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Impact of coloured LED-lighting zones on immune parameters and welfare of turkeys

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Summary

Coloured light is suggested to decrease the risk of feather pecking and to positively influence animal health. Only few studies comparing colored and white light have been published so far. Most of them did not consider possible differences in perceived light intensity due to spectral composition. Therefore, the aim of this project was to determine the impact of coloured LED-lighting zones with identic light intensity on welfare and health as well as on the immunological parameters in not beak trimmed fattening turkey hens. In two repeated experiments, two groups of turkeys (n =22 birds/group) were raised either under non-structured conditions (controls) or in a stable with coloured lighting zones (light enriched group), including white, red (λ=623nm) and green (λ=524nm) light. Over a period of 12 weeks (from fattening day 0 - 90) birds were video monitored for behaviour including feather pecking and cannibalism, and scored for plumage conditions and injuries using a hands-on method. Immunological parameters such as antibody responses following routine vaccinations and composition of circulating immune cell populations, as well as serum corticosterone levels were determined. The light enriched group showed no differences in blood cell parameters, but higher serum corticosterone levels at several time points compared to the controls ($p < 0.05$). No significant differences between groups were observed in the video analysis. The plumage-scores were significantly higher for the control-group indicating more severe

feather lesions until day 52; however at the end of the trial birds in the light enriched group had higher feather scores for the head region compared to the controls ($p < 0.05$). Our study suggests that coloured lighting might be used to influence feather pecking behaviour mainly in young turkeys, since this effect appears to correlate with age.

Introduction

In confined housing systems lighting is an important factor, influencing not only the behavior (MOINARD et al. 2001) but also physiological processes (SCOTT et al. 1994; MOHAMMED et al. 2016). The effects can be caused by different light parameters, such as quantity (intensity), quality (spectral composition or color), lighting period (day length) and others (dim-phases, light source, etc). There have been several investigations on effects of light intensity (BARBER et al. 2004) and preferences of turkeys for specific light intensities, but effects of the quality of light remain scarcely researched. Furthermore turkeys, like chicken, perceive colors different from humans (BARBER et al. 2006). To be able to compare effects of light of different color on animal health and behavior, light intensity needs to be adjusted between groups with respect to turkey's perception. An adjustment based on human light perception, which is based on the measurements in Lux, is not suitable (KÄMMERLING et al. 2017).

Lighting is well known to influence feather pecking and cannibalism (MOINARD et al. 2001) among other possible factors (genotype, diet, stable climate, social learning) (HUBER-EICHER et al. 1999; NATT et al. 2007; MARCHEWKA et al. 2013). Therefore, the aim of this project was to determine the impact of colored LED-lighting zones with identic light intensity on welfare and health as well as on the immunological parameters in fattening turkey hens with intact beak

Materials and Methods

In a first placement a group of 22 non beak-trimmed B.U.T. 6 turkey hens was exposed to light sources providing three differently colored lighting zones (white with a small proportion of ultraviolet, red (λ=623nm) and green (λ=524nm), light enriched group). This group was compared with another group exposed to white light with a proportion of ultraviolet (UV) radiation. Because both groups were lighted by LED - lamps a second control group,

lighted by fluorescence-type lamp was added. The lights in all stables were adjusted to 63 gallilux what corresponds to ~50 lux for the used spectral compositions of white light (NUBOER et al. 1992; PRESCOTT et al. 1999). All groups received light for 16 hours each day with a 30 minutes dim-phase at the beginning and the end of the day.

Turkeys were provided with copped wood as litter, water and feed ad libitum and fattened over 90 days. Over this period blood was drawn on five occasions (23, 43, 60 and 88 days post hatch) to count blood cell populations and collect serum. Body weight and ocular health were examined four times (0, 14, 52, and 88 days post hatch), and the condition of plumage was manually evaluated three times (14, 52 and 84 days post hatch). Animal behavior was recorded over the whole trial using video cameras and behavioral patterns were counted on five days over the fattening period (16, 30, 45, 58, and 73 days post hatch). On these days occurrence of seven pre-defined behaviors (feather pecking, head pecking, fighting, flying/running, foraging, preening, and dust bathing) were counted for all turkeys of the respective group over three minutes starting at 6, 8, 10, 12, 14, 16, 18 and 20 o'clock.

Corticosterone was extracted from serum (EIKENAAR et al. 2014) and measured via ELISA (Enzo Life Sciences, NY, USA). Blood cell counts were determined via flow cytometric analysis (SELIGER 2009; SELIGER et al. 2012). Birds were vaccinated against Newcastle disease (ND) based on a commercial schedule, and ND-antibody-titers were measured in serum with a commercial ELISA-kit (Synbiotics Corporations San Diego, CA, USA).

In a second placement the red zone was replaced by a second white zone with UV-content. Different to the first trial, the scoring of the plumage was done five times (14, 32, 42, 53, and 67 days post hatch) and ocular examination four times (1, 43, 50 and 71 days post hatch).

Results and Discussion

No negative influences of LED-light on ocular health (intraocular pressure and ophthalmic examination of the ocular fundus, anterior chamber, and posterior chamber) were detected in either group and experiment. In the second placement the colored light group showed elevated intraocular pressure on day 50 compared to the controls.
In the first placement head pecking was elevated in the light enriched group in comparison to both control groups (Kruskal-Wallis-test, $p < 0.05$). The

foraging behavior was counted more often in the colored light group in comparison to the fluorescence control group throughout the trial (ANOVA of Log-transformed counts, $p < 0.05$). In the second placement, when no red colored light was used, no significant differences were found in the different behavior parameters between groups.

In the first placement significantly higher plumage scores indicating increased loss of feathers were found in the light enriched compared to the control groups in the head- and wing-region. No differences were observed in the other body regions (Chi-square-test, $p < 0.05$). In the second placement animals of both the LED-control and light enriched groups had lower plumage scores than the fluorescence-exposed group at the neck and wing-region, while in the tails region only the light enriched group showed lower scores compared to the fluorescence group (Chi-square-test, $p < 0.05$).

In the first placement, serum-corticosterone was elevated on several days in the light enriched group in comparison to the fluorescence control (ANOVA of log-transformed values, $p < 0.05$). In the second placement, the only difference in corticosterone levels was found for day 88, when the LED-control group showed higher values than the other two groups. None of the lighting systems caused persistent differences in blood cell counts or antibody titers as measured by flow cytometric analysis and ELISA, respectively.

Overall, the enrichment with colored LED-lights did not significantly reduce feather pecking and cannibalism compared to the two control groups. Specifically, during the first placement, which included the red lighting zone, not only higher counts of head-pecks were observed in the light enriched group but also an increased loss of feathers was found in the neck and the wing region, which as associated with elevated serum corticosterone levels. Because of these findings, the red zone was replaced in the second placement with an additional white LED-light zone, and subsequently less pecking and improved plumage scores were observed in the light enriched group. Therefore, we may conclude that light enrichment under our experimental conditions did not significantly benefit the animal behavior, but it also did not have any detectable negative impact on the health parameters, determined in this study.

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