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EFFECTS OF FLOOR AND NEST EGGS ON HATCHABILITY AND CHICK QUALITY PARAMETERS IN BROILER BREEDERS.

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The quantitative and qualitative parameters of eggs and day old chicks are determined by broiler breeders. Floor and nest eggs are used by commercial hatcheries for incubation. This study was carried out to evaluate the hatchability and chick quality parameters between floor and nest eggs in broiler breeders. The experiment was conducted at the hatchery in a Complete Randomized Design (CRD) with two treatments. Five replicates were maintained for each treatment and each replicate consisted of 90 eggs. Nine hundred eggs from MX male x Cobb 500 female (35-40 weeks of age) were collected from the breeder farm. Eggs were incubated at *Petersime* commercial multi-stage (MS) incubator. Egg quality parameters; initial egg weight and shape index were measured just before the setter period. Egg weight reduction was calculated during incubation period. Live chicks and hatch residues were collected separately at the end of incubation period. Chick quality parameters such as chick weight, chick length and pasgar score were measured. Breakout test was conducted with hatch residues. Data was statistically analyzed using two sample t-test in SAS. Results revealed that there was a significant difference ($P<0.05$) on hatchability between two types of eggs. Nest eggs reported the highest hatchability (90.0%) compared to floor eggs. Initial egg weight, egg shape index, moisture loss, hatch of fertile, chick weight, chick length, chick yield and pasgar score did not show any significant difference ($P>0.05$) between two types of eggs. Breakout analysis showed that higher embryo mortality and contamination occurred in floor eggs compared to nest eggs. In conclusion, hatchability of nest eggs is better than those of floor eggs. However, floor eggs should be kept separately in the commercial hatcheries to minimize the contamination.

Keywords: Chick yield, Fertility, Hatchability, Hatch of fertile

Poultry industry in Sri Lanka has shown a phenomenal growth over the recent past. As a result, poultry products have become essential food items in Sri Lankan menus. Demand of chicken meat and eggs have been fulfilled by local production. The industry today is in the hands of private sector and is confined mostly for the implementation of poultry health management programs, research and policy development for further consolidation of the industry (Poultry Sector Forecast, 2016).

Broiler meat production has increased rapidly in the last two decades in line with the higher demand compared to other meats, for that reason quality of the Day-old Chick (DOC) is important. Day-old chicks are the end product of the hatchery meanwhile the most important input for the poultry farms. A good-quality DOC is the best product provide from the hatchery to the farm for quality chicken meat production. The success of the hatchery depends on the quality of all preceding steps of the production chain (Cobb Ventress Inc, 2008). The poultry industry always looks for many ways to increase its productivity such as possibility of increasing the hatchability, hatch of fertile, number of marketable day-old chicks and their quality by improving chick uniformity (Rifkhan *et al.*, 2016).

These criterions can be attained with a good quality egg, meaning that eggs are clean, not broken, and not containing cracks (Van Den Brand *et al.*, 2016).

Normally in breeder farms there are two laying systems such as floor laying and nest laying system. According to that egg quality is also influenced by the laying system under which the hens are kept. The absence of nest sites in conventional cages is considered to be the most serious welfare problem, and several experiments have shown that hens are strongly motivated to use a nest. Nests are important because of both the birds' preference for them and the birds' frustration when they are absent. Notwithstanding a nest-box, in free-run systems some hens will still lay their eggs on the floor, and these floor eggs are considered to be one of the major disadvantages of production systems due to bacterial contamination of eggs from floor litter (Singh *et al.*, 2006).

Losses from floor eggs can be a significant problem in the broiler chicken industry due to several types of cracks and bacterial contamination. It has been reported that 6.4% of broiler breeder eggs are not collected due to shell damage and permeability of the eggs due to floor laying. Currently, the commercial hatcheries use two different types of eggs such as floor and nest eggs for incubation to meet the competition and demand of market. Eggs from a flock consist different types of eggs such as nest eggs, floor eggs, double yolk eggs, damaged and tiny eggs. Among those, good and floor eggs have the tendency for incubation. Meanwhile, hatcheries receive considerable amount of floor eggs on peak production period, so that incubation of floor eggs cannot be avoided in hatcheries. Therefore, understanding of incubation characteristics and chick quality parameters of both egg types is a must to produce good quality day old chicks. This study was carried out to compare the hatchability and quality of the day old chicks from floor and nest eggs.

MATERIALS AND METHODS

Experimental location and grouping of eggs

The experiment was conducted at the commercial hatchery, Bairaha Farms PLC at Pasyala, Sri Lanka. Two different egg types of commercial Cobb 500 broiler breeder stock (MX male x Cobb 500 Female) were selected (from birds at the age of 34-45 weeks) and eggs were grouped as floor and nest eggs. A total of nine hundreds eggs (900) were obtained from both egg types representing four hundred fifty eggs from each group. The experiment was composed with two egg types each with five replicates and each replicate consisted of 90 eggs. Eggs were incubated at *Petersime* (Model no: 1152) commercial multi-stage (MS) incubator.

Egg loading process

Eggs were candled using egg grading machine to select the ideal eggs for incubation. One hundred and fifty eggs (150) from single egg type was set in a single setter tray of MS Petersime incubator and numbered from 1 to 150 separately and initial egg weight, length and width were measured using electronic balance and Vernier scale. Eggs from floor and nest were tagged accordingly. These trays were placed middle part of MS setter trolleys and eggs were stored for one day at 19^{o}C. Setter trolleys were taken out from the cool room and eggs were fumigated for 20 minutes with formaldehyde gas before the incubation. Fumigated trolleys were loaded into Petersime MS incubator. Incubation conditions were provided according to the incubator manufacturer's recommendations.

Incubation process of hatchery

Temperature and relative humidity were maintained at 99^{o}F and 86%, respectively. Temperature, relative humidity and egg turning were recorded in the check list once an hour. On the 10th day of incubation, eggs were individually candled in the transfer-room (around 24^{o}C and 60% relative humidity), using a hand held candling lamp. "Clear" eggs were removed and broken out for macroscopic examination to determine early-dead embryos (< 7 day) and fertility. On 18th day of incubation, MS incubated eggs were transferred from setter to hatcher.

After 18th day of incubation, individual eggs were weighed according to their respective numbers and weight losses of eggs were calculated. At the end of 21st day, the hatch was pulled out. Live hatched chicks were counted and recorded separately. Hatch of fertile was estimated.

Egg breakout analysis

Egg breakout analysis was carried out to find out the reasons of failure to hatch. Un-hatched eggs were opened, and examined macroscopically. Dead chicks were recorded separately.

Chick quality analysis

For the purpose of chick quality analysis from each replicate, number of 40% randomly sampled chicks were weighed individually using a sensitive beam balance. Chick length was taken by measuring the length of stretched chick from tip of the beak to the middle toe using a ruler and recorded in centimeters (cm). Pasgar scoring method was followed to analyze the chick quality.

Data analysis

Data were statistically analyzed using two sample t-test in SAS (ver. 9.0). Significant level was declared at P=0.05. Following standard formulas were used to estimate the different parameters.

$$\text{Moisture Loss \%} = \frac{(\text{Egg setting weight} - \text{Egg transfer weight})}{\text{Egg setting weight}} \times 100$$

(Meijerhof, 2009)

$$\text{Hatchability \%} = \frac{\text{Number of saleable chick}}{\text{Number of eggs}} \times 100$$

(Petek *et al.*, 2010)

$$\text{Hatch of fertile \%} = \frac{\text{Number of saleable chick}}{\text{Number of true fertile eggs}} \times 100$$

(Cobb Ventress Inc, 2008)

$$\text{Chick yield \%} = \frac{\text{Average chick weight at hatch}}{\text{Average egg weight at the point of set}} \times 100$$

(Djanet & Drüggelte, 2009)

$$\text{Egg shape index \%} = \frac{\text{Diameter of the egg}}{\text{Length of the egg}} \times 100$$

(Anderson *et al.*, 2004)

RESULTS AND DISCUSSION

Egg quality parameters

Table 1 shows the change of initial egg weight and egg shape index between floor and nest eggs. Initial egg weight and egg shape index were not significantly different (*P*<0.05) between two egg types. The highest initial egg weight (55.03g) and egg shape index (78.93%) were observed in nest and floor eggs respectively.

Table 1: The change of initial egg weight and egg shape index between floor and nest eggs

Parameters	Floor Eggs	Nest Eggs
Initial Egg Weight (g)	54.96 ± 0.17^a	55.03 ± 0.14^a
Egg Shape Index	78.93 ± 0.47^a	78.84 ± 0.30^a

Data are presented as mean ± SE. [a,b]Means within same row with different superscript are significantly different (*P*<0.05)

Egg size of the present study was in medium range as mentioned by King'ori (2011). Egg size affects hatchability (Jaya, 2007; Yassin *et al.*, 2008; King'ori, 2011). Hatchability of small eggs is lower compared to the medium and large eggs. Eggs within 45-56 g weight hatch better than lighter eggs. Normal hatchability of large (63-70g) and medium eggs (53-63g) were 88.2% and 84.8%, respectively. Those hatchability levels were higher than the hatchability of small eggs (37.5-44 g) (Yassin *et al.*, 2008). Jaya (2007) reported that, egg size has an influence on total incubation time of eggs. Beyond 50 grams, each 2.5 gram range prolongs the incubation time by half an hour. Some studies reported that internal egg composition or ratio, larger egg weight and poor shell quality increased early and late embryo mortality (Tona *et al.*, 2004; King'ori, 2011).

The shape index reported under the study falls within the "round" range. Normal eggs fit well to the trays and make less transit loss. Eggs are characterized using SI as sharp, normal and round if those eggs have an SI value of < 72, between 72 – 76, and > 76 respectively (Anderson *et al.*, 2004). There are limited findings about the relationship between egg shape index and incubation, chick quality parameters.

Incubation parameters

The change of egg moisture loss, hatchability and hatch of fertile between floor and nest eggs is shown in table 2. Hatchability was significantly different

(P<0.05) between two types of eggs. Moisture loss and hatch of fertile were not significantly different (P<0.05) between floor and nest eggs. However, highest egg moisture loss (10.49%), highest hatchability (90%) and highest hatch of fertile (92.65%) were observed in nest eggs.

Table 2: The change of incubation parameters between two types of eggs

Parameters	Floor Eggs	Nest Eggs
Moisture loss %	10.22 ± 0.38[a]	10.49 ± 0.12[a]
Hatchability %	83.16 ± 0.69[a]	90.0 ± 0.71[b]
Hatch of fertile %	89.01 ± 0.82[b]	92.65 ± 0.62[b]

Data are presented as mean ± SE. [a,b]Means within same row with different superscript are significantly different (P<0.05).

Egg moisture loss is very important for good quality chicks. For good quality chicks, 12% moisture loss is recommended because less than 6% and more than 14% is difficult for chicks to hatch. Moisture loss also depends upon the humidity levels in the incubators. Adequate water level in the incubators is essential to retain the required water inside eggs necessary to create air cell that helps chicks to come out from eggs in limited time. Air cell allows embryonic lung ventilation after internal piping for a successful hatch (Jabbar, 2018).

Environment temperature is the most important factor in incubation not only for hatchability but also for post hatch growth. Incubator temperature should be maintained between 36^{o}C and 38.9^{o}C. If the temperature inside the incubator drops below 35.6^{o}C, it induces small sized chicks and enhances mortality, because embryo uses their nutrients resources first to survive, instead of growing and developing the embryo. If the temperature rises above 39^{o}C, it induces small sized chicks as well, because of dehydration, and too fast yolk utilization (Lourens, 2008).

Chick quality parameters

The change of chick weight, chick length, chick yield and pasgar score between floor and nest eggs is shown in table 3. The chick quality parameters under study were not significantly different (P<0.05) between floor and nest eggs. However, highest chick weight (38.67 g), highest chick length (16.95 cm) and highest pasgar score (9.88) were observed in nest eggs, respectively.

Table 3: The change of chick quality parameters between floor and nest eggs

Parameters	Floor Eggs	Nest Eggs
Chick weight (g)	38.64± 0.06[a]	38.67 ± 0.04[a]
Chick length (cm)	16.75± 0.02[b]	16.95± 0.05[b]
Chick yield %	70.29 ± 0.17[a]	70.28 ± 0.17[a]
Pasgar score	9.71 ± 0.09[b]	9.88 ± 0.03[b]

Data are presented as mean ± SE. [a,b]Means within same row with different superscript are significantly different (p<0.05).

Some studies reported that the body weight is the most widely used parameter for assessing day-old-chick quality. But the differences observed in hatch weight may have been mainly influenced by initial egg weight and moisture loss during incubation (Petek *et al.*, 2010). It is agreed that chick weight may be related to slaughter performance of broilers (Tona *et al.*, 2004; Van Den Brand *et al.*, 2016; Jabbar, 2018). Some researchers found a positive correlation between chick length and body weight at 42-day of age. It is also emphasized that chick length is an indicator for chick quality and can be measured quickly (Decuypere *et al.*, 2001; Tona *et al.*, 2004; Pek and Sözcü, 2013). Pek and Sözcü (2013), reported that an increase in chick length in male broilers obtained from same egg size on hatching day resulted in an increasing of body weight. Chick length might be much more important for acquiring the greatest uniformity and predicting growth performance (Djanet & Drüggelte, 2009).

Water loss is very important for good chick yield. The recommended chick yield is 69% for quality chicks. Water loss and chick yield are related to each other. If chick yield excels more than 69%, it becomes a source of dehydration, creates difficulty for chicks to come out from eggs. The chicks yield with more than 69% becomes source of high mortality at farm. Chick yield less than 67%, the water retains in belly of chicks. The

chicks become lethargic and refuse to take feed at farm. The eggs with contamination on egg shell are unable to hold adequate water inside eggs necessary for proper hatching (Tona *et al.*, 2004; Jabbar, 2018).
The pasgar score is used to express the chick quality using a number and it has been developed by evaluating five morphological criteria such as reflex, navel, legs, beak and yolk sac volume of the chicks. A sample of at least 30 saleable chicks must be assessed to get a representative score for chick quality of a flock of chicks. Some studies reported that best quality chick have a pasgar score of 10 and one point is subtracted for each abnormality (Tona *et al.*, 2004; Djanet & Drüggelte, 2009).
Followings are the morphological criteria used to evaluate day old chicks. The appearance should be clean, dry, without dirt and contamination with bright and clear eyes. The chick should be alert, active and responding to sounds. The chicks having clear and deep yellow color is better than pale and light yellow. The navel area should be completely sealed. The whole body and legs should have normal confirmation, there should be no swelling or lesions on hock, or skin and the toes should be well formed. The beak should be well formed, firm and straight. The belly area should examine for thickness which is determined by temperature and humidity (Tona *et al.*, 2004; Pek and Sözcü, 2013).

Egg breakout analysis

Egg breakout analysis showed that higher rate of embryonic mortality: early (3-7 days) and mid, late (8-14 days, 15-21 days) were observed in nest and floor eggs respectively. Higher rate of contamination also observed in floor eggs. Higher amount of malposition and pipped eggs were observed in nest eggs.
The results of egg breakout are beneficial for trouble-shooting problems in production, egg handling and storage. The hatch day breakout analysis involves sampling unhatched eggs from breeder flocks, and classifying them into the various causes of reproductive failure. Those information could help to solve hatchery and breeder flock problems, or improve hatchability and fertility (Mauldin, 2009). Studies reported that high number of early dead of embryo indicates prolong storage or storage at elevated temperatures, or inadequate egg collection procedures. High temperature of embryo, nutritional deficiencies of breeder flocks and contamination are the reasons for high number of middle dead of embryo at the same time setter/ hatcher temperature and humidity problems, egg transfer damages, egg set upside down, insufficient water loss and nutritional deficiencies of breeder flocks are caused high number of late dead of embryo (Mauldin, 2009; Rifkhan *et al.*, 2016).

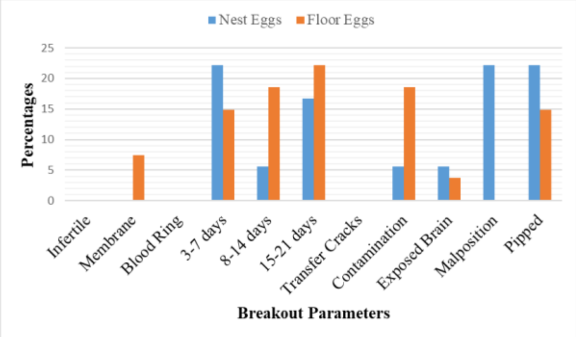

Figure 1: Effect of floor and nest egg type on egg breakout analysis

Results from a hatch breakout should be combined with other information to provide a total picture. This information should include hatchability records, breeder performance records, incubation records and hatch timing information. Normal pattern of embryo loss during incubation showing peaks in mortality during early and late incubation. High mortality at other development stages is not normal. A high incidence of mortality at a particular stage of development can indicate an acute problem during incubation caused by a machine failure. Experience of hatch breakouts with good hatching flocks is important for understanding what is normal and abnormal (Anon, 2015).

CONCLUSIONS

Hatchability of nest eggs is better than those of floor eggs. Floor eggs should be kept separately in the commercial hatcheries to minimize the contamination. Floor eggs can be used for incubation during shortage period of eggs.

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