EFFECTS OF MELATONIN ADMINISTRATION ON MORTALITY AND ECONOMICS OF BROILER CHICKENS EXPOSED TO CONTINUOUS LIGHTING AND HEAT STRESS

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ABSTRACT

This study was conducted to determine the impact of continuous lighting and heat stress on the mortality and economics of broiler chickens, administered with melatonin during the hot-dry season. Broiler chicks were assigned randomly into three groups, comprising 100 chicks each. Group I was raised under natural photoperiod of 12-h light and 12-h darkness, without melatonin supplementation. Group II was kept under 24-h continuous lighting, without melatonin administration. Group III was raised under 24-h continuous lighting, with melatonin supplementation at 0.5 mg/kg *per os*, via drinking water. Melatonin was administered once daily for 42 consecutive days at 17:00 h. The weekly mean temperature-humidity index recorded inside the poultry house was lowest at week 4 of the study, with the value of 48.60 ± 0.08 °C; but highest at week 1, with the value of 53.48 ± 0.97 °C ($P < 0.0001$). Groups I, II and III had overall mortality of 5, 6 and 1 %, respectively. The highest profit value of □667:55 was obtained in group III broiler chickens, administered with melatonin. In conclusion, oral administration of melatonin may enhance adaptation to heat stress and productivity of broiler chickens in the tropical zones of the world.

INTRODUCTION

Dietary manipulations of alleviation of detrimental effects of high environmental temperature on oxidative stress and performance of poultry are preferable to other methods because of their practicability and lower cost (Sinkalu *et al.*, 2009; Singh *et al.*, 2012). Studies have shown that diets enriched with antioxidants, such as vitamins C, E, A, zinc and chromium, may be used to attenuate the negative effects of environmental stress. The finding suggests that detrimental effects of environmental stress are largely due to induction of oxidative stress (Sahin *et al.*, 2002; Singh *et al.*, 2012), associated with increased generation of reactive oxygen species (ROS). Environmental variables influence pineal gland in many avian species (Sudhakumari and Haldar, 2001). Arendt (1988) suggested that the pineal gland acts as a photoneuroendocrine transducer that responds via melatonin release. Melatonin, *N*-acetyl-5-methoxytryptamine, is the main neurohormone synthesized and released by pineal gland. It sets the internal biological clock that regulates different daily and seasonal cycles or rhythms in various physiological systems, including the cardiopulmonary, reproductive, excretory, thermoregulatory, behavioural, immune and neuroendocrine systems in birds (Alarma-Estrany and Pintor, 2007; Melamud *et al.*, 2012). It is released during the hours of darkness in response to the activity of serotonin-N-acetyltransferase, the enzyme that catalyzes the synthesis of melatonin in both the retina and pineal gland (Lewis *et al.*, 2006; Gregory and Sadeh, 2012). During the day, the light-induced production of dopamine within the retina suppresses the production of serotonin in the photoreceptors and, as a consequence, inhibits the biosynthesis of melatonin (Morgan *et al.*, 1995; Zawilska *et al.*, 2007). Thus, broiler chickens exposed to continuous lighting modifies rate of sexual maturation in pullets, and may be severely deficient in serum melatonin (Vanecek, 1998; Lewis *et al.*, 2006). Besides its primary function as synchronizer of the biological clock, melatonin exhibits a powerful antioxidant activity, improves immunological defences and lipid metabolism during intense exercise (Maldonado *et al.*, 2012), and may be a potent antistress agent. There is paucity of information in the available literature on mortality of broiler chickens, administered with melatonin and the financial impact of stresses due to heat and continuous lighting, imposed on the birds.

MATERIALS AND METHODS

The experiment was conducted between 2nd April, and 14th May, 2010 during the hot-dry season, in a standard poultry house, located in the Department of Veterinary Physiology, Ahmadu

Bello University, Zaria (11° 10′ N, 07° 38′ E), situated in the Northern Guinea Savannah zone of Nigeria. Three hundred (300) broiler chicks belonging to the Marshall breed were obtained at a day-old from Fidan Farms, Ibadan. Simple random sampling was used to select and assign the broiler chicks into three treatment groups, each comprising one hundred (100) chicks. Group I was raised under natural photoperiod of about 12 h light and 12 h darkness cycle, without melatonin supplementation. Group II was kept under 24 h continuous lighting (CL), without melatonin supplementation. Group III was raised under 24 h continuous lighting and administered daily with melatonin (ISI Brands, Inc. Utah, USA) at 0.5 mg/kg *per os* (Nisbet *et al.*, 2008), via drinking water. Melatonin was administered once daily at 17:00 h (Deacon and Arendt, 1995). The broilers were raised on deep litter system and maintained on commercial feed (Vital Feeds, Grand Cereals and Oil Mills Limited, Jos, Nigeria). The dry- and wet-bulb temperatures were taken using dry- and wet-bulb thermometer (Brannan, UK). From the data, relative humidity (RH) measurements were extrapolated, while the temperature-humidity index (THI) was calculated using the equation of Tao and Xin (2003): $THI = 0.85DBT + 0.15WBT$; Where DBT = Dry-bulb temperature, and WBT = Wet-bulb temperature. Birds that died or culled were documented. Dead birds were examined by post-mortem dissection on the day of death to determine the cause of mortality. The gross margin for each treatment group was calculated according to the method of Onyimonyi *et al.* (2009).

RESULTS AND DISCUSSION

The results of the thermal environmental data during the study period showed that the weekly mean THI recorded inside the poultry house was lowest at 4th week of the study, with the value of 48.60 ± 0.08 °C; but highest at 1st week, with the value of 53.48 ± 0.97 °C ($P < 0.0001$). The high THI showed that the thermal environmental conditions, prevailing during the study period were uncomfortable for raising broiler chickens in the zone. The finding agrees with the report of Marai *et al.* (2002) that animals raised under conditions with THI higher than 29 °C suffer heat stress. Therefore, measures aimed at alleviating the adverse effects of heat stress on broilers, as evidenced high THI recorded in the present study, are of paramount importance in order to reduce economic losses. The mortality rates for all the broiler chicken groups are shown in Table 1. Groups I, II and III had overall mortality of 5, 6 and 1 %, respectively. Table 2 represents the economic analysis of the birds belonging to the various groups. A profit of ₦ 667:55 was made per bird on the melatonin-treated group as against ₦ 337:78 and ₦ 447:48 for birds on 12D:12L and 24CL treated groups, respectively. In a study by Onyimonyi *et al.* (2009), the corrected average profit of broiler chickens fed varying dietary levels of Neem leaf meal, containing antioxidants, was ₦528:85 for five treatment groups. The monetary value (₦528:85) was higher than those obtained in the present study in 12D:12L cycle (₦337:78) and 24-h CL (₦447:48); but lower than ₦667:55, recorded in melatonin-treated group. The highest profit obtained in the melatonin-treated group further showed that broiler chickens, administered with melatonin have significantly, the best performance, compared to the other two (12D:12L and 24-h CL) groups that were not treated with melatonin.

Conclusion

It is concluded that melatonin decreased mortality rate due to the adverse effects of heat stress and continuous lighting on broiler chickens, and its administration may enhance their productivity and profitability.

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Table 1: Percentage Weekly Mortality Rate of Marshall Broiler Chickens administered with Melatonin (n = 100)

Age in weeks	Group		
	I	II	III
I	-	-	-
II	-	-	-
III	-	-	-
IV	1.00	1.00	-
V	2.02	2.02	-
VI	2.06	3.09	1.00
Overall	5.08	6.10	1.00

Group = 12D:12L (12D:12L cycle); Group II = CL (Continuous lighting) and Group III = CL + MEL (CL + Melatonin administration)

Table 2: Economics of Marshall Broiler Chickens administered with Melatonin from 0 – 42 d of Life

Item	Groups		
	I (12D:12L)	II (CL)	III (CL + MEL)
1. Cost/kg of Feed (Vital Feeds, UAC Nig. Plc; ₦)	77.04	77.04	77.04
2. Feed intake/bird (kg)	3.17	3.81	3.42
3. Cost of feed consumed/bird (Product of items 1. and 2; ₦)	244.22	293.52	263.48
4. Cost/kg of dressed carcass (Mr. Biggs, UAC Nig. Plc; ₦)	600	600	600
5. Dressed carcass/bird (kg)	0.97	1.41	1.92
6. Selling price/bird (Product of items 4. and 5; ₦)	582	846	1152
7. Cost of light supply during night time (₦)	0	105	105
8. Cost of melatonin administered/bird (₦)	0	0	115.97
9. Profit (Items 6. minus items 3, 7. and 8; ₦)	337:78	447:48	667:55

Note: All other costs were assumed constant; 12D:12L (12D:12L cycle) = Group I; CL (Continuous lighting) = Group II; and CL + MEL (CL + Melatonin administration) = Group III