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Lighting programmes and its implications for broiler chickens

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The manipulation of the photoperiod by the use of lighting programmes is a useful tool, inexpensive and can help to reduce the negative effect on feed intake due to the stress caused by hot environments. Lighting programmes for broiler chickens are used to regulate feed intake, providing access to food and water, especially during the cooler hours of the day. The change in the length of the photoperiod can be an alternative way to improve the welfare, immune response and, consequently, the performance of birds that are subject to heat stress. The purpose of this paper was to review relevant research on the use of lighting programmes for broilers.

Keywords: light; broilers; welfare; performance

Introduction

The environment during production plays a fundamental role in modern poultry farming. Temperature, humidity, air velocity and radiation are the factors that mainly affect animals and can compromise homeothermy (Amaral *et al.*, 2011). According to Ferreira (2005), broiler chickens show maximum performance when the ambient temperature is between 18 and 26°C during the growth phase. In certain countries like Brazil, some challenges in poultry production have yet to be overcome, mainly due to profound climate changes and the high temperatures recorded in different regions, which often require farms to change management practices in order to achieve maximum animal performance (Rabello, 2008).

Among the various management techniques used to minimise the negative effects of the high temperatures on broilers performance, lighting programmes are gaining interest. Lighting programmes for broiler chickens are used to regulate feed intake, providing access to food and water, especially during the cooler hours of the day. For this reason, initially, continuous lighting programmes have been proposed and adopted.

The manipulation of the photoperiod by the use of lighting programmes is a useful tool which is inexpensive and can reduce negative effects of the hot environment on feed intake. This manipulation is associated with better animal performance and,

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consequently, better economics of production. The purpose of this paper is to review relevant research on the use of lighting programmes for broilers.

Lighting programmes

Lighting programmes are classified as continuous, intermittent and increasing. In the continuous lighting programme, the broilers are subjected to a constant photoperiod of 23 to 24 hours. This programme provides conditions to maximise feed intake and weight gain due to access to feeders. However, the birds become more susceptible to leg problems and they are more immunologically fragile. The intermittent lighting programme provides repeated cycles of light and darkness in a 24 hour period, and the increasing lighting programme provides increased schemes in photoperiod according to increases in age (Liboni *et al.*, 2013).

The term lighting programme includes various aspects including intensity, duration and wavelength of light. The duration (photoperiod) is the aspect that has been studied the most in research papers (Zheng *et al.*, 2013). The luminosity is the most critical of all environmental factors to birds, as it influences many physiological and behavioural processes in these animals, allowing them to settle, and synchronise many essential functions, including body temperature and feed intake (Olanrewaju *et al.*, 2006). Different lighting programmes have a significant effect on performance, immunity and stimuli for the secretion of various hormones that control growth and reproduction (Zheng *et al.*, 2013). According to Moraes *et al.* (2008), the photoperiod is artificially regulated to contribute to the growth and economic performance, without jeopardising bird health.

The most common light sources in Brazilian poultry houses are incandescent and fluorescent lamps. However, sodium vapour lamps are being widely used and they represent an economical light source to the poultry industry. Incandescent lamps provide uniform illumination range, and, although their installation is cheaper, the operation costs are high and they generate a lot of heat which is undesirable in warm weather. Fluorescent lamps produce more light per watt when compared to incandescent lamps however; they need to be replaced regularly due to decreases in intensity over time. Sodium vapour lamps have a higher initial cost, but lower maintenance and longer service life (Mendes *et al.*, 2010).

Mendes *et al.* (2013) evaluated the preference of broilers for white and yellow lights provided by LED lamps (light–emitting diodes) and the performance of the broilers exposed to LED and compact fluorescent lamps. The authors concluded that broilers showed no preference for white or yellow LED light, since they were evenly distributed between the two environments. However, the birds exposed to white LED light showed greater feed intake at 21, 28 and 35 days of age. The birds exposed to illumination by LED lamps showed better performance compared to birds exposed to illumination by fluorescent lamps.

The positioning and adequate distribution of light sources in the initial phase of broilers encourages the birds to search for food, water and heat. In the growth phase, it can be useful to regulate weight gain, increase production efficiency and birds' health (Olanrewaju *et al.*, 2006). Considering this, the application of lighting programmes should not compromise the performance of the birds and should be used as a tool to reduce costs at the farm (Liboni *et al.*, 2013).

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The effects of lighting programmes on feed intake, activity, behave and welfare

It has been assumed for a long time, that long lighting periods enable more time to access food and water, allowing broilers longer periods to feed and, consequently, increase growth rate. Programmes with a photoperiod of 23 to 24 hours of daily light have been widely used by the poultry industry to maximise feed intake. However, with the advancement in research, researchers have concluded that the best performance and bird welfare could be achieved with moderate photoperiod, which would allow an increase in the hours of sleep and a reduction in physiological stress (Rutz and Bermudez, 2004). Broilers exposure to continuous photoperiod induces sleep deprivation, causes severe physiological responses to stress (Abbas *et al.*, 2008) and does not bring as many benefits to the production process as was thought a few years ago.

The dark period is a natural requirement of any animal. Energy is conserved during the rest period, resulting in greater feed conversion, decrease in mortality and occurrence of locomotor problems. Dark periods increase melatonin production, which is important for the development of the immune system. The broilers uniformity and growth rate may be similar or better than those of birds raised in continuous lightning, when the compensatory gain is achieved (Liboni *et al.*, 2013). These results corroborate Renden *et al.* (1994) who observed that birds subjected to 23 hours of light showed body weight similar to birds subjected to 16 hours of light. This result shows that long photoperiods are not required to improve the performance of birds.

Other advantages of lighting programmes with moderate photoperiod include the best results of feed conversion due to energy conservation during rest periods (dark); lower mortality rate and fewer locomotor problems (Liboni *et al.*, 2013). Considering all of the above, the change in the length of the photoperiod can be an alternative to improve the welfare, the immune response and, consequently, the performance of birds that are subject to heat stress.

The concern about the period of the day in which the bird will consume food when subjected to a hot environment is due to the production of body heat after feed intake. The production of body heat is known as the caloric increment, which may increase the susceptibility to stress and affect performance, depending on the timing of the exposure to hot temperatures. To encourage and allow feed intake during the cooler times of the day is beneficial by reducing consumption during hot periods and minimising losses in performance.

Lighting programmes with longer dark periods may have advantages on the performance as well as the welfare of birds, allowing them to better synchronise their behavioural activities compared to continuous lighting programmes (Bayram and Özkan, 2010). Light – dark stimuli provide adequate environmental information necessary for physiological and behavioural adaptive changes (Abbas *et al.*, 2008).

Classen *et al.* (1991) studied continuous, increasing and intermittent light programmes. The authors observed no differences between the treatments for weight gain, feed intake and feed conversion. On the contrary, Ingram and Hatten (2000) reported that intermittent lighting programmes promote greater weight gain when compared to continuous lighting programmes. The results were explained by the splitting of dark periods with brief light periods. Thus, the birds are able to fulfil their needs by consuming food in the light period, and, during the dark period, they do not exert a great amount of energy, resulting in more weight gain. The authors noted that lighting programmes: 12 light: 12 dark improved feed conversion, however, there was a decrease in body weight, with no effect on mortality of the broilers.

In an experiment to compare almost continuous lighting programmes (23 light: 1 dark)

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and intermittent programmes (with six cycles of 1 light: 3 dark), Buyse *et al.* (1997) reported that using the intermittent lighting programme there was a temporary reduction in the growth rate of broilers during the initial phase, however these birds showed compensatory growth in the final phase.

Moraes *et al.* (2008) evaluated the effects of lighting programmes: 23 light, increasing lighting, 16 light and natural lighting. The authors observed that the weight of the birds were greater when the animals were subjected to increasing lighting programmes. They observed that feed conversion was similar for all treatments and the feed intake of birds that received increased lighting was similar to that of birds receiving 16 hours of light, and concluded that increasing lighting programmes would be most beneficial for broilers.

Researching the effect of lighting programmes on performance and carcass yield, commercial cuts and edible offal of broilers, Kawauchi *et al.* (2008) concluded that lighting restrictions, and consequent food restriction by using increased lighting programmes, does not affect broiler performance when compared to birds reared in continuous lighting. There is a compensatory growth in birds subjected to increasing lighting on the final phase of the growing period, which was explained by Classen *et al.* (1991), according to the synthesis of steroidal anabolic hormones resulting in compensatory growth. Moreover, Abreu *et al.* (2011) observed that the continuous lighting programme provides better performance of broilers. However, this programme results in greater energy expenditure and increases the mortality rate.

Rutz and Bermudez (2004) indicated that the alternated provision of one hour of light and three hours of dark improved feed conversion and reduced abdominal fat as compared to broilers raised in continuous lighting regimes. Moreover, during the dark period of the cycle: light/dark, heat output is reduced. In addition, according to the same authors, in selecting a light programme for chickens it is important to consider rest and sleep, as they can help the bird to face stressful environmental conditions.

According to Bayram and Özkan (2010), shorter photoperiods or alternative programmes should be considered due to concerns about welfare, reducing the susceptibility to metabolic diseases and leg problems, according to Charles *et al.* (1992). The authors investigated the manipulation of the photoperiod as a method of reducing the incidence of metabolic and skeletal diseases.

The incidence of leg abnormalities is widely recognised as a serious well-being problem and there is an urgent need to identify short-term breeding methods to limit the expression of these skeletal abnormalities (Sorensen *et al.*, 1999). The high initial growth rate results in an increase in the weight load on the broilers immature skeleton, which probably contributes to the increased incidence of leg problems. Thereby, the reduction in growth rate decreases the occurrence of this problem in animal production (Brickett *et al.*, 2007).

Renden *et al.* (1996) evaluated the effect of lighting programmes on the incidence of leg problems in broilers. The authors found that birds exposed to intermittent programmes (1 light: 2 dark) showed less leg problems compared to birds exposed to continuous lighting programmes (23 light: 1 dark), and attributed this best condition to the increased activity of the birds exposed to intermittent programmes. Sorensen *et al.* (1999) observed that an increase in the photoperiod was associated with the prevalence of tibial dyschondroplasia in broilers. According to Brickett *et al.* (2007), by increasing exposure to darkness, the growth rate of broilers can be reduced. In conjunction with this lower growth rate, a corresponding reduction in the incidence of leg abnormalities and metabolic disorders has been reported.

The better performance and health observed in broilers subjected to intermittent lighting programmes is, at least, partly due to the production of melatonin (Classen *et al.*, 1991). When exposed to continuous lighting programmes, birds have severe

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deficiency in melatonin, a hormone antioxidant, secreted by the pineal gland that can regulate the daily physiological rhythms, including the cardiorespiratory, reproductive, excretory, thermoregulatory, behavioural, immunomodulatory and neuroendocrine systems (Apeldoorn *et al.*, 1999).

Abbas *et al.* (2008) evaluated the effects of photoperiod on performance and immune response of broilers. The authors found that the intermittent lighting programme (2 light: 2 dark for 24 hours) improves the immune system functions and performance of broilers, when compared to continuous lighting programmes 23 light: 1 dark and 12 light: 12 dark. However, the lighting programme 12 light: 12 dark did not appear to induce the elevation of heterophil: lymphocytes ratio and the concentration of corticosterone in the plasma.

Besides the photoperiod, the importance of light in the poultry house takes into consideration the intensity of light, which is measured in lux (L). According to Olanrewaju *et al.* (2006), light intensity affects broilers activity: when subjected to intense lighting broilers increase their activity, while, under milder lighting, broilers reduce their activity and aggressive behaviour.

According to Lien *et al.* (2009), there are directives defining light intensity and the duration of the dark period that should be provided to broilers daily. The directives restrain the photoperiod from 16 to 20 hours, and the light intensity should be less than 20 L, according to the UK Farm Animal Welfare Council (FAWC , 1992). Lien *et al.* (2009) evaluated photoperiod and light intensity (23 light: 1 dark and 10.76 L; 18 light: 6 dark and 10.76 L; 23 light: 1 dark and 1.076 L; 18 light: 6 dark and 1.076 L). The authors reported that no previous papers have found an interaction between photoperiod and light intensity for broiler weight gain. They found a greater weight gain in the treatment with the longer photoperiod and higher intensity of light (23 light: 1 dark and 10.76 lux), whereas the treatment with the shorter photoperiod had the greater weight gain when the lower light intensity was tested (18 light: 6 dark and 1,076 L).

Blatchford *et al.* (2009) evaluated light intensity in broiler production and found minimal effects on broiler health, with the possible exception of eye health. However, the light intensity of at least 50 L stimulated the activity of broilers without adversely affecting weight gain. They concluded that the length of the day has more influence on the consumption of food than the light intensity.

Conclusions

Light management is used to improve broiler production efficiency and is an important and essential component to bird heath. The broiler needs a minimum dark period (about four hours) to re-establish, to rest, for melatonin synthesis and to reduce stress caused by the production environment. The concept and application of lighting programmes for broilers have developed over time, but, in the actual scenario, it is necessary to investigate not only their effects on performance, but also their effects on the health and welfare of birds.

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