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Broiler behavioural repertoires and the impact of lighting condition

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***Target Audience:** Policy makers, Broiler chicken farmers, General public.*

Abstract

The welfare of animals are dependent on their immediate environment which influences their ability to exhibit certain natural behaviour that can support their growth psychologically and physiologically. Animals' welfare and their behaviour are therefore linked, as the environment influences the welfare and the behaviour are dependent on the welfare. One of the environmental factors that influences the growth performance and other health indices in broiler is the light under which they are reared. In this review, response of broilers to two artificial light sources in their available colours and the attendant effects on their behavioural repertoire and welfare are explored. The artificial light sources most economical in the scheme of broiler production are the incandescent bulb (ICD) and compact fluorescent lamp (CFL) due to their low cost when compared to light emitting diode (LED) mostly used in developed climes. It is imperative to understand the impact of these light sources in their existing colours on the behaviour and welfare of broiler chickens. Furthermore, 8 categories of broiler behaviour were explored because the knowledge of these categories is essential in understanding their welfare. Some other factors, aside artificial lighting, that could also affect the natural behaviour of broiler chickens were evaluated, though not exhaustively.

***Keywords:** Broiler chicken; behaviour; animal welfare; artificial lighting; incandescent bulb; compact fluorescent lamp.*

Description of Problem

Animal welfare can be defined as a state of harmony between the animal and its environment i.e. the state of physical and mental balance and it implies freedom from pain, injury and disease, freedom from fear and distress, freedom from hunger and thirst, freedom from discomfort, and freedom to perform natural behaviour (1,2). Animal welfare can be assessed based on physiological indices (body weight, nasal discharge etc.) and natural behavioural indices (feeding and drinking pattern, body posture, flock distribution, gaits etc.) (5).

Animals' welfare and their behaviour are interconnected because the behaviour exhibited are dependent on the overall welfare of the animal (6). Behaviour is defined as the animal's response to environmental stimuli. The ancestors of the broiler chickens lived in a natural habitat, where the natural lighting was generously not quite the same as the artificial lighting utilized in commercial poultry buildings (7). Broiler chickens reared under artificial light behaved differently from those raised under natural light. Indeed, the responses of broiler to different light source, intensity, and illumination remains inconclusive despite years of research (8). The relationship between environmental factors (such as lighting) has been investigated by different researchers using two methodologies: preference tests and behavioural observation of birds under various lighting sources (9; 10; 11; 7).

Lighting is characterized by source, intensity, wavelength range and length of photoperiod (12; 13). Light, the most imperative part of broiler's physical environment (14) is probably the most critical of all environmental factors as it alters the release of hormones identified with development, maturation and reproduction (15). Lighting influences the brain organization that affect behavioural reaction (16) and capacity to adapt to stress. It has been accounted for that the intensity, wavelength and light source affects the behaviour and physiological reactions of birds (8) suggesting that vision influences the greater part of bird's behaviour (7). According to (17), ultra-violet (UV) light is hardly present at all in artificial lighting. This absence of UV light has been shown to increase levels of stress hormone and alter behaviour in chickens according to the study carried out by (18).

In the previous years, incandescent light (ICD) of various sorts and intensities have been utilized in poultry houses because of their low price (19), but are presently being eliminated because of their moderately high power utilization. Poultry farmers have been changing to more energy efficient lights (20). Fluorescent lights, particularly the Compact Fluorescent lights (CFL) offers an altogether lower energy utilization for a comparable light output and are now widely used by poultry farmers (21). This review sought to distinguish which of these artificial light sources enhance natural behaviour and improves animals' welfare as regard to broiler chickens. Few other broiler behaviour and welfare-influencing factors were also considered.

General behaviour of poultry

Domestic fowl have a well-developed sense of vision with sharp visual acuity, and perception (22). Ear is well developed in birds, although without pinna. Chicks are attracted by repetitive, short duration and low frequency sound. High frequency sound indicates distress in broiler birds, or a call for food. Poultry birds possess 300 taste buds necessary in poultry to identify potentially toxic substances (22). In intensive system of production, broiler birds learn to drink water by differentiation pressure in nipple drinker according to (22). Training is an important part of flock management, and it is observed that the boldest, most social and active broilers learned faster and apparently easier to manage (23). Birds are highly responsive to touch. Females will often adopt a sexual crouch when touched on the back. Pleasant human contact increases body weight, and feed conversion ratio (24). Physical contact seems to reduce fear more effectively and can decrease bird-to-bird pecking (25). Cransberg *et al.* (26) noted that walking slowly among young birds could reduce fear and mortality level in birds. Zulkifli and Azah (24) reported that young chicks often provided with a lot of human contact tolerate stress better, more resistant to diseases and are less fearful. The development of the 'perchery' system of housing is aimed at using the inherent behaviour to perch. The urge to perch in broiler birds have been weakened therefore modern-day birds do not necessarily seek to use perch. Perching behaviour is performed when possible, indicating welfare benefits (27), perching reduces fearfulness and aggression (28).

Broiler behaviour

The study of broiler behaviour is important to ensure that welfare of birds and productivity are maintained (29). The behavioural needs encompasses the need for foraging and exploration, resting/sleeping, sun bathing, preening, dust bathing, wing/leg stretching, social interaction/play, and locomotion (4). Most of these behaviours are innate and thus, occur naturally. Changes in broiler behavioural patterns can be used to assess their wellbeing. There is an occurring problem when certain behaviours are less performed, or occurred in a different manner. The ability to perform natural behaviour, especially foraging, preening and dust bathing seems to be important to prevent frustration (4). The following terms have been used by researchers to categorize broiler behaviours: social behaviour, consummatory behaviour, comfort behaviour, locomotory behaviour, inactive/resting behaviour, aggressive behaviour, exploratory/foraging, and reproductive behaviour.

Social behaviour

Social behaviour includes pecking order, threatening, chasing, kicking, fighting, avoiding, crouching and vocalizing. The social structure of a flock depends on the physiological, psychological and physical state of each member (30). Birds communicate through visual and auditory cues. Auditory cue include vocalization and alarm calls. Birds provide information about social status through alarm calls while visual cues include individual recognition, displays and body posture. Broiler birds can recognize up to 80 different individuals in a flock. Body postures include dominance and submissive posture (17). Synchronization is also a kind of social behaviour where broilers perform several behaviours simultaneously with conspecifics e.g. preening, feeding, resting, foraging (31; 4). Social facilitation is also expressed when certain behaviour increases in a flock because others see one doing it. For social interactions to occur, it is important that the provided lighting is of sufficient intensity, to enable visibility of the surrounding (31).

Consummatory behaviour

This consummatory behaviour includes feeding and drinking. Feeding is a process by which birds ingest available feed material. Feeding is divided into two phases, the appetitive phase (food seeking and foraging behaviour) and the consummatory phase (ingestion and eating of feed). Consummatory phase is the phase majorly expressed in the intensive system of rearing especially in cage system (32). When the appetitive stage of feeding is eliminated, it can result in behavioural problems such as feather pecking. Feeding behaviour in broiler birds differ from that of the red jungle fowl because through breeding programs, broilers birds had been genetically selected for meat production/ fast growth, thus their eating behaviour seems to be regulated only by satiety mechanisms in contrast to hunger mechanisms, that is, broilers continuously eat to their maximal physical capacity (33). Broiler birds spend twice as much as their time resting and half as much as their time eating. One of the factors that influence feeding is the form of feed presented. Pelleted feeds are much easier and faster to eat than mash. Broiler birds has high metabolic rate, thus, they exhibit panting behaviour to eliminate metabolic heat especially in the last few days of life. If heat dissipation is not adequate, it can lead to other behavioural problems (34). Rate of exhibiting drinking behaviour in broiler birds depends on the ambient temperature. Generally, during hot weather, birds drink more to regulate the body temperature and drink less during cold weather. Availability of good quality, cool and clean water is important in hot climates (35). At the first few days of life, broiler birds may require assistance to locate drinkers. Chickens reared on one type of drinker may also require assistance when moved to a new house with another type of drinker. Broiler birds can be raised with nipple drinker and bell drinker. They spend more time drinking from a nipple drinker about 60% of their daily time budget, the same amount of water it will take about 3% of their time to drink from a bell drinker. Drinking behaviour is closely associated with feeding behaviour. When broiler birds are deprived of feed, in an attempt to fulfil their feeding motivation, they overdrink. This abnormal drinking behaviour is called polydipsia (36).

Comfort behaviour

Comfort behaviour are those behaviours performed after the completion of basic needs (37). It is also regarded as maintenance behaviour and includes preening, dust bathing, foraging, wing flapping, stretching and feather-ruffling (38). It is any type of behaviour that stretch muscles to relieve muscular tension or skin irritation and improve physical comfort (39). Stretching of wings and legs, and wing flapping, are comfort behaviours that requires enough space for their expression. During stretching, the bird simultaneously elongate backwards one leg and one wing on the same side while during wing flapping, the bird stands upright, raise it wings and flap it against it body.

Preening and dust bathing are grooming behaviour. These are inherent behaviours used in maintaining feather condition. Preening include smooth rearrangement of feather with the use of beak and distribution of oil from uropygium or preen gland at the base of the tail over the plumage (4). The function of the oil secretion is to water proof the plumage and act as an anti-microbial agent (40). Self-picking is also a form of preening whereby the bird pecks the plumage surface to remove particles. Weeks *et al*. (41) noted that preening is reduced in broilers with decreased mobility.

Dust bathing is a behaviour commonly used to align feathers, get rid of ecto-parasites, maintain plumage thermo-insulating properties by getting rid of staled preen oil (6; 42). Broilers prefer to dust bath in dry, loose substrate e.g. sand and wood shaving, while the failure to dust bathe is believed to lead to reduced thermo-insulation and frustration (6). In the process of dust bathing, the bird finds a suitable substrate, make hallow in it and gently sit in it leaning towards one side. The bird scratches the substrate with one leg and distributes it with its wings. After several wing distribution of substrate, the chicken will arise and shake vigorously. Poultry shows a diurnal dust bathing rhythm which peaks around six hours after light has been made available. Reduced dust bathing can be used as an indicator of decreased welfare since lameness reduce occurrence of dust bathing (43).

Locomotory behaviour

This is movement from one place to another in response to stimuli either internal or external. Locomotory behaviour involves mobility, this include walking, running and jumping. During jumping, the bird lifts both feet away from the litter and there is no part of the body in contact with the litter material. While walking is a process, in which the bird takes one or two steps forwards, backwards, or sideways. In broiler birds, as the body size increases, mobility decreases (44). The decreased mobility results in possible behaviour disorders such as increased grooming (33). For example, leg problems will appear as a reduced motivation to walk (45). Running is also a form of play behaviour; its function is to stretch and exercise limbs. Running involves steps taking but in a very fast manner. Young broilers often run around without any apparent reason or cause. The frequency of running decreases as the age increases or as stocking density increases. However, it is unclear whether this decrease is caused by a decreased motivation to run, or decreased mobility (46). María *et al*. (47) associated reduced locomotion activity with increased stress caused by the frustration of the expression of some behaviours, such as lack of access to nests (48), or by high environmental temperatures, in an attempt to exchange heat with the litter.

Inactive/resting behaviour

Birds are said to be inactive when they are sitting, lying, or standing without any form of movement. When a broiler bird is standing, it is motionless in an erect position with no apparent movement of legs, but while sitting the abdomen touches the litter. The function of rest in poultry is assumed physiological recuperation of the body (49; 50). Quality of resting is influenced by housing conditions such as lighting regime, i.e. the duration of lighting (51; 50), space availability (31) and quality of the substrate (51). Sleep is strongly influenced by day or night pattern. Unlike other domestic fowl, broilers do not seem to be very motivated to perch while sleeping (52), this may be due to high body weight and/or lack of mobility rather than lack of motivation (33). Time spent resting increases as broilers grow older, which is thought to be another consequence of increased body size and decreased mobility (41; 33).

Aggressive behaviour

Aggressive/agonistic behaviour is usually used for territorial marking to establish dominance and for gaining access to food. Agonistic behaviour includes pecking, fighting and feather pecking although prevalence of this behaviour is low in broilers (52). Fighting is the frontal displays with hackles towards other birds, head pecking, jumping or kicking at another bird attacking the other birds in an aggressive manner. Bird to bird pecking is an abnormal behaviour which the bird expresses by pecking of combs, legs, and vent. Feather pecking is an aggressive peck when done vigorously by pulling of feather with beak. Effect of feather pecking is feather damage and this is an undesirable behaviour. According to (2), severe feather pecking results from motivational frustrations related to inadequate litter material. When there are no natural substrates for pecking, the bird replaces them by feathers (3). Pecking can be limited by environmental enrichment, providing foraging materials and reducing stocking density (4). Lighting condition have also been observed to contribute to incidence of feather pecking. In a study by (53), birds reared under incandescent lighting were observed have a higher incidence of wing injury caused by feather pecking. Prescott *et al*. (17) opined that the incidence of feather pecking could be due to the high red-saturation of incandescent light. However, this contradicts the result of a study carried out by (54) which indicated that red light reduced aggressiveness compared with white light.

Foraging/ Exploratory behaviour

Foraging behaviours include ground scratching and ground pecking (6), these behaviours are associated with feeding. Litter eating or litter pecking is also an undesirable behaviour mostly seen in broiler birds. This behaviour might be enhanced by the type of litter material used, groundnut / rice husk may support litter eating behaviour than wood shavings. Chicks often peck at litter materials while trying to exhibit exploratory behaviour; litter is often covered with paper to prevent chicks from developing pecking habit. Litter pecking could affect the gastro-intestinal tract. Broilers often continue to show foraging behaviour even if no feed is present, and sometimes, even when nutritional needs of broilers are met, they continue to exhibit foraging behaviours which are an indication that their behavioural needs are not yet met. Chickens in general show two daily peaks in foraging behaviour, with one peak occurring shortly after the onset of lighting and the second at the end of the light period (55). Sufficient space and lighting with appropriate forging substrate are essential to make environment suitable for foraging (4). It is worthy of note that foraging behaviour has a daily pattern with a U-distribution, the peak at the beginning of lighting and end of lighting. The time broilers spend forging usually decreases with age due to reduced mobility caused by high body weight (56; 33; 51) although the motivation to forge is not affected (44).

Reproductive behaviour

It is a common practice that broilers grow up without a broody hen present. Naturally, mother hen sit over it chicks to provide the heat needed. Under commercial circumstances, these tasks become irrelevant, but it is unclear if and how deprivation of their mother negatively affects welfare of broiler chicks (57). The photoperiod, intensity, spectra and regimen have all been proposed as factors controlling the reproduction performance of poultry (58; 59). Mobarkey *et al*. (60) showed that selective photo-stimulation under red light resulted in an early onset of lay in chickens. Foss *et al*. (61) found that red and white light stimulated the growth of the comb and testes in broilers, confirming the effect of red light in stimulating reproduction.

Factors that influences broiler natural behaviour

Housing and housing conditions

An important aspect of the broilers' environment is the amount of shelter it offers, which is believed to be imperative for security against predators or to avoid disturbances by other birds (62). Environment has a great impact on broiler behaviour and this continues as the birds grow and body weight increases. Broilers raised outdoors at the early stage of life have the tendency to express more natural behaviour (44). Broilers raised on free range and deep litter exhibit their natural behaviour than those in cages. In less intensive housing systems, the stocking density is lower, birds have the opportunity to range outdoors, hence the welfare conditions are better and birds exhibit normal behaviours (63). Stocking density has a great impact on the behaviour broilers exhibit. Broiler welfare is more affected by stocking densities than pen size. This was established in a study which revealed that broilers were willing to work for access to pens with lower densities (64). It is worthy of note that the more crowed birds are, the lesser the distance they move per hour. Pecking, scratching, preening and walking are reduced when birds are overcrowded. Broilers should be provided with sufficient space to fulfil its behavioural needs, with high quality food and drinking water to fulfil its nutritional needs, and be kept in a clean environment to meet its health-related needs (4). Another problem often encountered in conventional production systems is that broilers are not able to fulfil their behavioural needs due to environmental restrictions (65) even though they are motivated to do so (33). When broilers cannot carry out their behavioural needs, they become frustrated, which leads to stress and possibly physiological and/or behavioural problems (48).

Gene and Genetic selection

Selection for growth rate causes differences in activity levels and physiology of the chickens (4). The behavioural pattern of broilers has been negatively affected by intensive selection for growth rate (63). It has been noted that selection for production trait leads to reallocation of energy resources meant for active behaviours for growth (66), although birds still exhibit the active behaviours but the frequency of it occurrence has been greatly reduced (33). Knowles *et al.* (67) noted that decrease in locomotory activity and leg health is associated with fast growth rate. Generally, overall activity levels of fast growing broilers are decreased (33; 68).

Age and Hormones

Age influences resting time, as birds grow older, the time spent lying increases (69; 41). At four week, birds multiply their resting period. Weeks *et al.* (41) found out that Ross 308 chickens at five weeks of age spent 76-86% of their time lying /sleeping).

Hormones are usually known to affect the behaviour of many animals, and hormonal effects differ with the age of the animal. Certain behaviour such as reproductive behaviour is not exhibited until poultry birds get to certain ages. In sexually matured male birds, testosterone contributes to aggressive behaviour, vocalization, territoriality and mating behaviour. Female behaviour is usually influenced by oestrogen and progesterone, sexually matured female shows greater foraging and nesting behaviour (70). The recurrence of all sexual behaviour declines with age, suggestive of a decrease in libido. The decrease in drive is not sufficient to represent diminished fertility in heavy cocks at 58 weeks and is most likely a result of the conformation of the males at this age interfering in some way with the transfer of semen during mating (71).

Hormonal changes due to lighting can also influence broiler behaviour. For example, production of melatonin hormone during dark period can be influenced by changes in lighting (72). Melatonin hormone is involved in circadian rhythms, thermoregulation and immune function in chickens (73).

Environmental condition (Lighting)

The impact of light on broiler behaviour must be taken into account when attempting to provide the most efficient controlled environment for poultry production (70). Natural lighting was significantly not quite the same as the artificial lighting utilized in poultry houses (7). Firstly, the outdoor light intensity on a bright day might be as high as 100,000 lx (74). In addition, the range of sunlight furnishes a uniform vitality conveyance with wavelengths somewhere in the range of 350 and 700 nm, while artificial light sources give a smaller range of wavelengths, in this way giving light of a different colour in comparison to normal light (75). Vision is critical in poultry behaviour and welfare, due to this, poultry have evolved highly specialized visual systems to aid their survival, and most of their behaviour is mediated by their vision (7). Light enables the birds to build up rhythmicity and synchronize numerous basic functions, including body temperature and different metabolic processes involved in ingestion and digestion. Also, light stimulates secretory patterns of several hormones that control, in large part, growth, maturation, and reproduction (15). Light is an important management tool to regulate broiler production and welfare by modulating various behavioural and physiological pathways. As a central environmental factor in broiler production affecting growth rate, animal welfare and production economy, light itself is a complex and varied phenomenon (12). Light as an environmental factor consists of three different aspects: intensity, duration, and wavelength. Light intensity, colour, and the photoperiodic regime can affect the physical activity of broiler chickens (76). Hence, to create an ideal poultry production environment, the reactions of the birds to the three different aspects of lighting must be understood. Intensity (brightness of light) and duration (photoperiod) are factors to be considered when using lighting programs as a management tool since birds can distinguish various colours (77), wavelength (colour) and intensity are important tools in modifying broiler behaviour (15). Different light sources are used in the broiler industry to emit light of different wavelengths which affects their growth, production as well as their behaviour (78).

Light Sources

Light source is one of the four light components as stated by (12) and it is a major determinant of the spectral composition that can be seen by birds. According to (79), the emission spectra of available light sources can vary drastically from a direct increase from blue to red in incandescent to the many narrow peaks seen in compact fluorescent lamps (CFL) and finally the two or three gradual peaks seen in LED (figure 1). The spectral sensitivity of chickens, or their ability to see different coloured light, differs from that of humans (80). Light sources of different wavelengths (colours) may be perceived as being of different intensity, even if the photometric recording of intensity is the same for both sources, because the spectral sensitivity of the photometer is unlikely to have the same spectral sensitivity as the tested birds (That is, a yellow light bulb may be perceived as being brighter than a red or blue light bulb of the same intensity by birds) [80; 81].

Four kinds of bulb (light sources) which are; incandescent, metal halide, fluorescent and high-pressure sodium bulb are all in use in poultry facilities for laying hens, breeder flocks, broilers and turkeys (15). The use of incandescent is being phased out in favour of more energy efficient lighting alternatives. According to (82) incandescent light in poultry housing is at 12 to 14 lumen/watt which is below the 45 lumen/watt set as the minimum lamp efficiency standard in some countries. Many new lighting technologies that exceed energy efficiency requirements are currently being developed by different companies as potential replacements for ICD light sources, including cold cathode fluorescent lamps (CCFL), compact fluorescent lamps (CFL), and light emitting diodes (LED), among others (13). The major benefits of these bulbs are high efficiency, long, operating life, moisture resistance, and availability in differing peak wavelengths (83; 7). Each available light source are produced by manufacturers in different colours (figure 2) and intensities while the photoperiod/duration are controlled by farmers in their facilities.

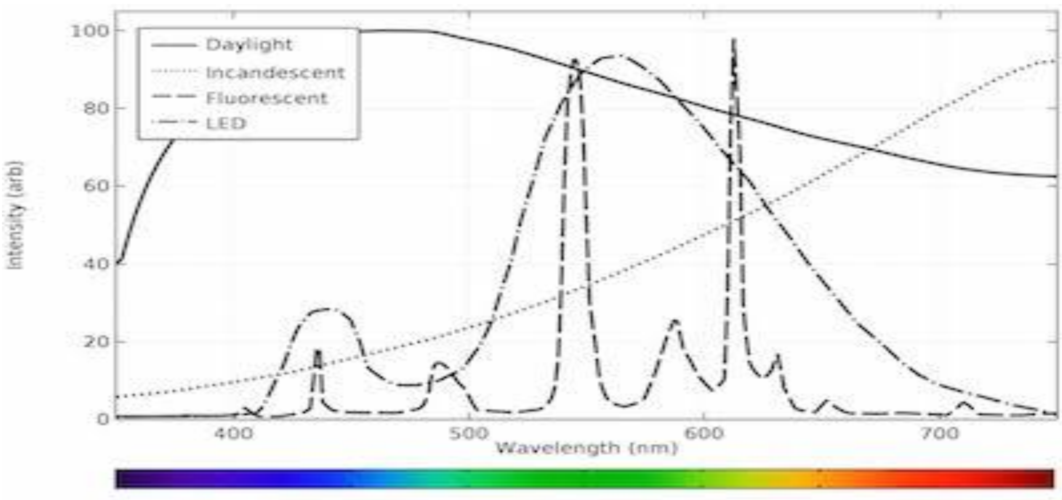

Figure 1: Emission spectra of incandescent bulb, fluorescent lamp and light emitting diode in comparison to natural daylight (COMSOL, 2016)

A

B

Figure 2: Variants of Incandescent bulb (A) and Compact fluorescent lamp (B)

Incandescent (ICD) versus Compact fluorescent lamp (CFL)

Incandescent bulb produces visible light by passing an electric current through a tungsten filament then, heating it to incandescence. The bulbs provide light energy about 8-24 lumens per watt and a rated short life span of about 750-2000 hours compared to 10,000 hours of CFL (84). CFL produces light by the passage of an electric current through a low pressure mercury vapour or gas contained within a glass tube. The mercury vapour electric stream gives off ultra-violet light which is absorbed by the phosphorus material coating inside o glass tube thereby causing it to fluoresce at a wavelength that are seen as visible light (85). For many years, the industry has relied on ICD to provide illumination in poultry houses (70). The ICD bulb is regarded as the current standard by which other bulbs are compared relative to poultry production (15).

Luminous efficacy of a typical ICD for 120V is 16 lumens per watt as relative to 60 lumen per watt for a CFL (86). They convert <5% of the energy they use into visible light, the remaining is converted into heat (87). Due to high energy consumption and low efficiency of ICD, CFL which offers a lower level of power consumption for a similar output are currently favoured by the industry (21). CFL cost four times more than traditional ICD, but last six times longer and is 70% more efficient than ICD (88).

Researchers have conducted field experiments to observe the impact of both light sources in their available colours either individually or combined on the growth indices, carcass characteristics as well as welfare indices such as behaviour of broiler chickens.

Prayitno *et al*. (81) in their study using blue, green, red and white coloured ICD bulbs of equal intensity of 30 lux and 23 hours photoperiod observed that when the birds were subjected to preference/free choice test, those reared in red ICD bulb lighting showed a quick preference for blue ICD bulb lighting within the first few hours of the test while others remained in their respective rearing lighting however, after a week of the preference testing, all birds showed preference for the blue ICD lighting except those reared in blue ICD who chose green ICD bulb lighting. The authors also reported a higher activity level as expressed by greater walking behaviour in the white ICD bulbs while wing stretching, floor pecking and aggression was higher under red ICD bulbs. Consummatory behaviours among all ICD bulb colours did not differ. The authors concluded that the rearing colours affected the birds; behaviour rather than growth and that green or blue ICD bulbs is preferable to red or white ICD bulbs for broilers due to their calming effects on the birds.

In a comparative study by (89), broilers were allowed access to natural light during the day and in addition, either yellow ICD bulb lighting of 40 lux or white CFL lighting of 27 lux during the night. It was observed that birds showed similar growth performance in both sources and colour but their behaviour differed with a higher incidence of pecking observed in those raised under the yellow ICD bulb lighting and consequently, ICD bulbs were discouraged for broiler production due to the agonistic behaviour observed. According to (90), the use of white CFL lighting resulted in higher occurrence of feeding behaviour, higher activity level as expressed by greater walking behaviour, and better exhibition of comfort behaviours (dust bathing and wing flapping) by birds.

In another further study by (91), three coloured CFL light sources (white, yellow and blue) were compared. A preference test was carried out on improved indigenous broiler chicks (FUNAAB alpha chicks) and it was reported that most birds showed preference for yellow CFL light source when released from the dark chamber. The feeding and drinking behaviours was also exhibited more by chicks under the preferred CFL colour. The authors recommended the yellow CFL lighting for birds at the early growth phase because in addition to the preference of the birds for it, it also resulted in a better feed conversion ratio.

In another research by (13) who evaluated three (3) light sources including CFL and two LED bulb types (each at 5 lux and 20 lux intensities) as a possible replacement for ICD concluded that there was no significant difference among the three (3) light sources at both intensities on the welfare indices (ocular development, immune response, tonic immobility, and gait score) evaluated hence, CFL and the LED bulb types tested against ICD are suitable replacements for use in poultry facilities to reduce energy cost and optimize production efficiency.

Preference of four (4) groups of broiler chickens for four (4) different light sources at two illuminances/intensities were assessed at 1 week and 6 weeks of age by (8). Broilers preferred to occupy biolux and warm-white fluorescent light sources over ICD and spectral-sensitivity matched light irrespective of the light intensities, when further study was conducted on rearing the birds in their two preferred light sources at either 5 lux (dim illuminance) or 20 lux (bright illuminance), the authors reported that at 6 weeks of age, birds spent 61% of their time resting but the resting behaviour was not significantly affected by the light source or intensity. However, less feather pecking behaviour was observed in warm-white fluorescent light source than in biolux light source.

Conclusion and Applications

1. Animals' welfare is an integral component and vital aspect of animal production in that, it influences the exhibition of natural (including locomotory, social, and consummatory) behaviour.
2. Poultry like other animals are affected by environmental factors such as temperature, breeding methods, and light sources.
3. Due to a well-developed vision, and ability of light to influence hormonal and natural behaviour, choice of light is expedient for growth performance in broilers.
4. Consummatory behaviour (drinking and feeding) is usually increased when artificial light is used in broilers especially from younger ages. These consummatory act increased more significantly in Compact fluorescent lamps (CFL) more than incandescent (ICD) bulb.
5. ICD produce more heat and has been found to increase aggressive behaviour in broiler chickens, light emitting diode (LED) produces variety of lights, but the initial capital outlay on investment and its limited availability makes it a lesser option by farmers.
6. To improve productivity, animal welfare and to reduce energy cost in poultry facilities, CFL light source is encouraged rather than ICD light source.

Conflict of interest

None declared

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