Response of domestic chickens to fasting and non-fast moulting programmes in a humid tropical environment

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Abstract

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The study evaluates the effect of fasting and non-fasting (Zn supplementation) moulting methods on performance of indigenous (IC) and Shaver brown (SB) hens in the hot humid tropical environment of Nsukka, Southeastern Nigeria. One hundred and twenty indigenous and Shaver brown hens (60/genotype) aged between 75 and 80 weeks were shared into three groups (20/group), T₁: hens fed layers diet at 125 g/bird/day (control group), T₂: hens fed layers mash supplemented with 20,000ppm Zn as ZnO at 125 g/bird/day for 14 days, and T₃: hens subjected to feed deprivation (FD) for 14 days. Water was given ad libitum to all birds. Data analyzed were pre-moult and moulting body weight, hen day egg production (HDEP), and egg weight. Moulting method significantly ($p < 0.05$) affected body weight in SB but not in indigenous hens; hen day egg production and day to stoppage of egg production in both genotypes with FD resulting in greater loss in body weight and an early cessation of egg production compared to zinc supplementation. Shaver Brown hens subjected to ZnO and FD lost 15.6 and 26.7 % of their initial body weight, respectively while IC lost 16.2 and 32.6 %, respectively. Hen day egg production was 0.00 ± 0.00 % in the last week of moulting in SB and IC moulted by FD but 8.32 ± 6.47 % for SB and 10.71 ± 3.25 % for IC moulted by ZnO. Egg production stopped on day 10 (D10) and 6 in SB hens submitted to ZnO and FD, respectively and on D13 and 5, respectively for the IC. In conclusion, zinc supplementation at 20,000ppm in the diet of laying chickens as moulting agent is a milder but equally effective moulting method as fasting and is recommended for intensive commercial and rural indigenous poultry production.

Keywords: Induced moulting, body weight loss, egg production, Shaver Brown, local chickens.

Introduction

Egg production in laying flocks is limited by age and decreases as hen ages. The aging process and cessation of egg production initiate natural moulting which usually lasts for about 4 months (Santos *et al.*, 2014). Moulting is therefore a major event in the annual life cycle of the domestic chicken and other avian species (Aygun and Olgun, 2010). Commercial egg producers in countries where the disposal of spent hens incurs additional costs to the farmer employ induced moulting to circumvent natural

moulting and to induce spent hens to rapidly enter a second laying cycle thereby extending the laying flock performance (North and Bell 1990; Aygun and Olgun, 2010). Induced moulting rejuvenates the hen's reproductive organs and improves the post-moult performance of the flock in livability, egg production, and egg quality compared to the immediate pre-moult performance (Holt, 2003; Webster, 2003). Programmes used to induce moulting in laying hens include feed deprivation, photoperiod reduction, mineral (Ca, Cu,

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Zn, Al, etc) supplementation and the use of low energy diets (Molino *et al.*, 2009; Santos *et al.*, 2014). These schemes cause total cessation of egg production, shading of body fat, and renewal (involution) of the reproductive organs (Hussen, 1996; Santos *et al.*, 2014). Feed deprivation was the primary method of induced moulting in hens (Gast and Rieke, 2003; Aygun and Olgun, 2010). Other moulting techniques were developed in response to welfare and public health concerns associated with fast moulting of birds (Rieke *et al.*, 2001; Yousaf and Ahmed, 2006). Moulting by Zn supplementation seems particularly attractive because zinc is an important micro mineral, and has been shown to possess immune-potentiating and antioxidant effects (Ogbu *et al.*, 2016).

Induced moulting of birds has received limited attention in sub-Saharan Africa including Nigeria. The practice is virtually nonexistent in rural poultry production in which indigenous chickens constitute 70 – 80 % of the flock. This is probably due to lack of awareness of the economic gains derivable from moulting aged flocks. Indigenous poultry farmers hence endure long periods of natural moulting with the attendant losses of revenue. For the commercial poultry industry employing exotic breeds, induced moulting is not practiced due partly to lack of awareness and probably because sale of spent hens is not a big challenge. However, when due to disease challenge, scarcity of chicks or other constraints a farmer is not able to raise replacement stock, the laying flock is kept longer than usual without being force moulted even when productivity is marginal. The practice of induced moulting could be very beneficial to poultry farmers in Nigeria. Apart from extending the productive and economic life of the hen, enabling higher revenue to the farmer, it could enable farmers to (1) purchase day old

chicks or point of lay at ease and at competitive prices as recycling of flocks will reduce the demand for day old chicks, and point of lay pullets (Aygun and Olgun, 2010), (2) reduce the frequency of brooding and rearing of young chicks in the farm and thereby minimize the anxiety associated with the brooding phase, (3) save the time needed for brooding and rearing a new replacement flock, and (4) reduce disease challenge in farms and avoid the costs associated with frequent vaccination and medication incurred during brooding and rearing (Moustafa *et al.*, 2010). Aygun and Olgun (2010) observed that induced moulting is an important tool for the economic management of laying flocks. Many studies have evaluated the response of exotic hens to moulting programmes but there is limited information on the response of indigenous and exotic hens to the same moulting methods. The present study was therefore conceived to evaluate and compare the performance of indigenous and Shaver brown hens during forced moulting using a fasting and non-fasting moulting programmes.

Materials and methods

The study was carried out at the Poultry Unit of the teaching and research farm of the Department of Animal Science, Faculty of Agriculture, University of Nigeria, Nsukka. One hundred and twenty local and Shaver Brown chickens (60/genotype) aged 75 – 80 weeks old were used for the study. The birds were shared into three treatment groups (T) namely: birds fed layers diet at 125 g/bird/day or control group (T₁), birds fed layers mash supplemented with 20,000ppm zinc as ZnO (El-Deek and Al-Harthi 2004) for 14 days at 125 g/bird/day (T₂), and birds subjected to feed deprivation for 14 days (T₃). Water was provided *ad libitum* to birds belonging to each treatment. The experimental groups

were evaluated for body weight, egg production, and egg weight before induction of moulting (pre-moult), and for 14 days during moulting treatment.

Statistical analysis

Data were subjected to analysis of variance in completely randomized design to compare between treatment groups while comparison between genotypes was by independent samples t-test.

Result and discussion

Trend in performance of hens pre-moult

Highest hen day egg production (HDEP) was 75 % in Shaver Brown hens before moulting and this was observed on days 3 (D3) and 4, respectively in the one week pre-moult (Fig. 1, panel A) however, HDEP ranged between 45 to 75 % within this period in hens of this breed subjected to ZnO treatment but 52 to 60 % in those of FD.

Fig. 1: Egg production and egg weight of Shaver brown (panel A) and indigenous hens (panel B) before moulting.

For the indigenous hens (Fig. 1, panel B), HDEP in the last week before moulting ranged between 12.5 to 62.5 % for ZnO group and 40 to 80 % for those of FD. Fig. 1 also shows that HDEP decreased gradually in SB but rapidly in local chickens. Egg weight did not fluctuate as much as egg production and showed some improvement as egg production decreased in the two genotypes. Body weight ranged between 1.50 and 1.95 kg and 1.45 and 1.90 kg in SB hens belonging to ZnO and FD groups, respectively. The corresponding values for indigenous hens were 1.00 and 1.80 kg and 1.25 and 1.60 kg, respectively. Hens are usually forced to moult towards the end of their first laying cycle due to ageing and

poor egg production (Moustafa *et al.*, 2010; Santos *et al.*, 2014). In Nigeria, such flocks are disposed and replaced with new stocks. In advanced economies other conditions that force farmers to moult laying flocks include poor egg sales compounded by high feed costs. The birds employed in the present study were 75 to 80 weeks old and showed declining laying performance such that they had become uneconomical to rear. These situations support the disposal and replacement of the flock or induction of moult to bring the birds into a second laying cycle (Webster, 2003) and avoid flock replacement costs (El-Deek and Al-Harhi, 2004).

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Trend in performance of hens during the moulting phase

The trend in performance traits of SB and

indigenous hens during moulting is presented in Tables 1 and 2, respectively.

Table 1: Trend in performance of Shaver Brown hens during moulting

Shaver brown	Body weight (g)	Egg production (%)	Egg weight (g)
ZnO supplementation			
Initial (before moulting)	1.67 ± 0.05 ^a	61.19 ± 6.16 ^a	62.70 ± 1.05
WK ₁	1.43 ± 0.05 ^b	30.73 ± 6.46 ^b	63.91 ± 1.05
WK ₂	1.41 ± 0.06 ^b	8.32 ± 7.65 ^c	62.40 ± 1.25
Feed deprivation (FD)			
Initial	1.62 ± 0.07 ^a	58.14 ± 6.52 ^a	62.49 ± 0.69
WK ₁	1.29 ± 0.07 ^b	28.57 ± 6.52 ^b	63.89 ± 0.69
WK ₂	1.18 ± 0.07 ^b	0.00 ± 0.00 ^c	-
Control			
Initial	1.63 ± 0.04 ^b	60.00 ± 6.97	58.80 ± 1.38
WK ₁	1.67 ± 0.04 ^{ab}	62.14 ± 6.97	60.70 ± 1.38
WK ₂	1.76 ± 0.04 ^a	59.29 ± 6.97	60.04 ± 1.38

WK: week; a-c: means on the same column with different superscripts are significantly different (p<0.05)

Shaver Brown hens fed diet supplemented with ZnO decreased in body weight from 1.67 ± 0.05 kg to 1.43 ± 0.05 kg in wk 1 (14.37 % loss) and to 1.41 ± 0.06 kg by the end of wk 2 resulting in a cumulative body weight loss of 15.57 %. For those subjected to FD, body weight loss was 27 % by the end of moulting (Table 1). Indigenous hens fed ZnO decreased in body weight from

1.36 ± 0.10 kg at onset of moulting treatment to 1.14 ± 0.11 kg at the end of moulting with body weight loss of 16.2 % whereas those subjected to FD decreased in body weight from 1.38 ± 0.18 kg to 1.05 ± 0.18 kg or a loss of 24% in wk1 and to 0.93 ± 0.16 kg by end of wk 2 or a cumulative loss of 32.6 % (Table 2).

Table 2: Trend in performance of indigenous hens during moulting

	Body weight (g)	Egg production (%)	Egg weight (g)
ZnO supplementation			
Initial	1.36 ± 0.10	32.14 ± 6.25 ^a	45.19 ± 2.02
WK ₁	1.27 ± 0.10	37.50 ± 6.25 ^a	43.36 ± 2.02
WK ₂	1.14 ± 0.11	12.50 ± 6.25 ^b	40.77 ± 2.18
Feed deprivation			
Initial	1.38 ± 0.10	60.00 ± 5.39 ^a	41.52 ± 0.67
WK ₁	1.05 ± 0.10	40.00 ± 6.03 ^b	42.10 ± 0.75
WK ₂	0.93 ± 0.09	0.00 ± 0.00 ^c	-
Control			
Initial	1.08 ± 0.08	35.71 ± 5.71	43.70 ± 1.70
WK ₁	0.97 ± 0.08	25.71 ± 5.71	39.34 ± 1.70
WK ₂	0.92 ± 0.08	35.71 ± 5.71	39.34 ± 1.70

WK: week; a-c: means on the same column with different superscripts are significantly different (p<0.05)

Shaver Brown hens in the control group showed significant increase in body weight at the end of the treatment while the local hens were not affected. The observed range of decreases in body weight in the moulted groups agreed considerably with values reported by other studies. For instance, Al-Kirkuki (2012) reported body weight losses of between 9.3 and 17.8 % over 9 days of moulting in broiler breeders fed between 15,000 and 25,000 ppm zinc. El-Deek and Al-Harthi (2004) reported body weight loss of 16 % within 14 days of moulting in hens fed 2 % ZnO and a loss of 21 % of the body weight in those fed 3 % ZnO, or subjected to fasting moult. Park *et al.* (2004) reported body weight loss of 15.52 and 15.60 % over 9 days in laying hens moulted with zinc acetate and zinc propionate, respectively while those subjected to feed withdrawal lost 25.12 % of their body weight within the same period. Molino *et al.* (2009) observed body weight loss of 21.19 % by D 7 in hens undergoing fasting moult which agreed with the result of the present study. Whatever the moulting method employed, body weight loss of 25 to 30 % has been advocated to optimize post moult performance (Sohail *et al.*, 2011). Berry (2003) however observed that body weight loss of up to 31 % improved post moult performance but suggested that a loss of more than 35 % may be detrimental on life of flock egg production due to long recovery period when no eggs are produced. In the execution of moulting in laying hens, achievement of target percent body weight loss and/or the time for complete cessation of egg production has determined the duration of moulting treatment (Berry, 2003; Reddy *et al.*, 2008; Sohail *et al.*, 2011). In the present study highest body weight losses in the moulted groups occurred in the first week of moulting and this agrees with Webster (2003) that phase one of physiological response to moulting

treatment lasts for about 3.5 days and is characterized by rapid decrease in body weight followed by the phase of rapid reduction in rate of body mass loss. Moustafa *et al.* (2010) observed body weight loss of 10.1 % on first day of fasting out of a total body weight loss of 25.2 % in 16 days. Indigenous hens subjected to moulting showed the highest body weight losses probably as a result of their lower adipose tissue. Generally, percent body weight loss varies according to breed of bird, moulting diet, duration of moulting and environmental conditions such as ambient temperature (Santos *et al.*, 2014). In the present study, HDEP decreased significantly ($p < 0.05$) from pre-moult value of $61.19 \pm 6.16\%$ to $8.32 \pm 7.65\%$ in wk 2 while egg weight was not significantly affected in SB hens subjected ZnO treatment (Table 1). In those moulted by FD, HDEP decreased to $28.57 \pm 6.52\%$ after one week and to 0.00 % in wk 2 while egg weight remained unchanged. For the indigenous hens (Table 2), HDEP decreased to $12.5 \pm 6.25\%$ by wk 2 in the ZnO group and from 60 % pre-moult to 40 % in wk 1 and subsequently to 0.00 % in wk 2 in those of FD. Again egg weight was not significantly affected. For the control groups, HDEP and egg weight was not significantly affected in both genotypes. In the study by El-Deek and Al-Harthi (2004) HDEP decreased from 46 % pre-moult to an average of 20.36 % (loss of 25.64 %) in wk 1 and to 1.3 % (loss of 44.7 %) in wk 2 in hens moulted by 2 % ZnO supplementation and from 46 % to 11.6 % (loss of 34.4%) in wk 1 and to 0.2 % (loss of 45.8 %) in wk 2 for hens fed 3 % ZnO. For hens subjected to fasting moult HDEP decreased from 46 % to 13.7 % (loss of 32.3 %) in wk 1 and 0.0 % (loss of 46 %) in wk 2. These observations agreed with our results of 30.46, and 29.57 % loss in HDEP in wk 1 in SB hens treated with ZnO, and FD, respectively but lower

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than the cumulative losses in wk 2 as a result of the higher initial (pre-moult) HDEP of the flocks employed in the present study.

The trend in HDEP of Shaver Brown and indigenous hens subjected to different moulting techniques is presented in Fig. 2.

Fig. 2: Egg production and egg weight of Shaver brown and indigenous hens subjected to moulting by ZnO supplementation (panel A: Shaver brown; panel B: indigenous hens) and by Feed deprivation (panel C: Shaver brown; panel D: indigenous hens).

Shaver Brown hens treated with ZnO stopped laying on day (D) 10 of moulting treatment (Fig. 2, panel A) while their indigenous counterparts stopped laying on D 13 (panel B). For the group subjected to FD, SB and indigenous hens stopped laying on D 6, and 5, respectively (panel C, and D, respectively). In the two moulting

treatments, egg weight fluctuated more in the indigenous hens compared to SB hens. Stoppage of egg production in moulting hens indicates reproductive quiescence and is used to determine duration of moulting (Gjorgovska *et al.*, 2012; Santos *et al.*, 2014). The observed number of days to stoppage of lay in birds fed ZnO agreed with

El-Deek and Al-Harthi (2004) who reported D 11 in hens fed 2 % ZnO, and D 10 in those fed 3 % ZnO. The results are however at variance with the 3.89 days reported by Sgavioli *et al.* (2013) for hens fed 28,000 ppm Zn and 25 days observed in Cornish hens, and 22 days in Rock hens fed 25,000 ppm ZnO, respectively as reported by Reddy *et al.* (2008). For hens subjected to FD, our findings disagreed with the 8 days reported by El-Deek and Al-Harthi (2004), 14 days reported by Reddy *et al.* (2008) in Cornish and Rock hens, respectively and 3.44 days reported by Sgavioli *et al.* (2013) probably as a result of differences in breed of birds, moulting diet and/or study environment.

Effect of moulting technique on performance of laying chickens during moulting

The effect of moulting methods on the performance of the experimental birds is

presented in Table 3 for SB and Table 4 for indigenous chickens. Shaver Brown hens subjected to FD had significantly ($p < 0.05$) lower body weight at the end of moulting compared to those moulted by ZnO while hens in the control group had the highest body weight (Table 3). No significant differences in body weight were observed between indigenous hens moulted by different methods and between moulted and unmoulted hens (Table 4). Hen day egg production differed significantly ($p < 0.05$) between hens subjected to different moulting methods and between moulted and unmoulted groups in each genotype being 0.00 ± 0.00 % by the end of moulting in SB and indigenous hens moulted by FD compared to 8.32 ± 6.47 % for SB and 10.71 ± 3.25 % for indigenous hens moulted by ZnO, and 59.29 ± 5.47 % for SB and 35.71 ± 3.25 % for indigenous hens in the control group. Egg weight was similar across treatment groups.

Table 3: Effect of moulting methods on performance of Shaver Brown chickens during the moulting period

Shaver brown	Moulting method		
	ZnO	FD	Control
Body weight (kg)			
Initial	1.67 ± 0.06	1.61 ± 0.05	1.63 ± 0.05
WK ₁	1.43 ± 0.07^b	1.29 ± 0.06^b	1.67 ± 0.06^a
WK ₂	1.41 ± 0.06^b	1.18 ± 0.05^c	1.76 ± 0.05^a
Egg production (%)			
Initial	66.67 ± 5.91	58.14 ± 5.00	60.00 ± 5.00
WK ₁	41.36 ± 9.66^{ab}	28.57 ± 8.16^b	62.14 ± 8.16^a
WK ₂	8.32 ± 6.47^b	0.00 ± 0.00^c	59.29 ± 5.47^a
Egg weight (g)			
Initial	62.60 ± 0.47^a	62.49 ± 0.40^a	59.80 ± 0.40^b
WK ₁	62.58 ± 1.70	63.89 ± 1.44	60.70 ± 1.44
WK ₂	62.40 ± 1.34	-	60.04 ± 1.13

abc: means on the same row with different superscripts are significantly different ($p < 0.05$).

Significant differences in the response of laying hens to different moulting methods have been widely reported (Reddy *et al.*, 2008; Aygun and Olgun, 2010; Santos *et al.*, 2014). Generally, hens moulted by FD has higher rates of body weight loss, and decreases in egg production during

moulting compared to non-fast moult treatments. The observed significantly lower body weight and HDEP of hens subjected to FD agrees with Reddy *et al.* (2008) and Aygun and Olgun (2010) who reported higher losses in body weight and egg production in layers subjected to

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Table 4: Effect of moulting methods on performance traits of indigenous chickens during the moulting period

	ZnO	FD	Control
Body weight (kg)			
Initial	1.36 ± 0.15	1.38 ± 0.10	1.21 ± 0.13
WK ₁	1.27 ± 0.15	1.05 ± 0.10	1.08 ± 0.13
WK ₂	1.14 ± 0.14	0.93 ± 0.09	1.07 ± 0.11
Egg production (%)			
Initial	32.14 ± 6.58 ^b	54.29 ± 6.58 ^a	35.71 ± 6.58 ^{ab}
WK ₁	37.50 ± 7.46	22.86 ± 7.46	25.71 ± 7.46
WK ₂	10.71 ± 3.25 ^b	0.00 ± 0.00 ^c	35.71 ± 3.25 ^a
Egg weight (g)			
Initial	45.19 ± 1.73	41.60 ± 1.73	43.70 ± 1.73
WK ₁	43.36 ± 1.67	42.10 ± 2.21	39.34 ± 1.67
WK ₂	40.77 ± 1.83	-	39.34 ± 1.69

abc: means on the same row with different superscripts are significantly different (p<0.05).

fasting moult compared to those fed different moulting diets as well as differences in the number of days to stoppage of lay. In the study by Reddy *et al.* (2008) Cornish and Rock layers fed high dietary ZnO stopped lay by D 25 and 22, respectively, while those subjected to fasting moult stopped egg production by D 14.

Effect of genotype on changes in performance traits during moulting of hens

Shaver brown hens moulted by ZnO had significantly (p < 0.05) higher losses in body weight and HDEP in the first week of moulting as well as higher cumulative body weight loss compared to the indigenous chickens (Table 5) while changes in egg weight did not differ significantly between the genotypes. For hens moulted by FD (Table 6), changes in body weight, HDEP, and egg weight did not differ significantly between genotypes.

Table 5: Comparative change in performance of Shaver brown and local chickens during moulting by ZnO supplementation

	Shaver brown	Local chicken
Body weight (kg)		
WK ₀₋₁	0.23 ± 0.03 (13.24) ^a	0.09 ± 0.05 (5.75) ^b
WK ₁₋₂	0.05 ± 0.03 (3.14)	0.13 ± 0.04 (9.39)
WK ₀₋₂	0.28 ± 0.03 (16.35)	0.21 ± 0.06 (14.65)
Egg production (%)		
WK ₀₋₁	30.45 ± 6.10 (53.18) ^a	-5.36 ± 12.16 (-55.24) ^b
WK ₁₋₂	24.79 ± 6.93 (74.78)	26.79 ± 10.71 (48.81)
WK ₀₋₂	55.24 ± 6.44 (90.25) ^a	21.43 ± 3.57 (72.86) ^b
Egg weight (g)		
WK ₀₋₁	-1.21 ± 1.26 (-1.95)	1.83 ± 1.66 (3.76)
WK ₁₋₂	0.18 ± 2.72 (-0.05)	1.98 ± 2.75 (3.88)
WK ₀₋₂	0.20 ± 1.88 (0.25)	3.68 ± 3.85 (6.82)

WK: week; a, b: row means with different superscripts are significantly different (p<0.05); negative value indicates increase in trait value; values in parenthesis are percentages.

Table 6: Comparative change in performance of Shaver brown and local chickens during moulting by feed deprivation

	Shaver brown	Local chicken
Body weight (kg)		
WK ₀₋₁	0.36 ± 0.04 (21.78)	0.33 ± 0.11 (15.31)
WK ₁₋₂	0.17 ± 0.03 (12.71)	0.12 ± 0.04 (7.27)
WK ₀₋₂	0.53 ± 0.05 (31.93)	0.45 ± 0.12 (21.45)
Egg production (%)		
WK ₀₋₁	29.57 ± 11.04 (51.26)	31.43 ± 5.95 (64.29)
WK ₁₋₂	28.57 ± 11.15 (71.43)	22.86 ± 9.18 (57.14)
WK ₀₋₂	58.14 ± 1.82 (100.00)	54.29 ± 5.71 (100.00)
Egg weight (g)		
WK ₀₋₁	-1.40 ± 1.07 (-2.25)	-0.85 ± 1.52 (-2.20)
WK ₁₋₂	-	-
WK ₀₋₂	-	-

WK: week; a, b: means on the same row with different superscripts are significantly different ($p < 0.05$); negative value indicates an increase in trait value; values in parenthesis are percentages.

Breed differences in response to moulting techniques reflect genetic differences in bird type. Reddy *et al.* (2008) reported a loss of 16 % in body weight to end of egg production due to ZnO in Cornish layers compared to 21.74 % in Rock layer, and 14.9 % loss due to fasting in Cornish layers compared to 16.18 % in Rock layers. The same authors reported that Cornish layers fed ZnO stopped laying by D 25 compared to D 22 for Rock layers. Santos *et al.* (2014) observed that among other factors, breed differences account for differences in response of layers to moulting methods.

Conclusion

Zinc supplementation at 20,000ppm in the diet of laying chickens as moulting agent is a milder but equally effective moulting method as fasting and is recommended for intensive commercial and rural indigenous poultry production.

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