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Light preferences of broiler chickens across functional zones in the broiler house

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ABSTRACT

Lighting plays a crucial role in the welfare and performance of broiler chickens, influencing growth, behaviour, and physiological responses. While numerous studies have examined the effects of monochromatic light on performance parameters, little is known about broilers' active light recipe preferences when given a choice, particularly in relation to functional zones of the housing environment. This study investigated broiler chickens' light recipe preferences across four functional zones: feeding, drinking, resting, and scratching area using a dynamic light-emitting diode system. A total of 1680 male ROSS 308 chicks were reared over four consecutive production rounds with four pens per round under controlled environmental conditions. Each pen contained four functional zones equipped with three distinct light recipes per zone: one control (white 3000 K) and two test light recipes that rotated between rounds to avoid location bias. Locations of the chickens were obtained through continuous video monitoring and object detection using the You Only Look Once (**YOLO**) algorithm, resulting in over 500 million individual bird detections. Results showed that occupation of functional zones varied with age: feeding and drinking areas were most used in the starter phase, while resting and scratching areas gained prominence as birds aged. Light colour significantly affected occupancy within each functional zone. In feeding areas, birds consistently avoided red light during starter and grower phases, preferring control and cyan lights. There was a tendency for control light to be preferred over yellow and cyan in the drinking areas. In areas designed to promote comfort behaviours, such as resting or preening, whether facilitated by platforms or not, birds consistently preferred cold white light (8000 K) across all phases. No consistent light preferences were observed in scratching zones designed to elicit foraging and play behaviours, although a relative preference for white+UV light was observed during the grower phase. These findings demonstrate that broilers exhibit zone- and age-specific colour preferences, emphasising the importance of specific lighting strategies to enhance welfare and behaviour in commercial poultry housing systems, such as omitting red around feeding zones and using cold white colours in zones that promote comfort.

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Implications

Light is one of the few factors that can be manipulated in poultry houses, with consequences for behaviour and production. Zone-specific and age-dependent light recipes could encourage birds to use areas that promote feeding, support rest, and facilitate natural behaviours such as scratching. Avoiding the use of red light in feeding zones to encourage feeding, while providing blue-enriched or cold white light in resting areas, may increase the frequency of comfort behaviours. Programmable lighting systems therefore offer a tool to adapt the light recipes to the birds' behaviour-specific preferences, thereby optimising space use and contributing to welfare-friendly poultry production systems.

Introduction

There is an increasing interest in providing broiler chickens reared in intensive farming conditions with good lighting (Galan et al., 2025; Linhoss et al., 2025). Lighting is fundamental in enabling the birds to show natural behaviour and perform well, as it affects growth (Cao et al., 2012; Yang et al., 2016), stress, fear

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responses (Xie et al., 2008; Riber, 2015; Remonato Franco et al., 2022a) and activity level (Perretti et al., 2025).

In contrast with trichromatic humans, birds possess a fourth cone, making them tetrachromatic and allowing them to perceive a larger range of wavelengths beyond human vision (Lewis and Gous., 2009; Kram et al., 2010; Wilson and Lindstrom, 2011; Jiao et al., 2014; Parvin et al., 2014; Egbuniwe and Ayo, 2016). Light not only impacts visual abilities but also stimulates the pineal gland and hypothalamus, regulating circadian rhythms and hormone secretion (Lewis and Morris, 2006; Baxter et al., 2014).

Light perception is influenced by three key parameters. The first parameter is the light intensity, also defined as brightness, illuminance or density (Deep et al., 2010; Blatchford et al., 2012; Raccoursier et al 2019). The second parameter is the light duration, also defined as the photoperiod (**L**) and scotoperiod (**D**). In commercial broiler chicken farms in the European Union, the light–dark cycle is typically 18L:6D during the rearing phase except for the first week and the last 3 days, according to European legislation (2007/43/EG; Linhoss et al., 2025). The last parameter, which is the subject of this study, is colour, defined by its peak wavelength in nanometres (nm) and units of kelvin (K) (Linhoss et al., 2025).

In the broiler production industry, commonly used light sources are classified as cool-white or warm-white light. Cool white light (>5000 K) appears bluish due to shorter wavelengths (450–490 nm), while warm white light (<3000 K) has yellowish tones from longer wavelengths (570–700 nm) (Linhoss et al., 2025). With the introduction of LED in broiler housing, selected single wavelengths can be emitted, and by extension, monochromatic light can be introduced in light recipes (Linhoss et al., 2025). A light recipe is a lighting program that specifies the intensity and spectral composition of light throughout a production cycle.

The effects of monochromatic lights on broiler performance, health, behaviour, and welfare have been extensively studied. Blue and green light have been associated with improved growth and calmness (Hassan et al., 2016; Mohamed et al., 2020), while red light has been linked to increased activity and aggressive behaviours, and reduced weight (Hesham et al., 2018; Soliman and El-Sabrout, 2019). In these studies, broilers were raised under a fixed experimental light throughout the production cycle and their behavioural response was measured. However, little is known about their preference between light colours. Preference testing offers a more animal-centered approach by allowing animals to choose between different lighting options. This does not identify absolute lighting needs, as it only reflects choices within the specific set of options presented.

Only a few studies have explored broilers' actual light colour preferences by offering them free access to multiple light colour options, suggesting that preferences may vary with age and time of day (Khosravinia, 2007; Riber, 2015; Aldridge et al., 2021; van der Sluis et al., 2025). Nonetheless, little is known about broilers' distribution among different light colours when provided with free choice, particularly in relation to functional zones such as feeding, drinking, resting and scratching areas. The present study aimed to investigate broiler chickens' light colour preferences when provided with free access to three light options in different functional zones (feeding, drinking, resting, and scratching areas) throughout the rearing period. The hypothesis was that broilers would preferentially select specific light recipes depending on the functional zone.

Material and methods

Study design

The study spanned 4 consecutive production rounds. In each round, 560 one-day-old chicks (male, ROSS 308) were purchased from a commercial hatchery (Belgabroed, Merksplas, Belgium), totalling 2 240 birds for the entire study. In each round, birds were randomly divided into four pens of 36 m^2, resulting in a stocking density of 3.8 birds/m^2 or 140 birds per pen (14 kg/m^2 at the end of the round). This lower density in comparison with conventional production (most commonly 42 kg/m^2) allowed us to assess preference for zones with less interference from social competition. The pens were allocated into two independently climate-controlled compartments with 2 pens per compartment. The solid concrete floor was covered with wood shavings (2.5 kg/m^2). The pens were fitted with a feeding line and drinking line having, respectively, three feeding pans and three areas of nipple drinkers, with each area containing three nipples (Roxell, Maldegem, Belgium). The round feeders had a diameter of 332 mm and were coloured yellow and grey. They were mounted so that the pan height approximated the breast height of the chicken. Each nipple drinker was supplied by a cup to avoid wet litter, and was coloured yellow. Its height was determined and modified according to the height of the growing chickens with their neck stretched.

This study was part of a larger project studying the effect of cooled platforms during heat stress in the finisher phase (Khalfi et al., 2024; Carvalho et al., 2026; Khalfi et al., 2026). To evaluate whether light colour preferences depend on environmental conditions, we tested the effects of heat stress and environmental enrichment in the form of multifunctional platforms. The functional and performance outcomes of these experimental conditions are discussed by Khalfi et al. (2024). In short, in each round, half of the pens, one per compartment, were fitted with three platforms. These provided the birds with a water-cooled perching area as well as a dark shelter underneath. The other half of the pens served as a control (no platforms). These platforms were present during the entire round. The zone around the feeding line (EAT), the drinking line (DRINK), a zone with or without platforms (both intended as resting zones: REST), and an open zone that was intended to promote scratching, playing and foraging behaviour (SCRATCH) served as the four functional zones per pen. In the control pens without platforms, there was no structural difference between REST and SCRATCH. Because no direct observational measurements were taken, no interpretation of specific behaviours could be made.

Each of the four functional zones (EAT, DRINK, REST AND SCRATCH) was fitted with a separate dynamic light-emitting diode system (Spectra, Explorentis, Leuven, Belgium). The smart spectra system, controlled by a central driver (Spectra Edge Controller, Explorentis, Leuven, Belgium), allowed light-emitting diodes to emit a variable spectrum. The design of a specific light recipe was channel-based by varying distinct primary colours (red, green, blue). An additional functionality allowed natural light spectrum to be incorporated (Spectra+, Explorentis, Leuven, Belgium). This system added intensity at specific wavelengths in addition to the three primary colours depending on external input, shifting from a channel-based to a spectral-based light. In addition to the experimental lights above the specific areas, there were also main lights in the broiler house. The experimental lights used a similar light–dark schedule as the main lights of the broiler house (L18D6; CORAX, HATO agricultural lighting, Sittard, The Netherlands). The experimental lights above functional zones emitted 30 lux at bird eye level during the trial period, and between light and dark periods, light faded gradually over the course of 20 min by means of the dynamic nature of the system. The light systems were mounted 80–100 cm above floor level. Two lamp units were used per recipe, totalling 6 lamps per functional zone and 24 lamps per pen.

Each functional zone possessed three light recipes. One recipe served as a control (**CON**, White correlated colour temperature (**CCT**) of 3000 K) based on regular poultry lighting systems, and two other colours served as test lights per functional zone; test light 1 (**T1**) and test light 2 (**T2**). T1 and T2 differed between functional zones and were chosen according to the specific needs of the

bird based on empirical evidence. The study was set up as an alternate block design in which, per production round, the three light recipes were rotated within a functional zone. In that way, each location of an individual feeding pan, drink nipple, area with/or without platform, and scratching areas were covered by a different light recipe throughout the study to limit location bias. The location of each light recipe was fixed within a round, enabling birds to learn their preferred location associated with the light (Table 1; Fig. 1A). To summarise, there were 4 production rounds, with each round containing 4 pens. Each pen was divided into four functional zones (EAT, DRINK, REST, AND SCRATCH). Within each functional zone, there were three light areas where broilers could express a preference.

In the eating zone, T1 and T2 were represented by respectively monochromatic RED and CYAN (Fig. 2). The narrow-band lighting resulted in low-contrasting viewing conditions, which might have influenced the perception of feed. The use of RED and CYAN was selected to induce respectively activity and calmness (Hesham et al., 2018). The drinking area held a similar rationale, with T1 and T2 being represented by dichromatic YELLOW (red and green) and CYAN, respectively. In the rest zone, colour temperature (Kelvin) was adapted with T1 having 2000 K by the addition of orange and red, obtaining WARM WHITE, and T2 having 8000 K by the addition of green and blue, resulting in COLD WHITE. The choice of a broad spectrum mimicking natural daylight might promote resting behaviour. The distinction between warm and cold colours between treatments mimicked variation in atmospheric scattering. In the last zone, which was designed as a scratching zone, treatments were induced by adding boundary spectra of UV as T1 and IR as T2. These spectra cover the broader visual range of birds compared with that of humans. This could increase the responsiveness of the birds to their surroundings and promote natural behaviour such as scratching and foraging between the wood shavings.

The dietary recommendations of the breeder were followed to create a three-phase diet: starter (mash, days 0 to 9), grower (pellet, days 10 to 22), and finisher (pellet, days 23 to 41). During the first week and last day of the rearing phases, a 23L-1D schedule was maintained. Between days 7 and 42, the birds received a 16L-1D-1L-4D-1L-1D lighting schedule. A stable temperature of 32 °C was maintained in the first week, after which it decreased gradually by 4 °C per week to be kept stable at 22 °C during the last two weeks. A mild cyclic heat stress was applied from days 29 to 33 and days 36 to 40 in one of the two compartments (**HS**), while the control compartment remained under thermoneutral conditions (**TN**). A daily heat stress cycle consisted of a 3-hour increase in temperature until 32 °C, which was maintained for 6 h (0900–1500 h, followed by a cool-down period of 3 h back to 22 °C. Humidity, temperature, and CO_2 were recorded hourly in both compartments during the HS period. Between rounds, the allocation of pens to platform and no-platform treatments and of compartments to heat-stress and thermoneutral conditions was rotated to balance the study.

Data acquisition and processing

A multicamera setup to monitor chicken distribution was employed, with four cameras per pen (Cardoen et al., 2025). Video recording followed a weekly schedule with recordings of 1 or 2 h, with 2 h between recordings; the recording pattern changed day by day but across the weekly schedule. In summary, every hour, the lights were on, and video was captured. Each video was processed using the YOLO algorithm for object detection, and detections were projected onto a common ground plane using calibration parameters, as described in detail in Cardoen et al. (2025). Because cameras were reattached after each cleaning round, calibrations were re-estimated for each iteration. This resulted in sixteen cameras recalibrated across four rounds, yielding a total of sixty-four independent calibrations. To ensure consistency, bundle adjustment was performed so that all cameras projected onto a unified ground map.

In total, 4798 h of video at 1 frame per second were processed, corresponding to approximately 534.8 million individual chicken detections. For each calibration, pen boundaries were manually defined, and each pen was subdivided into twelve light areas, with corresponding boundary areas (Fig. 1B). Boundary areas were added to avoid counting chickens that were located in a blend of two light colours. These areas were tuned individually for each of the four pens across 4 rounds, resulting in sixteen unique area definitions that accurately reflected the light colour occupation patterns observed in the experiment.

In addition to the main dataset, a more restrictive dataset was constructed to obtain an indication of active drinking and feeding behaviour, using the number of birds observed in close proximity to feeders and drinkers as a proxy (Fig. 1C). Centres of these areas were manually indicated for each pen and round. Around these centres, circular areas were defined whose radii varied with the age of the chickens. A bird was classified as feeding when its coordinates fell within the feeder pan plus one age-dependent broiler radius, and as drinking when its coordinates fell within two age-dependent broiler radii of the drinker centre (Supplementary Figure S1). The extra radius around the feeder accounts for a bird standing at the pan with its head in the feed. The drinker was treated as a point source: birds access the nipple from the side, and a bird standing beneath the drinker occupies that space, so a neighbouring bird must reach from further away. Because that occupied space scales with body size, the drinking zone was set to two age-dependent broiler radii from the drinker centre. The broiler radius was modelled as a linear function of age (in days) (ra-

Table 1
Spectral primaries of the used light recipes in all zones of the broiler house (ROSS 308). Each zone (EAT, DRINK, REST, SCRATCH) contained a control (CON) and two treatments (T1 and T2). The specific recipe associated with each treatment varied according to the zone.

Zone	Treatment	Recipe	Lux[1]	Gallilux[1]	CCT(K)	CIE1931x	CIE1931y
All zones	CON	WHITE 3000 K	36.27	53.37	3107.10	0.41	0.36
EAT	T1	RED	30.55	56.74	0.00	0.56	0.32
DRINK	T1	YELLOW	37.35	60.37	0.00	0.41	0.40
REST	T1	WHITE 2000 K	36.23	53.41	2016.75	0.50	0.38
SCRATCH	T1	WHITE+UV	31.65	47.24	2797.26	0.43	0.37
EAT	T2	CYAN	36.26	61.97	0.00	0.23	0.43
DRINK	T2	CYAN	36.26	61.97	0.00	0.23	0.43
REST	T2	WHITE 8000 K	33.46	65.09	8429.03	0.31	0.24
SCRATCH	T2	WHITE+IR	28.74	39.44	2683.16	0.45	0.39

Abbreviations: CCT = Correlated Colour Temperature (K; Kelvin); CIE 1931 (x,y) = International Commission on Illumination colour space.
[1] Measured on-site at chicken eye-level.

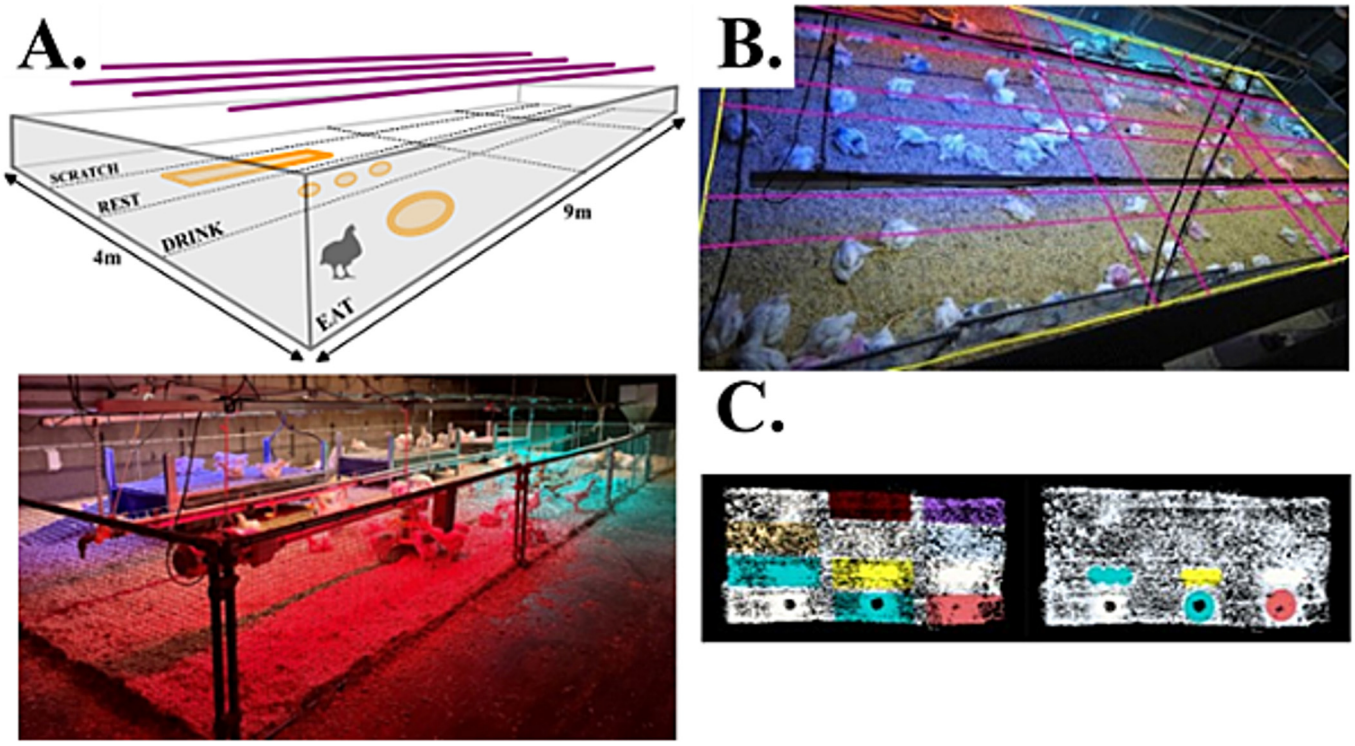


Fig. 1. A: Schematic (top) and photograph (bottom) of the trial set up with platforms divided into functional zones (EAT, DRINK, REST, SCRATCH). B: A view from one camera with the overlaid pen boundaries in yellow and subdivided light zones and dead zones between the purple lines. C. Example output from one pen over a one-hour period (four synchronised video streams). A total of 480 723 detections is shown, with each dot representing the location of a chicken within this time window. The left panel displays the postprocessed locations for each individual light zone, with colours corresponding to the light recipe assigned to that zone. The right panel shows the same detections mapped relative to the feeders and drinkers. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

dius = 0.3 × age + 5 cm). This adaptive scaling accounted for growth and ensured consistent classification of feeding and drinking behaviour throughout the experiment.

Statistical analysis

The data analyses were performed using R (version 2023.6.2.0). Two datasets were obtained: a main dataset spanning equally sized areas covering the entire pen surface excluding boundary areas, with each area covering one light recipe, and a second restricted dataset that proxied drinking and eating behaviour by registering chickens in the direct vicinity of the feeding pans and nipple drinkers as described above. The obtained average bird count per frame per area (relative distribution) was expressed as the fraction of animals per functional zone between the three light recipes and was calculated as follows: average count per light recipe within a functional zone divided by the total animals per functional zone per frame. To obtain an indication of the distribution per functional zone based on average absolute count per pen and production round, a linear model was tested with functional zone as a fixed effect. The statistical analyses to assess light preference were performed on averaged absolute and relative counts per functional zone, pen and per production phase (starter, grower and finisher), resulting in 48 observations per phase over 4 consecutive production rounds and 4 pens per production round. Data were modelled using the mean count of each light recipe area per production phase as the experimental unit nested within pen and compartment and fixed location within the pen to limit bias due to location preference. The added treatment effects of the larger study, i.e. platforms and heat stress (the latter only in the finisher phase), were added as an interaction with recipe to test the interaction of recipe on the added treatments. In all but one case, this interaction was not significant ($P > 0.05$). Therefore, added treatments were modelled as covariables in a reduced model.

For observation y_{ijkl} measured in zone l, pen k, compartment j, the model is:

$$fullmodel: y_{ijkl} = \mu + \alpha_r + \beta_c + (\alpha\beta)_{rc} + u_j + v_{k(j)} + w_{l(kj)} + \varepsilon_{ijkl}$$

$$reducedmodel: y_{ijkl} = \mu + \alpha_r + \beta_c + u_j + v_{k(j)} + w_{l(kj)} + \varepsilon_{ijkl}$$

where: μ= overall intercept; α_r= fixed effect of light recipe; β_c= fixed effect of challenge; $(\alpha\beta)_{rc}$= interaction effect and $(u_j + v_{k(j)} + w_{l(kj)})$ representing the nested random effect structure for a zone $(w_{l(kj)})$, within pen $(v_{k(j)})$ within a specific round (u_j).

Normality of the distribution of the residuals was tested with histograms and q-q plots of the used model. The model was deemed significant if P-value < 0.05. Estimated marginal means, pooled SEM and Wald chi-square test statistic were reported, and a posthoc ANOVA with Tukey correction was used to test pairwise differences between recipes. The graphical representation of mean preference over time was estimated using locally estimated scatterplot smoothing.

Results

An initial analysis of the overall mean distribution across areas revealed that chickens remained predominantly around the feeder and drinking zones in the starter period, with an average of 14.7 ± 5.2 and 15.4 ± 5.4 chickens per area within these zones, respectively (Fig. 3). Occupancy in these areas was higher than in the resting and scratching zones ($P < 0.001$), where only 2.6 ± 2.3 and 1.3 ± 2.3 chickens per area were observed, respectively. During the grower period, a shift in distribution occurred, with increased

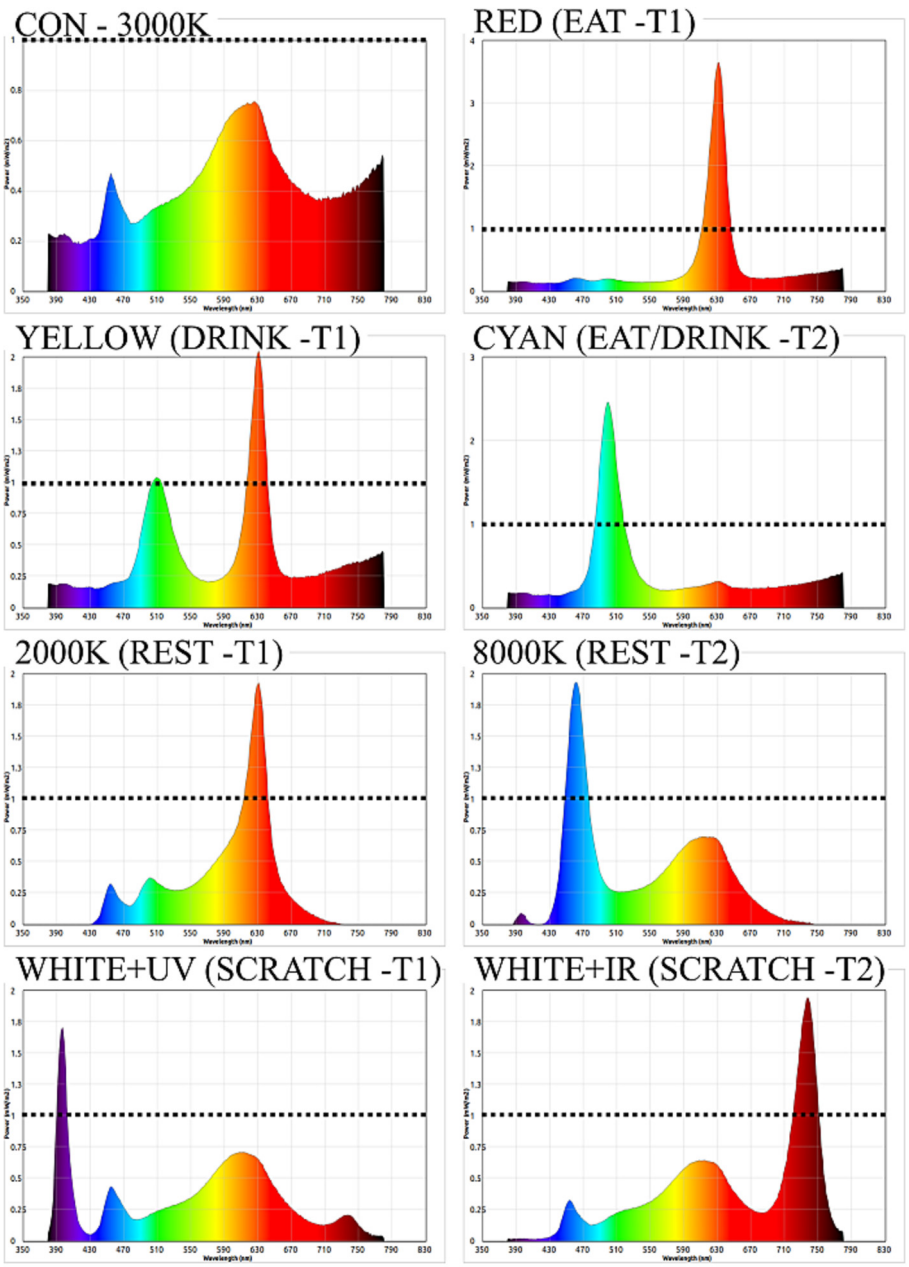


Fig. 2. Designed spectral power distributions per light recipe (mW/m^2 per nm) used to investigate light preferences in broiler chickens. Abbreviations: CON = control; T1 = test light 1; T2 = Test light 2.

occupancy in the resting and scratching zones (5.9 ± 2.8 and 6.0 ± 3.6 birds, respectively) and a decrease in the drinking area to 10.3 ± 4.0 birds. The feeder area continued to show the significantly highest occupancy, with 12.5 ± 3.6 chickens per area compared to the other zones. In the finisher period, this distribution stabilised, with the resting and scratching areas, showing similar occupancy (6.1 ± 2.4 and 6.7 ± 3.1 chicks, respectively). A significantly higher occupancy rate was observed in the drinking area (9.0 ± 2.9 chickens), although the feeder area remained the most frequently occupied, with a mean of 13.2 ± 3.8 chickens per area.

Similar absolute distribution patterns across areas were observed for all light recipes (Fig. 4). Further analyses of colour preference were therefore conducted for each phase (starter, grower, and finisher). The relative distribution across the three areas of a single functional zone remained relatively stable throughout the study, although the data suggest that relative occupancy depended on light colour.

In the eating zone, significantly fewer birds were counted under red light during both the starter ($P < 0.001$, $X^2 = 30.22$) and grower ($P = 0.008$, $X^2 = 9.70$) as compared to CON and CYAN (Fig. 5; Supplementary Table S1). No significant preference was observed in the finisher period, although there was a tendency towards a preference for CYAN compared to CON and RED ($P = 0.069$, $X^2 = 5.35$). The posthoc test was not significant. In the drinking zone, birds occupied the YELLOW light area less frequently in the starter period compared to CON and CYAN ($P < 0.001$; $X^2 = 21.79$). During the grower period, when occupancy declined in the drinking area, a distinct gradation in preference was observed: the control recipe attracted the highest number of birds, followed by YELLOW; while CYAN attracted the fewest. The occupancy beneath the control

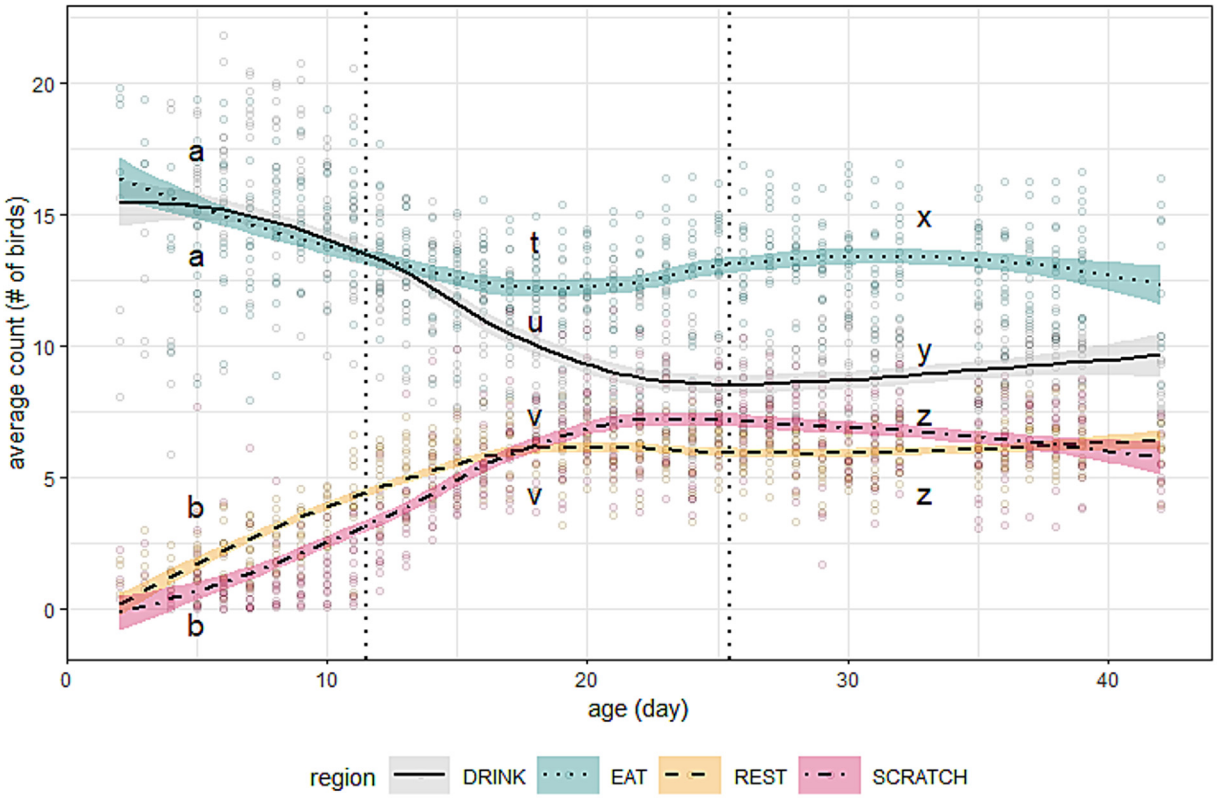


Fig. 3. Average count of chickens (ROSS 308) per location in the pen (3 locations per functional zone) throughout the rearing period (d0-43) irrespective of the light recipe (one light per location). Each dot represents the mean absolute number of birds per area according to age (day) per functional zone (EAT, DRINK, REST, SCRATCH). Dotted vertical lines represent the change in production phase (starter, grower, finisher). Letters denote statistical differences per production phase in occupancy between functional zones. Similar letters mean no significant difference.

light was significantly higher than occupancy beneath the CYAN recipe ($P = 0.037$, $X^2 = 6.60$). A similar pattern was observed in the finisher period but was not significant ($P = 0.092$, $X^2 = 4.76$). In the resting area, most birds were consistently counted in the cold white (8000 K) zones across all rearing phases (starter: $P = 0.004$, $X^2 = 10.85$; grower: $P < 0.001$, $X^2 = 53.55$; finisher: $P < 0.001$, $X^2 = 25.98$). No significant differences were detected in the scratching area during any phase (starter: $P = 0.819$, $X^2 = 0.40$; grower: $P = 0.269$, $X^2 = 2.63$; finisher: $P = 0.340$, $X^2 = 2.07$). Similar patterns were observed in relative distribution across light recipes except for the relative distribution of the scratch area, where there was a significant preference for WHITE +UV light in the grower phase ($P = 0.011$, $X^2 = 8.96$).

In the restrictive dataset (Fig. 6; Supplementary Table S2), the number of chicks counted within a bird's length around the feeding pan was highest under CON and lowest under RED during the starter period ($P < 0.001$, $X^2 = 16.47$). Low counts under RED were also observed in the grower and finisher periods, with this difference being significant in the finisher period ($P = 0.047$, $X^2 = 6.11$). However, this was not confirmed by posthoc analysis. These differences were also reflected in the relative distribution (starter: $P < 0.001$, $X^2 = 40.54$; grower: $P = 0.077$, $X^2 = 12.52$; finisher: $P = 0.003$, $X^2 = 12.62$). No effects of light were detected on absolute bird counts within two birds' lengths of the drinkers. However, relative distribution analysis suggested an avoidance of CYAN drinkers in the finisher period compared to CON and YELLOW ($P = 0.026$, $X^2 = 7.27$).

No significant interaction effects of platforms and/or heat stress on light colour preference were detected except for the relative distribution of birds during the starter period in the rest area, where the combination of a control pen without platform and warm white showed significantly lower prevalence, whereas cold white was preferred in pens with platforms ($P = 0.037$, $X^2 = 6.62$). There were some significant main effects for platforms as a covariate with decreased counts at the feeders during the grower ($P = 0.002$, $X^2 = 9.29$), drinkers during starter ($P = 0.002$, $X^2 = 9.23$), resting area during grower ($P = 0.006$, $X^2 = 7.62$) and finisher ($P = 0.008$, $X^2 = 11.83$) phases, when platforms were available (Supplementary Table S1).

Discussion

Generally, broilers expressed various preferences and avoidances of light recipes. These preferences depended on age and functional zone. During the starter and grower phases, broiler chickens were mainly attracted to the control light (CON, White CCT of 3000 K) and CYAN in the feeding zone. This is consistent with the findings of Hesham et al. (2018), in which blue light was reported to increase the feeding behaviour of broilers compared to red, yellow and green. In the present study, the birds consistently avoided RED in the feeding zone during both the starter and grower phases irrespective of whether the absolute or relative occupancy was calculated or whether the full or restrictive (close to feeders only) dataset was used. This could indicate an association of feeding behaviour with the recipe. In line with our findings, previous studies have reported that red light reduces feeding and drinking behaviour in broilers, leading to reduced performance and carcass weight (Khosravinia, 2007; Soliman and Hassan, 2019; Soliman and El-Sabrout, 2019). This avoidance could be associated with increased aggression and activity, manifested as more intense walking, head movement, litter scratching, wing flapping and feather pecking in poultry (Prayitno et al. 1997; Hesham

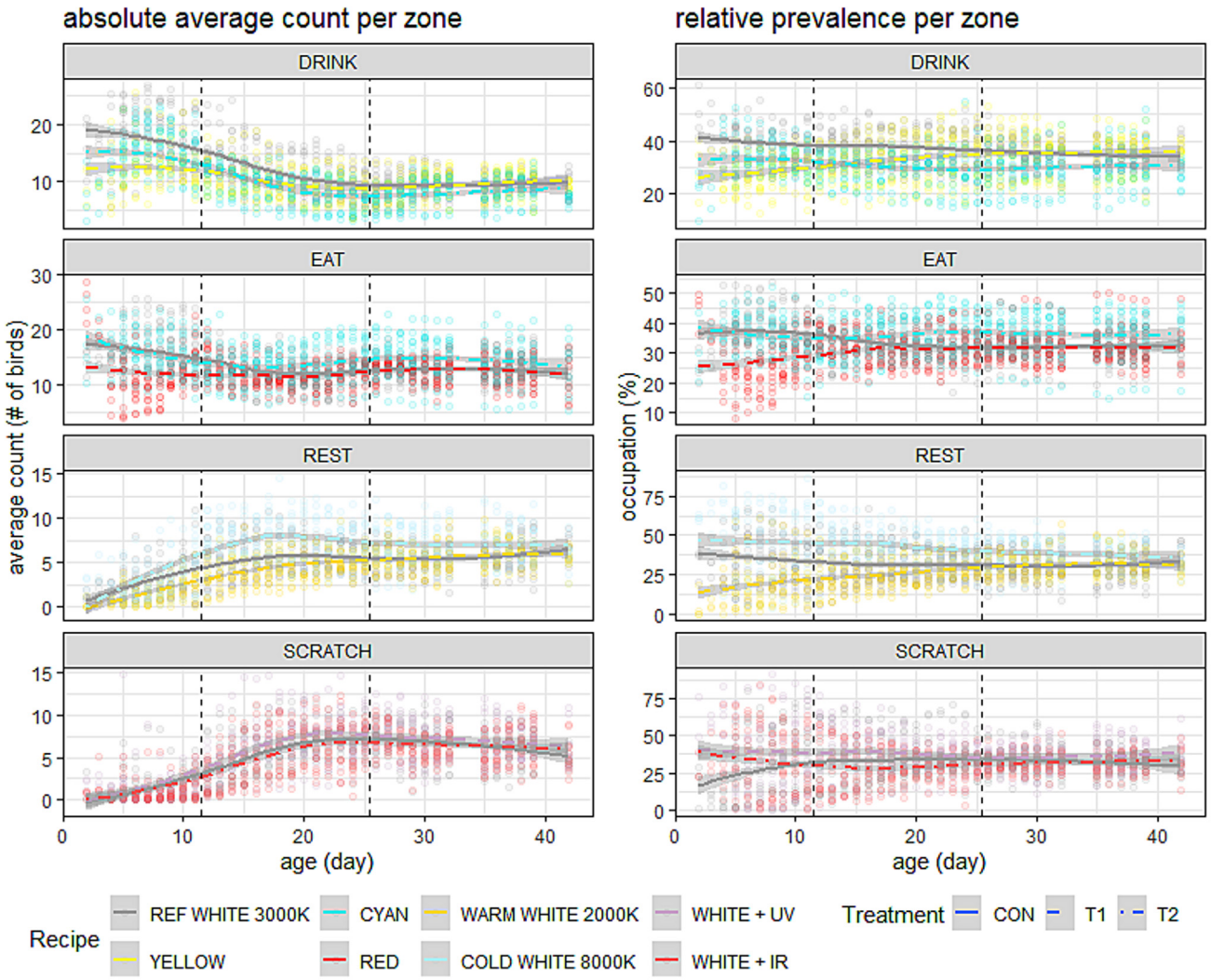


Fig. 4. Average absolute daily count of chickens (ROSS 308) per frame and relative daily count per functional zone (EAT, DRINK, REST, SCRATCH) according to age (day) and light recipe (CON = control, T1 = test light 1, T2 = test light 2). Total counts are based on the total pen area excluding the boundary area. Dotted vertical lines represent the change in production phase (starter, grower, finisher), with the grey area representing the SEM.

et al., 2018; Soliman and El-Sabrout, 2019). In addition to stimulating activity, long-wavelength colours, such as red, compared to blue and green–blue, have been shown to stimulate fear responses in ROSS 308 broilers, as indicated by prolonged tonic immobility (Sultana et al., 2013). Another hypothesis is that the tetrachromatic vision of birds allows them to distinguish palatable feed more effectively under shorter wavelengths, i.e. feed is less attractive or visible under red light. The presence of shorter wavelengths, including white light, has previously been shown to be associated with better drinking and feeding behaviour (Hesham et al., 2018; Li et al 2020). The overall association with feed and the colour red is context-driven and based on previous learning experience (Teichmann et al., 2020). The possible better visibility or contrast of feed under other light might induce its attractiveness rather than avoidance under RED. As birds aged, they might have learned that feed under red light is as palatable as in the other condition. This could explain the disappearance of the avoidance of red light in the feeder zone during the finished phase.

Birds showed absolute and relative light colour preferences beneath the drinking line during the starter and grower periods based on detections on the whole dataset. Their avoidance of YELLOW observed in the full dataset was absent in the restrictive dataset where the analysis focused on the immediate area around the drinkers. In the restrictive dataset, there was a significant avoidance of CYAN beneath the nipple drinkers compared with YELLOW in the finisher period. The avoidance of blue light was also reported by Remonato Franco et al. (2022a), who documented that female broilers spent more time drinking under white light compared to green and blue. However, these results contrast with other studies, where blue and green lights were associated with higher drinking and feeding frequencies (Hesham et al., 2018; Li et al 2020) or the absence of an effect of light colour on drinking behaviour (Sultana et al., 2013). This shows that the preference for a certain light colour would depend on much more than colour alone and that other environmental factors, such as light intensity, background, or social competition, could play a role as well.

The overall occupancy of the resting zone was higher in the grower and finisher phases than in the starter phase. Broilers in this zone consistently preferred COLD WHITE light, which contained a higher proportion of blue wavelengths than WARM WHITE. This finding aligns with Riber (2015), who observed a preference for cold-white light (6065 K) over neutral-white light (4100 K) during resting. Archer (2018) reported that broilers raised under cool LED lighting had lower plasma corticosterone concentrations and lower heterophil-to-lymphocyte ratios, vocalised less during isolation, and wing-flapped less intensely compared with

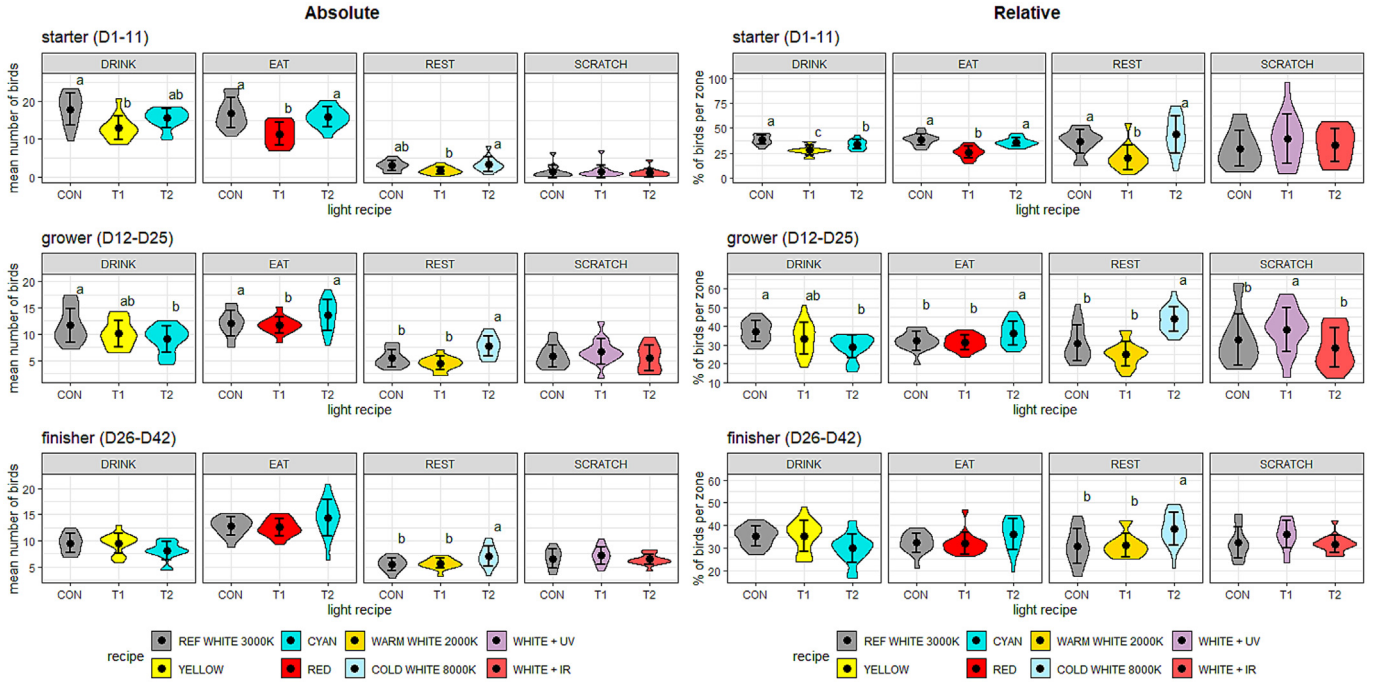


Fig. 5. Average absolute daily count of chickens (ROSS 308) per frame and relative daily count of the light recipes (CON = control, T1 = test light 1, T2 = test light 2) per functional zone (EAT, DRINK, REST, SCRATCH) and production phase (starter, grower, finisher). The counts were based on the total area covered by the light where there is no overlap between areas. Data represent arithmetic mean ± sd with a violin plot showing distribution around the mean. (a–c) letters denote pairwise statistical differences ($P < 0.05$) between light recipes (within the same production phase and functional zone).

birds reared under warm LED lighting. The blue light frequencies have been consistently associated with a calming effect in poultry (Hesham et al., 2018; Abdel-Azeem and El-Metwaly, 2018; Lucena, et al., 2020), lowering fear responses (Mousa-Balabel et al., 2017; Mohamed et al., 2020; Linhoss et al., 2025), alleviating stress (Xie et al., 2008; Mohamed et al., 2017; Helva et al., 2019; Remonato Franco et al., 2022a) and promoting resting behaviour (Sultana et al., 2013; Hesham, et al., 2018). Also, according to Remonato Franco et al. (2022b), improvements in spatial vision were observed in birds exposed to blue light.

Apart from a significant relative preference during the grower phase for WHITE+UV, no significant light colour preferences were observed in the scratching zone across the different rearing phases. This result can be supported by Sultana et al. (2013), who reported that scratching-related behaviours, such as ground pecking, wing flapping, and stretching, were not affected by light colour. However, since behaviour was not analysed in the present study, a specific association between light colour and scratching behaviour could not be tested. Nevertheless, the significant relative preference for WHITE+UV in the grower and numerical preference in the finisher phase showed the importance of the UV spectrum in avian vision. UV light has been reported to reduce stress and fear responses in broilers (House et al., 2020; James et al., 2020; Wu et al., 2022). An important side note is that the UV part of this recipe is limited to 390 nm, and birds can perceive wavelength frequencies as low as 360 nm, which limits the potential and interpretation of effects of this recipe (Prescott and Wathes, 1999).

Preference studies have several limitations. First, they only provide information on relative preferences among the options offered. Second, a demonstrated preference does not imply that the preferred option is meaningful to the animals. Third, such studies often assume that the option animals prefer is beneficial to them. This assumption requires further empirical testing to confirm that preferred choices are indeed associated with improved welfare or outcomes. In this study, a higher bird count at one of the three lights within a functional zone was considered as an indication of attraction to that particular recipe, whereas a lower count was interpreted as avoidance compared with the other two light recipes. However, the distinction between avoidance and attraction could not be determined from this study design. Covariables such as heat or enrichment had little effect on preference towards a certain light recipe. Although caution is needed when generalising outcomes from this particular study, the preference for specific light colours across zones or schedules within a broiler house would therefore seem to be rather independent of climate or the presence of structural components in the environment. Moreover, because the functional zones were consistently arranged in the same spatial configuration, with the feeding zone located in the centre of the compartment and the scratching zones positioned along the sides, a potential spatial bias cannot be excluded.

Stocking density was kept low in this study to test preferences and minimise competition and other social effects. At higher conventional stocking densities, where competition around feeders and drinkers would be greater, social effects may override the preference for either colour studied. Social competition for preferred areas may influence the ability to express preferences, and in regard to stocking density, such competition in the present study was likely greater when the birds were larger and older, but other social interactions may also have occurred, including group behaviour where the preference of one animal induces a similar behaviour in the others (Buijs et al., 2009). Hence, whether age-related differences truly relate to light colour preferences or changes in social influences is hard to disentangle and would require further study.

Lastly, the present study documented that, independently of light preference, the occupancy of the different functional zones changed markedly, reflecting shifting behavioural and physiological priorities of broilers as they age. The feeding and drinking zones were consistently more occupied during the starter phase, highlighting the high nutrient demands at that age. However, while the feeding zone remained highly used, the occupancy of the drinking zone declined during the grower phase. The progressive rise in occupation rates of resting and scratching zones reflects a transition from huddling as chicks near the feeding and drinking zones

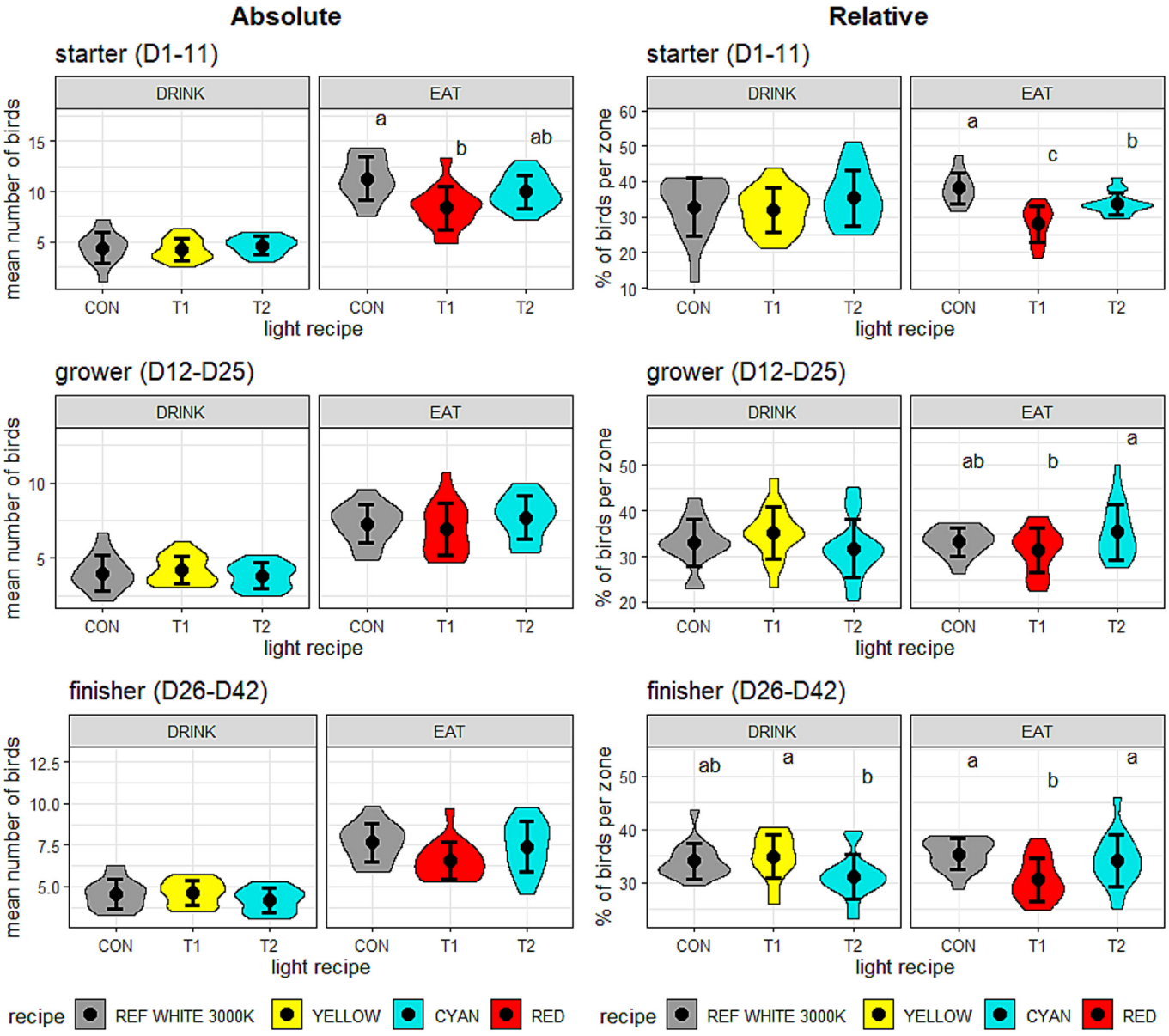


Fig. 6. Average absolute daily count of chickens (ROSS 308) per frame and relative daily count of the light recipes (CON = control, T1 = test light 1, T2 = test light 2) per functional zone (EAT, DRINK) and production phase (starter, grower, finisher) of the total count of restricted area around feeding pans and nipple drinkers. Data represent arithmetic mean ± sd with a violin plot showing the distribution around the mean. (a–c) letters denote pairwise statistical differences ($P < 0.05$) between light recipes (within the same production phase and functional zone).

towards greater use of the available space as birds age. These trends suggest a behavioural shift from feeding and drinking activities in early life to maintenance and comfort behaviours in later phases. Moreover, the high energy demand associated with walking in later stages may coincide with an increase in resting behaviour (Sultana et al., 2013; Riber, 2015; Dawson et al., 2021). On the other hand, gait problems may induce a motivation to stay closer to the feeding pans. This choice would likely depend on the degree of gait problems and motivation to rest beneath colder lights. An additional hypothesis explaining the drift towards resting areas is the decline in litter quality around feeding and drinking areas, inducing the search for more friable dry litter. With this shift in mind, our findings indicate that light preferences change according to functional zones and age. This suggests that light recipes could be used to increase and decrease certain activities at certain ages, and to attract or repel birds from certain areas of the barn. This might influence performance, welfare as well as litter quality. However, which light recipes are optimal for each combination of activity and age requires further study.

Conclusion

Clear interactions between lights and occupancy were observed in this study. In the starter and grower period, there was a preference towards CON and CYAN in the feeding area, whereas CON tended to have higher occupancy in the drinking area. In contrast, there were indications that longer wavelengths included in RED were avoided in the feeding area. Preferences for shorter wavelengths were further indicated by the higher bird counts under COLD WHITE (8000 K) and WHITE+UV in the resting and scratching areas, respectively. While practical, the results indicate that the assumption that a single light colour is suitable for all functional zones and ages may be naive. It may be beneficial to provide specific light colours depending on the functional zone and age of the birds.

Supplementary material

Supplementary Material for this article (https://doi.org/10.1016/j.animal.2026.101970) can be found at the foot of the online page, in the Appendix section.

Ethics approval

The experimental protocol of this study was approved by the ethics committee of the Flemish Research Institute for Agriculture, Fisheries and Food (ILVO), Merelbeke-Melle, Belgium (authorisation number 2022/414).

Data and model availability statement

None of the data were deposited in an official repository. The raw data supporting the conclusions of this article will be made available by the authors on request.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used ChatGPT in order to review grammar and spelling. After using this tool/service, the author(s) reviewed and edited the content as needed and took full responsibility for the content of the publication.

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Declaration of interest

None.

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