# THE EFFECTS OF LIGHT INTENSITY AND LIGHT SOURCE ON INJURIES DUE TO PECKING OF MALE DOMESTIC TURKEYS (*MELEAGRIS GALLOPAVO*)

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**Abstract** *Animal Welfare 2001,* ***10:*** 131-139

*It has been shown that, in small groups of intact male domestic turkeys, supplementary ultraviolet (UV-A) radiation, visual barriers, and added straw (environmental enrichment) minimize the incidence of injurious pecking under incandescent light at 5 lux. This paper describes two experiments, each involving eight groups of 100 non beak-trimmed birds up to 5 weeks of age, that assessed the effectiveness of these procedures at higher light intensities and with fluorescent light. Experiment 1 examined 5 or 10 lux of incandescent or fluorescent light. Experiment 2 studied responses to 5, 10, 36 or 70 lux of fluorescent light. Individual inspections of the birds, for wing, tail and head injuries due to pecking, were conducted daily.*

*Fluorescent light significantly reduced the incidence of tail injuries (*$P = 0.03$*), and tended to reduce those to the wings (*$P = 0.08$*), compared with incandescent light. No difference was observed between 5 and 10 lux for either tail or wing injuries. In Experiment 2, the incidence of tail and wing injuries was significantly and positively correlated with light intensity (tail,* $P = 0.05$*; wing,* $P = 0.02$*). Injuries to the head were minimal in all treatments. These results suggest that turkey poults may be kept with minimal injurious pecking, under fluorescent light at an intensity of 10 lux, with appropriate environmental enrichment.*

**Keywords**: *animal welfare, injurious pecking, light intensity, light source, turkeys*

## Introduction

Domestic turkeys *Meleagris gallopavo* kept under commercial conditions often perform injurious pecking (feather pecking, head pecking and cannibalism) which can lead to death or necessitate culling (Classen *et al* 1994; Hughes & Grigor 1996). These behaviours are of considerable welfare and economic concern, and, in an attempt to lower the impact of them, the commercial industry frequently trims beaks and keeps birds at low light intensities (<1 lux, Lewis *et al* [1998]). These practices are not wholly satisfactory because: i) beak-trimming is a painful procedure which may cause chronic pain (Gentle 1992); and ii) eye abnormalities have been reported under these low light intensities (Siopes *et al* 1984).

It is widely accepted that feather pecking is a redirected foraging behaviour triggered by an impoverished foraging environment; the provision of straw to laying hens will significantly reduce feather pecking (Huber-Eicher & Wechsler 1997). It has also been suggested that social learning might be involved in the development of feather pecking (Lindberg & Nicol 1994) and head pecking (Sherwin 1998). Accordingly, it has been suggested that the use of visual barriers should reduce the opportunity for birds to see these behaviours and prevent them from being learned from pen mates (Wechsler & Schmid 1998; Sherwin *et al* 1999). Aspects of the bird's visual ecology should also be taken into account; this might play a role in the bird's recognition of foraging items in the pecking substrate, of plumage markings (Sherwin & Devereux 1999), and of its perception of pen mates (Bennett & Cuthill 1994). Past work has underlined the fact that artificial visual environments which are appropriate for humans might not be the most suitable environments for birds (Manser 1996). Intensity, spectral distribution and source of light can be manipulated to better suit the birds' preferences. For example: i) turkeys chose to spend more time at 5, 10 or 25 lux than at an intensity of less than 1 lux (Sherwin 1998); ii) domestic fowl are believed to perceive light from an incandescent source, of the same lux reading, to be brighter than from a fluorescent source (Lewis & Morris 2000); and iii) both turkeys (Sherwin 1999) and domestic fowl (Widowski *et al* 1992) showed a preference for fluorescent over incandescent light. Additionally, poultry are capable of vision in the ultraviolet spectrum (UV-A) (Hart *et al* 1999; Prescott & Wathes 1999); and Moinard & Sherwin (1999) reported that turkeys preferred a principally UV-A-enriched environment to one illuminated by fluorescent light alone. The difference in the sensitivity of a bird's eye from that of a human, shows that both the spectral composition of the light source and its intensity should be given consideration when housing birds in controlled environment facilities. Effectively, incandescent and fluorescent light sources emit minimal UV-A radiation (at 320-400 nm), and these two types of light source are commonly used in commercial practice.

This work complements previous research (Sherwin *et al* 1999) which has shown that supplementary UV-A, visual barriers, and added straw (environmental enrichment) minimized the incidence of injurious pecking in turkeys maintained under incandescent illumination at 5 lux. However, 5 lux is still a low light intensity and probably marginal for satisfactory bird inspection. Therefore, stock personnel sometimes temporarily increase the light intensity, with the possibility of causing alarm for the birds (Appleby *et al* 1992). This paper describes two experiments that assessed the effectiveness of these enrichments on the incidence of injurious pecking in young male turkeys which had not been beak-trimmed nor had their snood removed (intact). Experiment 1 compared two light sources (incandescent or fluorescent) at 5 or 10 lux. Experiment 2 studied four light intensities (5, 10, 36 and 70 lux) of fluorescent light. These experiments focused on the first 5 weeks of life, because earlier studies indicated that injurious pecking amongst turkey poults occurs consistently from an early age (Sherwin *et al* 1999).

## Methods

### *Ethical note*

This investigation was conducted under a UK Home Office project licence (CSA3028-G31504) and was part of a MAFF funded study to develop a method of rearing turkeys such that injurious pecking was minimized. In terms of welfare, the following steps were taken: i) the minimum number of replicates was used to allow satisfactory statistical analysis; ii) the minimum number of birds was used which, it was believed, remained representative of commercial conditions; iii) the duration of the study was minimized; and iv) poults were culled if injuries perforated the skin to a depth of more than 3mm or if head pecking caused an injury larger than $1cm^2$ in area (experience indicates that birds head-pecked to this extent are likely to be pecked incessantly and almost always fatally). When culling was necessary, UK Home Office approved methods were used, ie cervical dislocation for birds weighing < 3kg and an overdose of anaesthetic by intravenous injection for birds > 3kg.

***Animals, housing and husbandry (Experiments 1 and 2)***

For each experiment, we used 800 intact BUT-Big 6 male turkeys. At 1 day of age, they were separated into eight groups of 100 birds; each group was housed on a wood shaving litter floor in a light-proof room (4.3x4.6 m). All poults were given continuous illumination for the first 24h from a centrally-positioned single incandescent lamp (Sylvania, 100W pearl, SLI Lighting Ltd, Shipley, UK). On days 1 and 2, light intensity was 240 lux, measured at bird's eye height under the light source, and 70 lux at the perimeter of the room. On day 2, a 12L:12D (0600 - 1800 h) lighting regimen was imposed. On day 3, the incandescent lamp was removed, and each room was then illuminated by four, wall-mounted light sources located at a height of 2m. Additionally, from day 1, supplemental UV-A radiation was supplied for the duration of the photoperiod from two blacklight-blue tubes (Philips 'TL' D, 36W/08, Philips Lighting, Einhoven, The Netherlands), each suspended at a height of 2m and 1.2m from the edge of a side wall. These produced a radiation intensity that ranged from 0.06 (room corner) to 0.16 (under the tube) $Wm^{-2}$ (proportion: 0.988 UV-A and 0.012 UV-B) at a height of 10cm, as calculated from energy output data supplied by the lamp manufacturer. From day 1, in all rooms, visual barriers, ie four, free standing plywood boards, 120x30 cm, were arranged in an unconnected cross shape to divide the room into approximate quarters while allowing the birds free access within the room. From day 3, rough-cut wheat/straw was given at an approximate rate of 2 kg $room^{-1}$ every third day.

On day 1, the birds were given commercial starter crumbs (BOCM Pauls, Ipswich, UK) *ad libitum* on large sheets of paper covering the litter (to facilitate feeding) and in three feeders (each 39cm in diameter). On day 5, the paper was removed. Water was provided *ad libitum* from two circular hanging bell drinkers (45cm diameter), that were supplemented during the first week by three, free-standing bell drinkers. Fresh wood shavings were added at various intervals, as required, but simultaneously in all rooms.

The desired room temperature that was achieved by warm air blown through a glass fibre ceiling, was reduced every second day in 1°C steps from 35°C on day 3 to 18°C on day 34. In the early stages, thermoregulation was assisted by two, dull infra-red (>780 nm) emitters, so that the birds were in complete darkness during the scotoperiod (period of darkness) of the lighting regimen.

The lighting patterns and air temperature regimen approximated those used for the rearing of commercial turkey poults.

***Treatments***

Treatment intensities were set up by measuring the light at nine evenly spread locations in the room on a digital light meter (Megatron DL5, Megatron Ltd, London, UK) with its lens held horizontally at a height of 10cm. To achieve the desired intensities, voltage reduction equipment was used for incandescent lamps, and aluminium foil was wrapped around the fluorescent lamps.

*Experiment 1*

In all the rooms, light was provided by either four compact fluorescent lamps (Osram Dulux EL 7W, Wembley, UK) or four incandescent lamps (Sylvania, 40 W Pearl, SLI Lighting Ltd, Shipley, UK). Mean (± SEM) light intensities were 5 ± 0.3 lux incandescent (IN5), 5 ± 0.3 lux fluorescent (FL5), 10 ± 0.3 lux incandescent (IN10), or 10 ± 0.3 lux fluorescent (FL10).

There were two rooms in each treatment except, due to an inadvertent error in setting the light intensity, three rooms for IN5 and one room for IN10.

*Experiment 2*

In each room, light was provided by four fluorescent bulbs (Osram Dulux EL, 7 or 14 W) giving a mean white light intensity of 5 ± 0.3 lux (FL5), 10 ± 0.3 lux (FL10), 36 ± 1.2 lux (FL36) or 70 ± 1.9 lux (FL70). There were two rooms in each treatment.

***Observations (Experiments 1 and 2)***

Each bird was examined visually for signs of injury (fresh or congealed blood, or scab) on a daily basis at 1200h, including their position on the body (tail, wing and head). For welfare reasons, the birds were also monitored on several other occasions each day, but the data presented are restricted to those gathered during the observation period.

***Statistical analysis (Experiments 1 and 2)***

Each room was treated as an experimental unit. Daily counts of injuries were plotted for both the tail and the wings. The area under these curves was used as a measure of any treatment effect. For Experiment 1, the data were subjected to a Mann-Whitney *U* test. For Experiment 2 a linear regression analysis was carried out. Injuries to the head were minimal, so these data were not subjected to statistical analysis.

## Results

***Experiment 1***

Injuries due to wing pecking were first observed on day 6 (both FL5 rooms, Figure 1), and were recorded in all rooms by day 11 (Figure 1). Injuries due to pecking to the tail were first observed on day 10 (IN10, Figure 2), and were recorded in every room by day 28 (Figure 2). For the entire duration of the experiment, only two birds with pecking injuries to the head were observed at 24 and 25 days of age (both in FL10).

From a descriptive point of view, using the areas under the curve for each treatment, the mean values were ranked. For wing injuries, FL5 = 36.5 < FL10 = 61.5 < IN5 = 80.7 < IN10 = 240; for tail injuries, FL10 = 10.5 < FL5 = 13 < IN5 = 23 < IN10 = 55. When comparing the different values obtained for each area in terms of light source effect (IN vs FL), injuries to the tail were significantly less common under fluorescent light ($z = 2.17$, $df = 1$, $P = 0.03$); and injuries to the wing tended to be less common under fluorescent light ($z = 1.73$, $df = 1$, $P = 0.08$). When the values were grouped according to light intensity (5 vs 10 lux), a separate Mann-Whitney *U* test showed that light intensity had no significant effect on either tail or wing injuries.

***Experiment 2***

Wing injuries were first observed on day 5 (in one of the FL36 rooms, Figure 3), and were recorded in all rooms by day 12 (Figure 3). Tail injuries were first observed on day 18 (in one of the FL36 rooms, Figure 4), and were recorded in every room by day 28 (Figure 4). For the entire duration of the experiment, only three birds with pecking injuries to the head were observed (at 27 and 33 days of age in one of the FL10 rooms and at 29 days of age in one of the FL5 rooms).

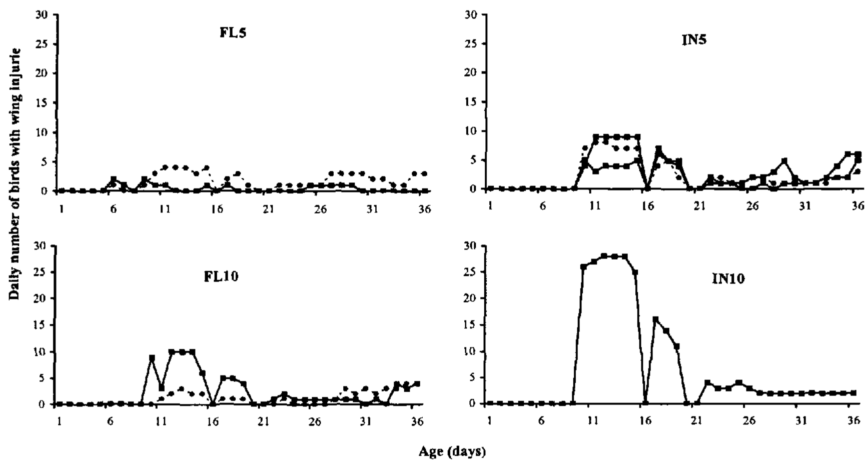


**Figure 1** **Daily numbers of turkeys with wing injuries, under different light intensity and source conditions. Each line represents data from one room (n = 100 birds) for each treatment. FL5 - 5 lux fluorescent; IN5 - 5 lux incandescent; FL10 - 10 lux fluorescent; IN10 - 10 lux incandescent.**

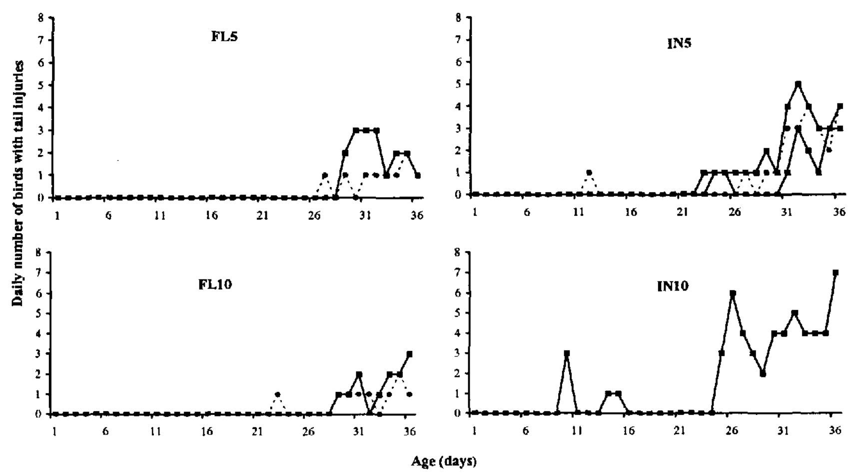


**Figure 2** **Daily numbers of turkeys with tail injuries, under different light intensity and source conditions. Each line represents data from one room (n = 100 birds) for each treatment. FL5 - 5 lux fluorescent; IN5 - 5 lux incandescent; FL10 - 10 lux fluorescent; IN10 - 10 lux incandescent.**

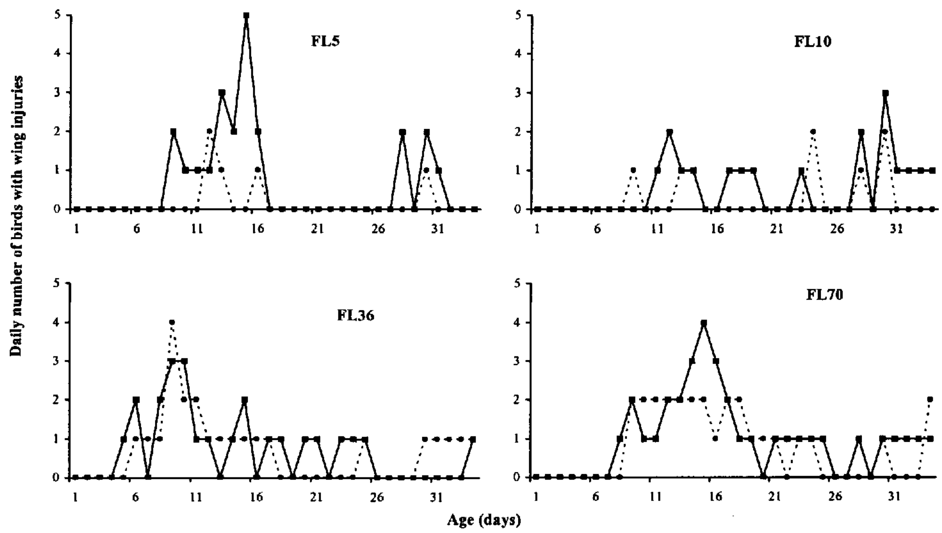


Figure 3 Daily numbers of turkeys with wing injuries, under different fluorescent light intensity conditions. Each line represents data from one room (n = 100 birds) for each treatment. FL5 - 5 lux fluorescent; FL10 - 10 lux fluorescent; FL36 - 36 lux fluorescent; FL70 - 70 lux fluorescent.

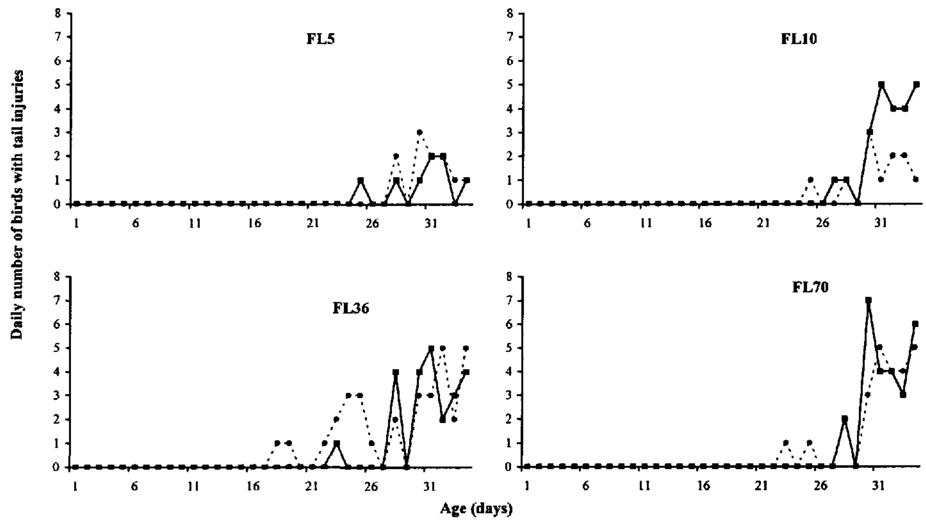


Figure 4 Daily numbers of turkeys with tail injuries, under different fluorescent light intensity conditions. Each line represents data from one room (n = 100 birds) for each treatment. FL5 - 5 lux fluorescent; FL10 - 10 lux fluorescent; FL36 - 36 lux fluorescent; FL70 - 70 lux fluorescent.

From a descriptive point of view, using the areas under the curve for each treatment, the mean values were ranked. For wing injuries, FL10 = 13.0 < FL5 = 13.5 < FL36 = 23.5 < FL70 = 30.5; for tail injuries, FL5 = 9.5 < FL10 = 17 < FL36 = 25.5 < FL70 = 27.5. The number of birds with injuries to the tail ($r^2 = 0.49$, $df = 6$, $P = 0.05$) and to the wing ($r^2 = 0.64$, $df = 6$, $P = 0.02$) were significantly and positively correlated with light intensity.

## Discussion

The onset of wing and tail injuries due to pecking correlated closely with previous findings (Sherwin *et al* 1999), with wing pecking starting at the end of the first week of life, and tail pecking towards the end of the second week. The concurrence of these timings at which pecking first occurred might indicate an important stage in the development of the plumage and/or of the behaviour of turkey poults which has yet to be fully understood. The only information currently available is the coincidence of the emergence of UV-A reflective markings on the plumage and the commencement of pecking (Sherwin & Devereux 1999). Artificial light sources (minimal UV), as provided in a controlled environment, might change the appearance of these markings and, so, stimulate injurious pecking behaviour.

At least two explanations can be advanced for the lower incidence of tail and wing pecking under fluorescent compared with incandescent light (Experiment 1). First, if fluorescent light is perceived to be less bright than incandescent light (Lewis & Morris 2000), the difference observed in the incidence of pecking could be explained by a simple reduction in the perceived light intensity (Lewis *et al* 1998). Second, one large difference between the spectral composition of incandescent and fluorescent light is the proportion of red (630-780 nm) light they contain (10% in fluorescent vs 70% in incandescent, Lewis & Morris [2000]). This difference might change the bird's visual environment such that changes in behaviour might occur (Gill & Leighton 1984).

The increased incidence of injurious pecking in Experiment 2 at higher light intensities concurs with earlier findings (Lewis *et al* 1998; Sherwin *et al* 1999). However, the lower (numerically) incidence of pecking in FL70 (Experiment 2) than in IN10 (Experiment 1) suggests that, despite the seven fold higher intensity, fluorescent light may have a positive impact on the birds' welfare. There has been some concern as to whether the discontinuous nature of fluorescent light might be perceived by hens as flicker, particularly in Europe where fluorescent lamps operate at a frequency of 100Hz. Whereas the modulation is probably perceived as a flicker at high light intensity, it is unlikely that it is so at low light intensity (Nuboer *et al* 1992). Turkeys have also been shown to demonstrate a preference for fluorescent over incandescent sources of illumination at 10 lux (Sherwin 1999), further suggesting that flicker does not create problems for them. Alternatively, it is possible that the threshold for perception of flicker at the intensities used in our trials was less than 100Hz.

### *Animal welfare implications*

These experiments were designed to determine whether, by using several forms of environmental enrichment (ie supplemental UV-A, straw and visual barriers), it would be possible to use a brighter light intensity without increasing injuries due to pecking. The results are very encouraging. In experiment 2, birds were kept at 70 lux with no mortality and minimal injurious pecking. However, in an earlier trial (Lewis *et al* 1998) in which there was no environmental enrichment and only incandescent illumination, the total mortality (deaths plus culling) during the first five weeks reached 4 per cent at 1 lux and 8 per cent at 10 lux. It is worth remembering that the birds used in our studies and in the earlier trial were neither beak-trimmed nor desnooded; in commercial conditions, these are normal practices to minimize the incidence of injurious pecking.

Whereas our studies and an earlier trial (Lewis *et al* 1998) have shown some important ways in which a modification of the bird's visual and material environment can reduce the incidence of injurious pecking in growing turkeys, it must be appreciated that the relative contribution made by the light intensity, the light source and its spectral characteristic are still unknown. It is also clear that a better understanding of the internal and external causal factors of injurious pecking would contribute towards the identification of an environment that might minimize all types of pecking. Before any of the techniques from these experiments are introduced into commercial turkey practice, it would be prudent to re-evaluate them in large-scale field trials and to conduct the trials through to a slaughter age of 20-22 weeks.

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