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Self-administration of an Analgesic Does Not Alleviate Pain in Beak Trimmed Chickens

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ABSTRACT : Beak trimming in laying hens is a routine practice in which about 1/3-1/2 of the upper and lower beak is removed with the aim of reducing cannibalism. This experiment aimed to identify if this procedure causes pain by examining self-administration of an analgesic (carprofen) and pecking behaviour in 80 laying pullets beak-trimmed by two different methods at one day of age using hot-blade cauterisation or infra-red cauterisation. We also tested a control treatment, pullets with intact beaks, and a positive control treatment of pullets beak trimmed at 10 weeks of age which were expected to experience some pain due to recent severing of the underlying nerves in the beak. At 11 weeks of age birds trimmed at 10 weeks of age pecked more ($p<0.001$) gently (0.6±0.06 N) at a disc attached to a force-displacement transducer than birds trimmed at 1 day of age with an infra-red machine (0.9±0.1 N) or a hot blade (1.1±0.07 N) and intact birds (1.2±0.1 N). Maximum force of pecks recorded was also lower ($p<0.001$) in birds trimmed at 10 weeks of age than birds trimmed at 1 day of age with an infra-red method or a hot blade and intact birds. However, the pecking force in birds trimmed at 10 weeks of age was not increased by providing them with analgesic-treated feed, though birds that ate more carprofen had a higher maximum force of peck ($p = 0.03$). Pecking force in birds beak-trimmed at 1 day of age was the same as the pecking force of intact birds, and was unaffected by feeding pullets carprofen. A method of self-administration of an analgesic had previously revealed that chickens in neuromuscular pain arising from lameness consumed more of a feed containing carprofen than healthy chickens. However, we found no evidence that beak-trimmed pullets consumed more carprofen-treated feed than pullets with an intact beak. It should be noted that the three beak trimming methods resulted in an average 34% reduction in beak length, considered a light trim, and is perhaps not representative of commercial birds where greater portions of the beak are removed. We conclude that although carprofen has been reported to have an analgesic effect on neuromuscular pain in chickens, it appears to have no analgesic effect on potential neuropathic pain arising from the nerves severed by a light beak trim. (**Key Words :** Beak Trimming, Analgesic, Hens, Neuropathic Pain, Carprofen)

INTRODUCTION

There is a pressing need to develop reliable and unequivocal indicators of pain in farm animals to identify the welfare implications of various routine industry procedures. Beak trimming in laying hens is the removal of about 1/3-1/2 of the upper and lower beak of the young chicken, commonly using a hot-blade which simultaneously amputates and cauterizes. This routine industry practice is undertaken because it reduces the extent of cannibalism and vent pecking during rearing and in adulthood (Glatz, 1990) and is particularly effective in free-range production (Miao et al., 2005). Within the industry, beak trimming is also often considered to improve feed efficiency and this has been supported by some studies (e.g. Glatz, 2000; Davis et al., 2004), though others have failed to find any improvement in feed conversion following beak trimming (e.g. Carey and Lassiter, 1995). The beak of the chicken is a complex functional organ with an extensive nerve supply that is used for food manipulation, exploration of the environment, preening and social interaction. Objections to beak trimming have centered on the possibilities that this practice causes acute and/or chronic pain and that trimming deprives the chicken of sensory feedback and impairs the function of the beak (Glatz, 2000).

To date, animal welfare research has provided some behavioural and neurological evidence to inform the debate on the acceptability of routine beak trimming within the

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industry (see Cheng, 2006 for a recent review). However, there are limitations to both these lines of evidence: first, it is unclear whether the reported reduction in pecking following beak trimming, termed guarding behaviour, indicates pain or arises from the loss of sensory perception in the beak. Since the nerves have been severed, pecking with a trimmed beak will not provide the sensory feedback that an intact beak may provide, and may thus reduce the sensory stimulation achieved through exploration with the beak resulting in less pecking. Additionally, the regrown tips of the beak do not always contain afferent nerves or sensory corpuscles (Gentle et al., 1997), therefore the loss of sensory feedback may be long-term and may explain long-term evidence of guarding behaviour. It appears that the amount of beak removed appears critical, with some evidence that sensory receptors are still present in moderately trimmed birds (Lunam et al., 1996). It should also be noted that the main objective of beak trimming, a reduction in cannibalism, could arise both from a resultant reduction in the tendency of birds to peck or by reducing the amount of damage that birds can cause each other. Second, it is also unclear whether nerves that form neuromas project to the brain, and if they do whether they transmit action potentials to brain areas that may interpret these as pain. Animal welfare research therefore urgently needs reliable and unequivocal indicators of pain in beak trimmed birds that will aid the moral debate as to the suitability of this routine procedure.

When given a choice of feeds, rats with clinical symptoms of pain will consume more of an analgesic-containing feed than animals not in pain (e.g. Colpaert et al., 2001). It has been known for some time that chickens are able to select some feeds over others, even when both feeds are visually similar but differ only in nutrients, such as by consuming more feed high in selenium than feed lacking in selenium (Zuberbueher et al., 2002). Similarly, Danbury et al. (2000) found that when given a choice of feeds with and without an analgesic (carprofen), lame broiler chickens consumed more of the analgesic-treated feed than sound birds. Additionally, the consumption of carprofen in chickens was positively correlated to the severity of lameness, and consumption resulted in an improved gait (Danbury et al., 2000). The authors conclude that lame birds are able to select feeds with analgesics, thereby indicating that they are in pain and that they will actively seek relief from this pain. Carprofen is a non-steroidal analgesic which has previously been shown to have an effect on chickens, by improving the gait of lame broilers (McGeown et al., 1999). In the present experiment we used a method based on the approach described by Danbury et al. (2000) to investigate the potential impact of pain in beak trimmed birds. If trimmed birds are in pain and attempt to guard the beak from further pain stimulation, then we predicted that trimmed birds should peck more gently than intact birds. This difference in pecking force should however be removed by administering an analgesic. We also trained chickens using colour cues to distinguish between carprofen-treated feed and untreated feed as undertaken by Danbury et al. (2000). We predicted that beak trimmed birds should consume more analgesic-treated feed than intact beak birds when both feeds were presented simultaneously.

Chickens were beak trimmed at one day of age by either a hot-blade or an infra-red method by a commercial hatchery as is common commercial practice. We also tested intact beak birds as a control condition and birds that had been beak trimmed at 10 weeks of age using a hot-blade as a positive control; behavioural and neurological evidence (Megret et al., 1996; Gentle et al., 1997) indicates that birds trimmed at 10 weeks of age are likely to experience pain in the two weeks following trimming.

MATERIALS AND METHODS

Eighty Hyline Brown laying pullets were housed in pairs in cages measuring 50×55 cm (w×d) ×50 cm high at the front of the cage at 10 weeks of age in an open sided layer shed. Pullets were *ad libitum* fed with pullet grower crumbles (Ridley Agriproducts, Victoria), and water was available from nipple drinkers. Fluorescent lights were on a 14 h light: 10 h dark cycle and temperature was 21±5°C. Four groups of twenty chickens had been subjected to one of 4 beak trimming methods as follows: 1) hot-blade trimming at 1 day of age, 2) infra-red beak trimming at 1 day of age, 3) hot-blade beak trimming at 10 weeks of age and 4) intact beaks. Trimming at one day of age was undertaken by staff at a commercial hatchery (Kean’s Poultry, Huntley, Victoria), and trimming at 10 weeks by an experienced technician, and in both cases about 1/3rd of the upper and lower beak was removed.

At 11 weeks of age chickens were given experience of two different feeds on alternate days for 6 days. The feeds consisted of grower crumbles which were coloured either red or blue using food dye (Queen’s blue and red food colouring, Queen fine foods, Queensland, Australia) at a concentration of 125 ml/20 kg crumbles. Feed was provided in individual metal feeders 20×14×10 cm at front (20 cm at the back and sides) and sprayed with the food dye colour. One of these coloured feeds was treated with an analgesic, carprofen (Pfizer animal health, rimadyl injection) at a dose of 80 mg/kg of feed. Mixing of the feed with the colouring (and carprofen) was achieved by spraying the solution into the feed in a cement mixer until a visually even colour was achieved. According to Danbury et al. (2000) the dose would provide each bird with therapeutic levels of carprofen (see discussion). The respective position of each feeder (i.e. left or right side of the cage) was chosen at

Table 1. Mean (±sem) beak length, gap between the upper and lower beaks and the latency to peck the round disc in the pecking force tests for pullets from the four beak methods, and results from the ANOVA tests

Beak treatment	Beak measurements		Latency to peck disc (s)	
	Beak length	Gap	Analgesic	Untreated
Intact	17.7±0.3	N/A	161±74	264±95
Infra-red 1 day	11.1±0.3	2.6±0.2	177±68	137±78
Hot-blade 1 day	12.0±0.4	1.6±0.3	73±27	95.4±45
Hot blade 10 weeks	12.1±0.4	3.0±0.2	299±97	201±90
ANOVA	$F_{2,57}$ = 2.2, p = 0.13	$F_{2,57}$ = 9.9, p<0.001	Beak effect, $F_{3,36}$ = 2.8, p = 0.05. Feed type effect, $F_{1,36}$ = 0, p = 0.96.	

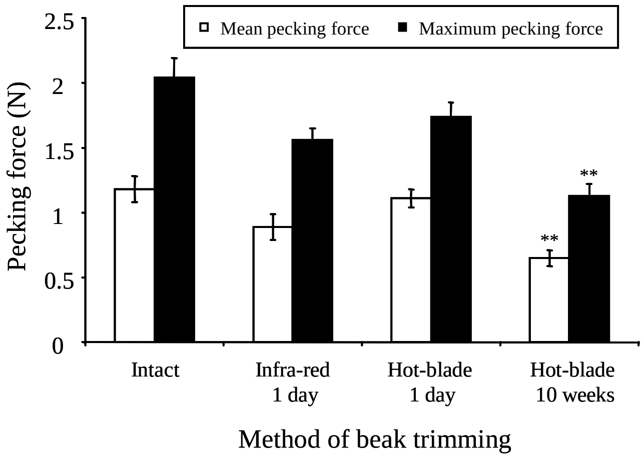

Figure 1. The mean pecking force (white bars) and maximum pecking force (black bars) in Newtons of 20 pecks (i.e. analgesic-treated and untreated feed data combined) from birds from four beak trimming methods. Birds trimmed at 10 weeks of age pecked more gently (** p<0.001) than other birds (see text).

random on the first day, and thereafter this choice was maintained for the entire duration of the experiment. Half of the chickens from each beak trimming method were provided with red analgesic-treated feed and the other half with analgesic-treated blue food, with untreated feed sprayed with the alternative colour.

For the first four days of training with different coloured feeds, the force of pecks at 5 black pebbles glued to a 10 cm diameter white disc was measured using a force-displacement transducer (GRASS (reg.), Australia) and recorded using Chart 5 software (ADInstruments). No attempt was made to distinguish the pecks of the two birds in each cage, so each cage provided a single measure for the pecking force analysis. The duration from placing of the disc through the front of the cage to the first peck of the disc was measured, along with the force of the first 10 pecks on one day when analgesic-treated feed was provided, and one day when untreated feed was provided. Measurements of pecking force began two hours after feeding, and the order of recording on days when treated and untreated feed was balanced for order effect.

At the end of the fourth day, one bird from each cage was removed and placed in a cage alone for two further days so that all 80 birds were in individual cages, randomly assigned in blocks of 10 pullets from each treatment along two rows of cages. Analgesic-treated feed was given one day and untreated feed the other day, and the relative position of the side of the cage that each feeder was placed was retained from the first four days. All coloured feed was then removed and birds were returned to uncoloured grower crumbles for 12 h. After this period, both analgesic-treated and untreated coloured feed were simultaneously given to the pullets in two feeders/cage. The feeders were weighed daily to measure the amount of each coloured food consumed. After weighing, the feeders were replenished with enough fresh feed (about 150 g) to ensure that both colours were available *ad libitum*.

Beak length was measured in all birds and the difference between the upper and lower beak measured in beak trimmed birds using a vernier calliper. Pecking force was analysed in a General Linear Mixed Model (SPSS 14.0, SPSS Inc., USA), with cage as a replicate and four beak methods and two feed treatments (analgesic-treated or untreated) as the repeated measure. The amount of analgesic-treated feed consumed was analysed in a General Linear Model with 4 beak conditions.

RESULTS

Beak length and pecking force

Beak length did not differ between the three beak trimming methods (ANOVA, $F_{2,57}$ = 2.2, p = 0.13; Table 1), with trimming resulting in an average 34% reduction in beak length. The difference between the upper and lower beaks was lowest in birds trimmed with the hot blade at 1 day of age (ANOVA, $F_{2,57}$ = 9.9, p<0.001; Table 1). Birds trimmed at 1 day of age with the hot blade appeared to peck at the disc sooner after exposure than birds from the other beak conditions (ANOVA, $F_{1,36}$ = 2.8, p = 0.05; Table 1). The latency to peck the disc was not influenced by feeding of analgesic-treated or untreated feed (ANOVA, $F_{1,36}$ = 0, p = 0.96 or the feed type/beak condition interaction, ANOVA, $F_{3,36}$ = 0.47, p = 0.70).

There was a difference between the four beak methods in both the mean force of pecks (ANOVA, $F_{1,36}$ = 7.5, p<0.001) and the maximum force of peck (ANOVA, $F_{1,36}$ =

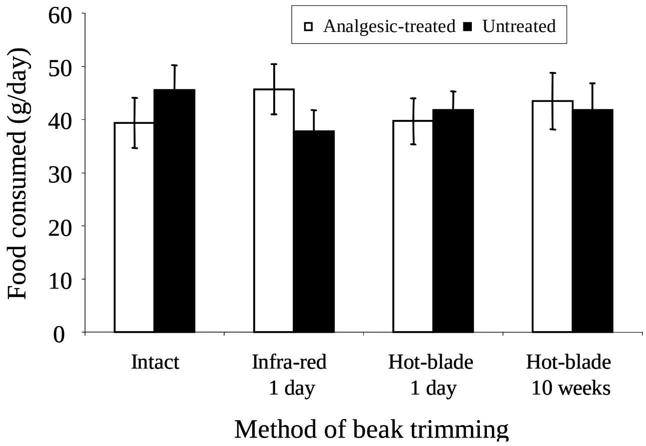

Figure 2, Birds from four beak trimming methods showed similar daily food consumption and consumed similar amount of analgesic-treated and untreated feed.

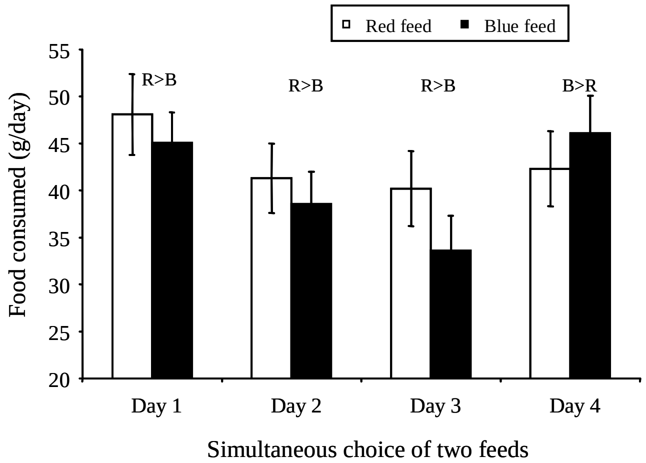

Figure 3. Choice of red and blue feeds, irrespective of presence or absence of carprofen, by all chickens during the simultaneous choice period. Chickens appeared to prefer red feed to blue feed for the first three days but on day four this preference was reversed ($p<0.05$).

9.5, $p<0.001$; see Figure 1). Birds beak trimmed at 10 weeks of age using a hot-blade had a lower mean force of peck than birds with intact beaks (Tukey's post-hoc test, MD = 0.53, p = 0.001) and birds beak trimmed with the hot-blade at 1 day of age (Tukey's post-hoc test, MD = 0.0.46, p = 0.004). The maximum force of peck was similarly lower in birds trimmed at 10 weeks of age with the hot-blade than intact birds (Tukey's post-hoc test, MD = 0.92, $p<0.001$) and birds trimmed at 1 day of age with the hot-blade (Tukey's post-hoc test, MD = 0.0.61, p = 0.007). The maximum force of peck tended to be lower in birds trimmed at 10 weeks of age with the hot-blade than those trimmed at 1 day of age with the infra-red method (Tukey's post-hoc test, MD = 0.43, p = 0.085). Feeding of analgesic-treated or untreated feed had no effect on either the mean force of ten pecks (ANOVA, $F_{1,36}$ = 1.68, p = 0.20) or the maximum force (ANOVA, $F_{1,36}$ = 2.83, p = 0.10). However, the maximum pecking force of birds trimmed at 10 weeks of age with the hot blade was positively correlated with the amount of analgesic-treated feed eaten (Pearson Correlation = 0.66, N = 10, p = 0.032), though the average pecking force was not correlated to the amount of analgesic-treated feed eaten (Pearson Correlation = 0.51, N = 10, p = 0.13). No other significant differences were found either from the interaction of terms in the ANOVA tests or other post-hoc tests.

Simultaneous choice of analgesic-treated and untreated feeds

No evidence was found that birds from the four beak trimming methods consumed different amounts of analgesic-treated feed when both feeds were presented simultaneously (Figure 2, ANOVA, $F_{3,70}$ = 0.41, p = 0.74). Birds appeared to prefer red analgesic-treated feed over blue analgesic-treated feed for the first 3 days of the simultaneous feeding period, but this preference appeared to reverse on the fourth day (Figure 3; day/colour of feed interaction, ANOVA, $F_{3,210}$ = 2.8, p = 0.039). No evidence was found that food consumption of the treated and untreated feeds varied throughout the four days when both feeds were presented simultaneously (day/beak condition interaction, ANOVA, $F_{3,210}$ = 1.16, p = 0.32). No other significant third order or second order interactions were found (day/beak condition/colour interaction, ANOVA, $F_{3,210}$ = 0.91, p = 0.52; day/ colour interaction, ANOVA, $F_{3,210}$ = 1.44, p = 0.24).

Daily food consumption was 83.5±1.03 g of feed, irrespective of colour or drug. Over the four simultaneous choice days similar amounts of analgesic-treated and untreated feed were consumed (Figure 2; Paired t-test, t = 0.08, N = 80, p = 0.94). Similar amounts of red feed (42.3±2.3 g/day) and blue feed (41.4±1.9 g/day) was eaten irrespective of whether it was treated or not (Paired t-test, t = 2.0, N = 80, p = 0.84).

DISCUSSION

The pullets beak trimmed at 10 weeks of age pecked more gently than intact pullets, consistent with the hypothesis that these recently beak trimmed pullets were guarding a painful beak from further contact. Pullets trimmed at one day of age with the hot blade or infra-red method did not show a reduced pecking force compared to intact pullets. No general effect of carprofen was found on the force of pecks, though there was a positive correlation between the amount of analgesic-treated feed eaten and maximum pecking force in birds trimmed at 10 weeks, suggesting that birds that ate large amounts of the analgesic-treated feed may have experienced an analgesic effect. Following a period of training to distinguish between carprofen-treated feed and untreated feed as used by Danbury et al. (2000), beak trimmed pullets did not consume more treated feed than intact pullets when both feeds were presented simultaneously. We found no evidence of pain in birds at 11 weeks of age that were trimmed at one day of age by either the hot blade or the infra-red method.

Neurological studies on beak trimmed hens have shown neuromas in trimmed beaks some time after trimming (Breward and Gentle, 1985; Gentle, 1986), and neuromas are linked to chronic pain in humans, as occurs in amputated limbs (Wall, 1981). Trimming at day-old appears to reduce the incidence of neuromas as compared to trimming at older ages (Megret et al., 1996), and it may be that neuromas are resorbed sometimes between 10 weeks and 70 weeks following trimming (Lunam and Glatz, 1996). In the present study beak trimming resulted in a 34% reduction in beak length with no difference in beak length between the three trimmed methods, which would be considered a light trim compared to the more usual industry practice of removing about 50% of the beak. The amount of beak removed is likely to have a strong effect on the potential pain experienced (Glatz, 2000), so our current results should be considered relevant to a light trim and perhaps not representative of what birds may experience following removal of a larger portion of the beak. Trimming with a hot blade at 1 day of age resulted in the least difference in the length of the upper and lower beaks, which may be expected to facilitate these birds' ability to pick up and manipulate food. It should be noted though that different hatcheries may achieve different results with respect to the gap between the upper and lower beaks.

Laying hens reduce pecking-related behaviour in the first 2 weeks after trimming (Gentle et al., 1997) which has been considered to indicate protection of a painful area from further contact and stimulation (guarding behaviour). Furthermore, the observed decline in feeding rate after beak trimming can be prevented by the application of topical analgesics to the recently trimmed beak (Glatz et al., 1992). The lower pecking force of pullets trimmed at 10 weeks of age compared to intact pullets and those trimmed at 1 day of age in the present study supplements the above studies by indicating that even a light trim at this age appears painful to the hen for at least the first week after trimming. VanLiere (1995) found that beak trimmed birds are slower to peck a novel object than intact hens at 42 weeks after trimming, possibly indicating long-term guarding behaviour, though in the present study we found no evidence that the trimmed birds took longer to peck the novel round disc. It is unclear why our results did not replicate those of vanLiere (1995), though one possibility is that responsiveness in beak trimmed birds declines some time between 10 and 42 weeks of age.

Chickens in this study consumed on average 83±1 g of feed per day, which would have provided them with 6.6mg of carprofen/day on training days when only analgesic-treated feed was provided. This dose of carprofen compares well with the dose provided by Danbury et al. (2000) in their second experiment, in which they found that lame birds provided with a simultaneous choice of analgesic-treated and untreated feed ate 6.7 mg of carprofen/day, a significantly greater amount than sound birds. This dose in lame broilers resulted in a plasma concentration of carprofen of 0.28 μg/ml and improved their gait. In the present study, the maximum pecking force in birds trimmed at 10 weeks of age was positively correlated with the amount of analgesic-treated feed consumed, suggesting that very high doses of carprofen may have had an analgesic effect in these birds.

In light of the above evidence that indicates that birds in the present experiment received sufficient carprofen for an analgesic effect, it was surprising to find that birds trimmed at 10 weeks of age did not peck with more force when provided with treated feed. One possibility is that the reduced pecking force in birds trimmed at 10 weeks of age was not an expression of guarding behaviour, but instead arose from a bio-mechanical effect linked to the relatively recent shortening of the beak. Aside from the abovementioned correlation between pecking force and amount of analgesic-treated feed consumed by birds trimmed at 10 weeks, no effect of the treated feed was found on pecking force and no selection of treated feed by trimmed birds was found when treated and untreated feeds were provided simultaneous, raising the possibility that carprofen had no analgesic effect on the type of pain arising from beak trimming.

Support for this latter explanation is provided by Kupers and Gybels (1995). They found that rats with neuropathic pain, induced by partial sciatic nerve injury, did not consume more fentanyl (an opioid analgesic) than control rats. In contrast, rats with nociceptive pain, adjuvant induced monoarthritis, consumed significantly more fentanyl than control rats. They concluded that fentanyl has a good analgesic effect on neuromuscular pain but a poor analgesic effect on neuropathic pain. It may be that carprofen has a similar selective analgesic effect in chickens, in being effective for neuromuscular pain in lameness as reported by Danbury et al. (2000) but having no effect on neuropathic pain following beak trimming in the present study. Unfortunately, the mode of action of carprofen in birds is unknown.

Additionally, it is possible that the effects of carprofen observed by Danbury et al. (2000) may have arisen from the known (in mammals) anti-inflammatory action of carprofen, rather than from its analgesic action. The possibility that neuropathic pain is not affected by some analgesics raises two recommendations for future research on using self-administration of analgesics as a means to examine pain in beak trimmed birds. Firstly, future investigation of pain following beak trimming should consider using analgesics known to alleviate neuropathic pain in chickens, or at least a combination of different analgesics. Second, the possibility that some analgesics may alleviate pain associated with beak trimming, and that some analgesics may not, provides a methodological tool for investigating the neural pathways involved in processing any possible neuropathic pain following beak trimming.

In conclusion, neither pecking force analysis or a previously used self-administration of analgesic technique provided any evidence of pain at 11 weeks of age in laying pullets receiving a light beak trim at 1 day of age by a hot-blade or infra red method. Although we found evidence that birds trimmed at 10 weeks of age may have been in pain one week after the procedure, this pain was unaffected by carprofen. In contrast to the effect of carprofen in alleviating neuromuscular pain associated with lameness in broiler chickens as previously shown by Danbury et al. (2000), carprofen administered in a similar manner is not effective in alleviating neuropathic pain following beak trimming in laying pullets.

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