

Zhang, Y. N.; Zhang, H. J.; Wang, J.; Yue, H. Y.; Qi, X. L.; Wu, S. G. and Qi, G. H. 2017. Effect of dietary supplementation of organic or inorganic zinc on carbonic anhydrase activity in eggshell formation and quality of aged laying hens. Poultry Science 96:2176-2183. https://doi.org/10.3382/ps/pew490