EFFECTS OF MELATONIN ADMINISTRATION ON THE PHYSICAL PROPERTIES OF EGG SHELL AND INTERNAL EGG QUALITY IN LAYING HENS DURING THE HOT-DRY SEASON

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ABSTRACT
Poor egg shell quality and poor internal egg quality as a result of heat stress are detrimental to poultry egg industry. The aim of the present study was to determine the influence of melatonin administration on egg shell properties and some internal egg quality traits of laying hens during the hot-dry season in the Northern Guinea Savannah zone of Nigeria. Birds were divided into 2 groups of melatonin-treated (0.5 mg/kg) and control. Egg, shell, egg content, albumin and yolk weights were examined. Total egg weight, egg content weight, albumin weight and yolk weight in both groups were not significantly different ($P > 0.05$). Conversely, the egg shell weight was significantly greater in the control group than in hens treated with melatonin ($P < 0.001$). In conclusion, melatonin supplementation may, be better-suited in birds raised for meat rather than in those for egg production.

INTRODUCTION
The avian pineal gland synthesizes melatonin in a rhythmic fashion, such that plasma levels of melatonin are highest at night in response to the activity of serotonin-N-acetyltransferase, the enzyme that catalyzes the synthesis of melatonin in both the retina and pineal gland (Binkley *et al.*, 1973). This ubiquitous pineal molecule is secreted into the blood, where it circulates throughout the body to exert its effects on a myriad of target tissues (Alexander *et al.*, 2013). The hot-dry season is characterised by high ambient temperatures and high humidity, which cause heat stress on chickens. Heat stress may influence the rate of secretion of hormones and their metabolic clearance rate (Ayo *et al.*, 2011). The average daily calcium turnover in laying hens is about 1 g/kg body weight, which is higher than that of virtually any other animal (Miller, 1992). External quality characteristics of eggs, which include freshness, cleanliness, egg weight and shell quality are important in consumers' acceptability of egg shell (Salawu *et al.*, 2007). Imbalanced calcium utilisation frequently occurs especially in heat-stressed laying hens, manifested as poor egg shells, and skeletal defects like fractures and osteoporosis (Alexander *et al.*, 2013). Poor egg shell quality is detrimental to egg industry and raise ethical questions concerning animal health and it is a major cause of disease outbreak in poultry (Guard-Bouldin and Buhr, 2006). Egg is the most excellent vehicle to incorporate numerous health promoting components (Singh and Neelam, 2010) and nutritional composition of egg may be modified by dietary manipulation of feed (Singh *et al.*, 2012). The effects of melatonin administration on egg physical properties in terms of egg production in laying birds during the hot-dry season has not been elucidated.

MATERIALS AND METHODS
The experiment was performed in a standard poultry house at the Department of Veterinary Physiology, Ahmadu Bello University, Zaria (11°10′N, 7°38′E), located in the Northern Guinea Savannah zone of Nigeria, where the birds were raised. Twenty-six, apparently, healthy Isa Brown laying hens served as subjects. Simple random sampling was used to assign the birds into two groups; melatonin-treated (n = 14) and control (n = 12) groups. A total of 30 eggs selected at random from each group were used for this study. Birds in the control group were given water and feed only, while those in melatonin-treated group were individually administered at 18:00 h with melatonin orally at 0.5 mg/kg daily throughout the experimental period that lasted for 12 days. The birds were managed intensively on deep-litter system in a standard poultry house. This management system was in compliance with the new European Union (EU) council directive 99/74/EC to face out the conventional layer cages by the year 2012. The house was demarcated into two compartments, housing 14 melatonin-treated and 12 control birds. The house was made of cement blocks and plastered floor with zinc roofing. Wood-shavings were used as bedding. The house measured 6.5 m x 6.2 m wide and 2.0 m high, with wire mesh on top of the cement blocks and at 0.80 m to the roof, to allow for adequate ventilation. The

laying hens were fed commercially compounded, pelletized layers' mash (Vital Feeds®, Jos, Nigeria), and given access to feed and water *ad libitum*. Proximate analysis (Table 1) of the feed was conducted at the biochemical laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria. All routine vaccinations, medications, and other related management practices were carried out on the birds as recommended by the National Veterinary Research Institute, Vom, Nigeria.

Table 1: Proximate Analysis of Layer Feed*

Ingredient	Values, %
Dry matter	94.58
Crude protein	16.19
Crude fibre	6.24
Oil	4.87
Ash	4.76
Nitrogen free extract	67.94

**Proximate analysis of the feed, conducted at the biochemical laboratory of the Department of Animal Science, Ahmadu Bello University, Zaria, Nigeria.*

The weights of the eggs were measured after washing and drying with towel to remove contaminants from the shell. Eggs were broken gently and the contents poured into a Petri dish. Shell weight was measured after removal of remaining albumen with water and subsequent air drying overnight. The weight of albumen was calculated by subtracting the weights of yolk and shell from the weight of the whole egg. Egg collection was done twice daily at 8:00 h and 14:00 h. An electronic top loading scale (sensitive at 0.01 g) was used to obtain the egg weight, shell weight (dried eggshell), yolk weight and albumen weight of the sampled eggs. Egg shell thickness was measured using micrometer screw gauge (Onimisi, *et al.*, 2012). Values were expressed as mean ± SEM. Data were analyzed using the Student's *t*-test to compare between melatonin-treated and control hens. Analyses were performed using Graphpad prism software package version 4.0 for windows (San Diego, California, USA, www.graphpad.com). Values of $P < 0.05$ were considered significant.

Table 2: Egg quality of control and melatonin-treated laying hens during the hot-dry season (Mean ± SEM, n = 30)

Group	Whole weight (g)	Shell weight (g)	Egg content weight (g)	Albumin weight (g)	Yolk weight (g)
Control	55.20 ± 0.798	5.57 ±0.166***	49.63 ± 0.531	35.07 ± 0.452	14.93 ± 0.374
Melatonin	54.07 ± 0.798	4.73 ±0.165***	49.33 ± 0.728	34.40 ± 0.548	14.57 ± 0.196

Total egg weight, shell weight egg content weight, albumin weight and yolk weight
***= $P < 0.001$. Data were given as mean ± SE

RESULTS AND DISCUSSION

Total egg weight, egg content weight, albumin weight and yolk weight in both groups were not significantly different ($P > 0.05$). However, the egg shell weight was significantly greater ($P < 0.001$) in eggs laid by the controls, compared to those obtained from melatonin-treated birds (Table 2). Contrary to the findings of Alexander *et al.* (2013), who reported that melatonin increased egg content weight, it was observed that there was no significant ($P > 0.05$) difference in egg content weight of both melatonin-treated and control groups. It has been shown that each egg contains over 2.3 g of calcium carbonate, an amount which is roughly equivalent to 10 % of a hen's total calcium stores each day, and the medullary bone is partially dissolved by osteoclastic activity in order to provide calcium for use in the matrix of developing egg shell. This activity is inhibited by melatonin. This may explain why reduced egg shell mass was observed in melatonin treated group. The marked production losses such as bone strength, bone weight and body weight gain in heat-stressed, meat producing birds has been associated inadequacies of minerals like calcium (Smith *et al.*, 2003). Alexander *et al.* (2013) reported that melatonin-treated birds were found to deposit less calcium in egg shell than controls, as evidenced by reduced shell weight, while simultaneously affecting an equivalent amount of mineralisation in cortical bone. Further studies are required to determine the effects of melatonin directly on the function of the shell gland and medullary bone *in vitro* in laying hens.

Conclusions

Melatonin-treated laying hens were found to deposit less calcium in egg shell than controls. Melatonin supplementation may be better-suited in birds raised for meat rather than in those for egg production.

REFERENCES

Alexander, T. C., Maria, H., Ashli and Paul, A. B. (2013). The effects of melatonin on the physical properties of bones and egg shells in

laying hens *Plos ONE* 8(2): e 55663. Doi: 10.1371/ journal. Pone. 0055663

Ayo, J. O., Obidi, J. A. and Rekwot, P. I. (2011): Effects of heat stress on the well-being, fertility and hatchability of chickens in the northern Guinea Savannah zone of Nigeria: A Review. *ISRN Vet. Sci.* http://dx.doi.org/10.5402/2011/838606

Binkley, S., MacBride S. E., Klein, D. C. and Ralph, C. L. (1973). Pineal enzymes: Regulation of avian melatonin synthesis. *Sci.*, 181: 273-275.

Guard-Bouldin, J, and Buhr, R. J. (2006). Evaluation of eggshell quality of hens infected with *Salmonella enteritidis* by application of compression. *Poult. Sci.* 85(1): 129–135.

Miller, S. C. (1992). Calcium homeostasis and mineral turnover in the laying hen. In: Whitehead CC, editor. *Bone Biology and Skeletal Disorders in Poultry*. Poultry Science Symposium No. 23: Carfax Publishing Co., Oxfordshire, UK.

Onimisi, P. A., Orunmuyi, M., Musa, A.A., Bale, S. and Bawa, G.S. (2012). Effects of feed lysine content on laying performance and egg quality of late laying hens. *Intern. J. Appl. Res. Technol.*, 1: 104-110.

Salawu, I. S., Orunmuyi, M. and Okezie, O. (2007). The use of hotelling T^2 statistic in comparing the egg weight of quail, Brown strain of commercial and duck. *Asian J. Anim. Sci.*, 1:53-56.

Singh, V. P. and Neelam, S. (2010). Nanotechnology: The new opportunities and threats to food. *Indian Food Industry*, 29: 46-49.

Singh, V. P., Pathak, V. and Akhilesh, K. V. (2012). Modified or enriched eggs: A review. Am. *J. Food Technol.*, 7: 266 – 277.

Smith, M. O. Soisuvan, K. and Miller, M. C. (2003). Evaluation of dietary calcium level and fat source on growth performance and mineral utilization of heat-distressed brqilers. *Intern. J. Poult. Sci.*, 2 (1): 32-37.