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Diurnal Effects of Periodic Litter Change on Egg Production and Physical Qualities in a Deep Litter System

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Abstract: Five hundred and forty Lohmann hybrid point of lay birds aged 22 weeks were used to study the effect of periodic litter change on egg production and physical qualities. The birds were divided into 3 treatment groups consisting of 180 birds. Each treatment group was further replicated 3 times, made of 60 birds per replicate. Each treatment was allotted to three treatment periods of egg collection identified as T_1 (morning 0700-1100 hrs). T_2 (afternoon 1100-1400000 hrs) and T_3 (evening 1400-1700 hrs) in a Completely Randomized Design (CRD). The birds were provided with water and feed ad-libitum. Litter was changed every 12 weeks and the experiment lasted for forty-eight weeks. The results of the climatic environmental conditions of the experimental site i.e. the ambient temperature, rectal temperature, relative humidity and wind velocity showed non significant difference ($p>0.05$) between T_1 morning and T_3 evening values but they differed significantly ($p>0.05$) from T_2 afternoon values. The hen day egg production (61.15±0.87), hen housed egg production (59.04±0.91) and laying house mortality (4.69±0.43) for T_1 morning were similar ($p>0.05$) to T_3 evening hen day egg production (64.76±0.95), hen house egg production (61.41±0.73) and laying house mortality (3.91±0.42). Feed consumption, feed conversion and weight of the birds did not show any significant difference ($p>0.05$) between the treatment groups. The albumen weight, Haugh unit, egg length and width followed the same pattern as in the hen day egg production. The egg weight, yolk weight, shell weight and thickness in T_1 morning, T_2 afternoon and T_3 evening did not differ ($p>0.05$) significantly between treatment groups. The pees-wees, cracked eggs and small-sized eggs were similar ($p>0.05$) in T_1 morning and T_3 evening period but significantly lower ($p<0.05$) than T_2 afternoon values. The large sized and extra large eggs were similar in T_1 and T_3 but significantly ($p<0.05$) higher than T_2 values. The results of this study show that litter change in a deep-litter system should be in the morning or evening must have finished egg laying for the day and when the ambient temperature must have fallen and is within the thermoneutrality zone between 12.8°C and 26°C.

Key words: Periodic litter change, layers, egg production, physical characteristics

Introduction

Egg number is the major index of performance of commercial layer. It accounts for about 90% of the income in egg production farms (Oluyemi and Roberts, 2000). Egg qualities particularly egg size is another important economic trait. It determines to a large extent the price received in any market and the standard range should be between 53 and 63 grams (Obioha, 1992). Omeje, 1983 indicated that mean percentage hen-day production reported in Nigeria for most exotic and hybrid layers ranged from 48.05 to 53.3 grams. Oluyemi and Roberts (2000) indicated that egg number and qualities are affected by some environmental factors: nutrition, egg, temperature, humidity, photo period and ventilation, Obioha (1992) demonstrated that management systems and management conditions to which the birds are exposed affect egg production and egg qualities. Anyaehie and Madubuike (2007) showed that egg appearance, size, texture and shape appealed to customers. Eggs help in the provision of much needed animal protein in Nigeria and are nutritious and complete food to man (Adejomo, 2000). Eggs are regarded as a wholesome diet because an egg contains adequate amounts of proteins, amino acids, vitamins and minerals to satisfy the body requirements (Obioha, 1992).

Egg production is highest when temperatures are within neutrality range (Smith, 1990). According to Poultry International (1992) at air temperature of $25^{o}5$ and above, a drop in egg number, weight and egg size have been observed and a high temperature of 30°C decreases the productivity of layers. Under high ambient temperature, core blood supply to the egg synthesizing rate is reduced through the neuro-endocrine mechanism. Under this condition, the nutrients needed for egg production will not be adequately supplied (Iheukwumere *et al.*, 2006). Intensively managed birds, under high temperatures, often practice all sorts of vices, which include feather pecking and sucking of egg yolk due to stress. Layers managed intensively in deep litter

Table 1: Composition of Layers Diet in the Experiment

Ingredient (%)	Mash Percentage
Maize	50.00
Soya bean meal	18.00
Fish meal	3.10
Wheat bran	19.00
Bone meal	2.15
Oyster shell	7.10
Salt	0.25
Vit/Premix*	0.20
Dc-methioonine	0.20
Total	100
Calculated Analysis	
Crude protein (%)	16,31%
Metabolizable energy	2246
Calcium (%)	3.41%
Phosphorus available (%)	0.43
Lysine (%)	0.63%
Methionine+Cystine (%)	0.61
Crude fibre (%)	5.62

*Premix supplied per kg of feed: Vit. A 10000 iu, Vit D 2000 iu, Vit E 5 iu, Vit. K 2 mg, Riboflavin 4.20 mg. Vit B12 0.01 mg, Panthothenic acid 5 mg. Nicotinic acid 20 mg, Folic acid 0.5 mg, chlorine 3 mg, Mn 55 mg, Fe 20 mg, Cu 10 mg, Zn 50 mg, Co 125 mg, iodine 0.8 mg

building are always in physical and close contact with the litter. Adejomo (2000) demonstrated that litter is an important input that must be well managed to prevent unhealthy environment and disease conditions. Smith (1990) and Oluyemi and Roberts (2000) revealed that a well-managed litter is friable, has a crumbly consistency, a low concentration of pathogens and is practically free from ammonia but they concluded that poorly managed litter manifested opposite characteristic. Neshein *et al.* (1979) showed that litter should be changed between one year and two years whereas Obioha (1992) and Oluyemi and Roberts (2000) indicated that old litter should be changed between 10 to 12 months. Adejomo (2000) maintained that litter should be changed at the end of each rearing period. Obeng-Asamoan (1982) revealed that where the layer house is far away from human settlement, the litter could be allowed to build up to six months before changing but Ekeman (2003) demonstrated that litter should be changed as it gets old to increase ventilation, better environment and comfort of both the attendants and birds. He further showed that change of litter had no specified time but controlled by litter condition and stocking density of the birds. Farmers are used to changing litter in deep litter managed flock of commercial layers at anytime or period of the day without considering the effects of these periods of change on egg production and egg physical characteristics.

This study was designed to evaluate the effects of the periods of litter change in deep litter managed flock on egg number and egg physical characteristics under the humid environment.

Materials and Methods

Management of the experimental birds: Five hundred and forty points of lay Lohmann Brown hybrid birds aged 22 weeks were used for this investigation. The birds were reared on conventional deep litter system. Deep litter system affords one of the efficient means of commercial egg production. The litter was made of well-dried wood shavings of 10 cm in depth. The birds were provided water and layer feed *ad-libitum*. Laying nests were provided at strategic corners of the laying house for the birds. Eggs collection was done three times daily and all the necessary medications were administered to the laying birds. The litter was turned every morning after cleaning all feeders and washing the drinkers. The litter was changed according to the period designated for each treatment (every 12 weeks) between 0700-1100 hours, 1100-1400 hours and 1400-1700 hours respectively.

Experimental design: The birds were randomly allotted to three treatment groups identified as T_1 morning (07700-1100) hours, T_2 afternoon (1100-1400) and T_3 evening (1400-1700) hours. Each group was made up of one hundred and eighty birds and was replicated three times with 60 birds per replicate in a Completely Randomized Design (CRD). All the birds were raised in a deep litter system. The litter was changed every 12 weeks. The experiment lasted for 48 weeks.

Experimental procedure: Data on egg production were collected daily by adding up the number of eggs laid by the birds in each replicate and totaling up for each treatment and dividing the cumulative number in the treatment by the total number of birds in the treatment. Data on egg weight, egg grades and egg physical qualities were taken twice weekly by randomly selecting ten eggs in each replicate that made up the treatment, that is thirty eggs per treatment group. Egg weights from each treatment were totaled and mean egg weight obtained by dividing the total with the total number of eggs taken from each treatment. Similarly data on egg length and egg width were collected using vernier caliper, for each treatment group and dividing by total number of eggs whose length and width were determined respectively as described by Anyaehie *et al.* (2007). Ten eggs from each treatment group were randomly taken, broken into a flat disc and physically separated into the component parts using a pair of forceps to unwrap the albumen from the yolk. The yolk was immediately weighted while the shell was air-dried before weighting. The weight of the albumen was obtained by difference. The Haugh unit and yolk index were determined as described by Olomo (1975). The shell thickness was determined with pocket paper gauge using the method of Britton and Hale (1976). The

Table 2: Periodic Climatic Condition of the Experimental During Litter Change

Parameters	Treatments		
	Morning (0700-1100 hrs)	Afternoon (1100-1400 hrs)	Evening (1400-1700 hrs)
Ambient temperature (0^c)	24.36 ± 0.45^b	32.36 ± 0.58^a	25.52 ± 0.98^b
Rectal Temperature (0^c)	0.87 ± 0.04^b	0.95 ± 0.04^a	0.83 ± 0.02^b
Relative humidity (0^c)	51.80 ± 1.36^a	40.42 ± 1.76^b	$54.25\pm1.26_a$
Wind velocity (Km/hr)	5.57 ± 1.34^a	3.03 ± 0.71^b	4.85 ± 1.01^a

a,b: Means within row having different superscripts are significantly different ($p<0.05$). Ambient and rectal temperature were observed in the findings of Oluyemi and Roberts (2000) and it has been shown to affect egg production Umesiobi (2000) and Iheukwumere *et al*. (2006)

Table 3: The Effect of Periodic change of Litter in a Deep-:Litter System on egg Production

Parameters	Treatments		
	Morning (0700-1100)	Afternoon (1100-1400)	Evening (1400-1700)
Hen-day egg production (%)	61.15 ± 0.87^a	56.35 ± 0.94^b	64.76 ± 0.95^a
Hen-housed production (%)	53.25 ± 0.72^b	61.41 ± 0.73^a	61.41 ± 0.73^a
Days to 50% egg production (days)	170±8.26	172±7.94	168.6 ± 0.54^{NS}
Feed intake for 48 wks in lay (kg)	37.53±4.2	37.08±3.9	$37.61\pm0.\ 4.9^{NS}$
Feed conversion ratio kg feed/kg egg	2.61±0.28	2.8±3.4	2.63 ± 0.47^{NS}
Wt. of birds at 48 wks in lay (kg)	1.76±0.21	2.8±0.34	2.63 ± 0.47^{NS}
Laying house mortality (%)	4.68 ± 0.43^b	8.72 ± 0.38^a	3.91 ± 0.4^b

a,b: Means within row having different superscripts are significantly different ($p>0.05$), NS = Not significant

climatic condition of the experimental site was monitored and recorded daily and thereafter mean weekly ambient temperature, rectal temperature, relative humidity and wind velocity (M/hr) were obtained.

Statistical analysis: The data from the study were subjected to statistical analysis using the analysis of variance (Steel and Torrie, 1980), while the treatment means were compared using Duncan's New Multiple Range Test as described by Obi (1990).

Results and Discussion

The results in Table 2, show no significant difference ($p>0.05$) in ambient temperature, relative humidity, wind velocity and rectal temperature between T_1 morning and T_3 evening in the climatic variables of the experiment, however, T_2 afternoon differed significantly ($p<0.05$) from T_1 and T_3 periods in all the parameters evaluated.

The results in Table 3 show the effects of periods of litter change on egg parameters. The hen-day and hen-housed production of 61.15±0.87 and 59.04±0.91 in T_1 morning were similar ($p>0.05$) to T_3 evening with hen-day and hen-housed production of 64.70±0.98 and 61.41±0.78. T_1 morning and T_3 evening were significantly ($p<0.05$) better than T_2 afternoon in hen-day and hen-housed production of 56.35±0.16 and 53.25±0.72. The data showed that the birds laid more eggs in the morning and in the evening when the ambient temperature and relative humidity were within the thermoneutrality zone. The least mean egg number was recorded in the T_2 afternoon. This is attributable to the high ambient temperature. High temperature has been reported by Smith (1990) to affect egg production. Oluyemi and Robert (2000) and Obioha (1992) agreed that high environmental temperature affect egg production.

Days to 50% egg production, feed intake, feed conversion ratio and weight of birds at the end of the experiment were similar in all the treatments. However, T_2 afternoon laying house mortality was significantly ($p<0.05$) higher than T_1 morning and T_3 evening laying house mortalities. This is attributed to high ambient temperature of the afternoon. This is consistent with Adejomo (2000) and Smith (1990).

Results on the effects of the periods of litter change on physical egg characteristics are summarized in Table 4. There were no significant ($p>0.05$) differences among T_1 morning, T_2 afternoon and T_3 evening periods in egg weight, Yolk weight, shell weight and thickness. The mean egg weights of 55.2±1.03 gm, 52.34±0.95 gm and 57.28±1.15 gm for T_1 morning, T_2 afternoon and T_3 evening periods compare favourably with the mean egg weight of 55.58 recorded by Olomo (1975) as an average egg weight for the exotic chicken and regarded this as standard. The similar yolk weights obtained for the treatments were expected and consistent with Neshein *et al*. (1979) who showed that yolk weight appeared to be very constant, for any given hen, for all clutch positions.

There were no significant ($p>0.05$) differences in egg length and width between T_1 and T_3. However, T_1 and T_3 were significantly ($p<0.05$) superior to T_2 in egg length and width. This is attributed to high ambient temperature of the afternoon periods, disturbances caused by change of litter and physiological adjustment of the birds consequent to adverse environmental conditions of the

Table 4: Effects of the Periodic Litter Change in Deep Litter System on Physical Egg Characteristics

	Treatments		
Parameters	T_1 Morning (0700-1100 hrs)	T_2 Afternoon (1100-1400 hrs)	T_3 Evening (1400-1700 hrs)
Egg weight (gm)	55.2±1.03	52.34±0.95	57.38±1.15^{NS}
Yolk weight (gm)	15.74±0.82	15.17±0.91	15.86±0.73^{NS}
Albumen weight (gm)	33.48±0.41^{a}	31.56±0.47^{b}	35.75±0.26$_{a}$
Shell weight (gm)	5.98±0.25	5.62±0.32	5.67±0.18^{NS}
Shell thickness (gm)	0.47±0.03	0.36±0.04	0.46±0.02^{NS}
Haugh Unit	85.78±0.94^{a}	78.32±0.71^{b}	86.80±0.64^{a}
Egg length (cm)	4.65±0.05^{a}	3.81±0.03^{b}	4.95±0.04^{a}
Egg width (cm)	2.96±0.003^{a}	2.48±0.005^{b}	3.14±0.003^{a}
Egg index	0.69	0.66	0.71
Yolk index	0.46	0.42	0.46

a,b: Means within row having different superscripts are significantly difference ($p<0.05$), NS = Not significant

Table 5: Effects of the Periodic Litter Change in Deep Litter on egg Grades

	Treatments		
Parameters	T_1 Morning (0700-1100 hrs)	T_2 Afternoon (1100-1400 hrs)	T_3 Evening (1400-1700 hrs)
Peewees (%)	1.30±0.002^{b}	2.96±0.003^{a}	1.05±0.004^{b}
Cracked eggs (%)	2.50±0.005^{b}	4.40±0.006^{a}	2.61±0.003^{b}
Small sized eggs (41 gm)	9.45±0.26^{b}	13.41±0.18^{b}	8.94±0.21^{b}
Medium sized eggs (51-60 gm)	31.05±0.94	35.86±1,67	30.09±0.64^{NS}
Large sized eggs (51-60 gm)	49.35±1.05^{a}	40.01±0.86^{b}	51.36±1.02^{a}
Extra large eggs (61 gm)	6.05±0.07^{a}	3.36±0.05^{b}	5.95±0.04^{a}

a,b: Means within row having different superscripts are significantly different ($p<0.05$)

afternoon. This is in agreement with Oluyemi and Robert (2000) and Adejomo (2000) who showed albumen weights of 33.48±0.41 gm and 35.75±0.26 gm obtained for T_1 and T_3 compared favourably with 34.70 gm reported by Ayorinde (1987) for shaver star cross.

The significantly ($p<0.05$) reduced albumen weight and Haugh unit obtained in T_2 (afternoon) compared to T_1 and T_3 is attributed to high ambient temperature and relative humidity of the afternoon period. This is consistent with Ayorinde (1987) who demonstrated that decreased albumen weight and Haugh unit resulted from adverse climatic variable. A strong relationship ($r = 0.92$) was observed between albumen and egg weights. Iheukwumere *et al.* (2006) observed a similar relationship in chicken eggs and noted that majority of variation in egg weight can be accounted for by albumen weight.

Table 5 shows the results of the effects of the periods of litter change in deep litter managed flock on egg grades. The percentage of peewees, cracked and small-sized eggs were significantly ($p<0.05$) higher in T_2 afternoon than in T_1 morning and T_3 evening but T_1 and T_3 evening were similar ($p>0.05$) on the number of peewees, cracked and small-sized eggs. The higher number of peewees, cracked and small-sized eggs observed in the afternoon period are attributed to the harsh environmental conditions of the afternoon periods. This is in agreement with the findings of Oluyemi and Roberts (2000) that high ambient temperature and relative humidity depress egg size. However, Neshein *et al.* (1979) showed that there was treat variability in size of hen's eggs but the specific cause in this variation was not well established but they maintained that the specific shape may be modified by abnormal or unusual conditions in either the isthmus or the uterus. They agreed that the position of an egg in the clutch affected its weight. The first egg in the clutch is usually the heaviest with a progressive decrease in the weight of the egg laid on each successive day. Neshein *et al.* (1979) demonstrated that the decrease in egg weight was almost entirely the result of a decrease in the amount of albumen, since yolk size appeared to be very nearly constant for any given hen for all clutch position. T_1 morning and T_3 evening were similar ($p>0.05$) in the percentage of large and extra large eggs but significantly ($p>0.05$) higher than T_2 afternoon. Brown eggs occurred because pigment was deposited in the shell as it was formed in the uterus. The large and extra large eggs observed in the morning and evening periods when the weather was cool and the temperature within the thermoneutral zone is expected. This finding is consistent with Obioha (1992) and Umesiobi (2000) who showed that layers performed better whether in egg number of egg size when environmental conditions are conducive and the birds undisturbed.

Conclusion: The results of the study suggest that periods of litter change in a deep litter managed flock of commercial layers should be in the morning or evening periods, preferably in the evening period when the birds must have finished egg laying for the day and when the ambient temperature must have fallen and is within the thermoneutrality zone between 12.8°C and 26°C.

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