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EFFECT OF MULTI-STAGE INCUBATOR TYPES ON HATCHABILITY AND CHICK QUALITY OF BROILER CHICKEN

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Cooling system of egg incubators influences the quantitative and qualitative parameters of day old chicks. Two types of multistage incubators such as water cooling (WC) and air cooling (AC) are used by commercial hatcheries to hatch eggs. This study was carried out to evaluate the hatchability and chick quality parameters between air and water cooling incubators. The experiment was conducted at the Hatchery, Bairaha Farms PLC, Sri Lanka. One thousand two hundreds (1200) eggs from MX male x Cobb 500 female were collected from the breeder farm. Eggs were incubated in water and air cooling incubators separately. Egg quality parameters such as egg weight reduction and hatchability, were measured at the end of the setter period. Live chicks and hatch residues were collected separately at the end of incubation period. Chick quality were evaluated by measuring the chick weight, chick length and pasgar score. Egg break out test was conducted with hatch residues. Data was statistically analyzed using two sample t-tests in SAS. Results revealed that there were significant differences (p<0.05) in egg weight reduction, hatchability, chick length and chick weight between two incubators. Higher values for egg weight reduction (9.7%), hatchability (90.4%), chick weight (42.4 g) and length (18.8 cm) were observed in WC incubator compared to AC incubator. Pasgar score did not show any significant difference (p>0.05) between two incubators. Egg breakout analysis showed that higher embryo mortality occurred in the AC type incubator. It is concluded that WC incubator performs better than AC incubator. The WC incubator could be recommended for commercial broiler hatcheries to produce good quality day old chicks.

Keywords: Multi stage incubators, Hatchability, Pasgar score, Hatch Residue

Poultry is one of the most important livestock sectors in Sri Lanka. About 70% of the livestock contribution comes from chicken meat and eggs. Poultry products have now made the most consumed animal protein source in the average Sri Lankan diets. As the industry today is in the hands of the private sector, the role of the state is confined mostly for implementation of poultry health management programs, research and policy development for further consolidation of the industry. The poultry industry in Sri Lanka is growing as a lucrative sector despite minor constraints (Alahakoon *et al*., 2016). Hatcheries are an important segment of the broiler industry that provides the basic trial for a product on cycle. Commercial broiler strains have been genetically improved for short life cycle with the incubation period unchanged. Consequently, broiler chickens today spend more than one third of their life as embryos. This highlights the importance of environmental factors and also provides an avenue to enhance the hatchability and/or post-hatch performance. Temperature, humidity, ventilation, turning and types of incubation equipment are the relevant factors that influence the success of the incubation process (Elmehdawi, 2013).

The success of any hatchery depends on number of quality chicks that are produced. The number is expressed as a percentage of all eggs set for incubation which is termed as "hatchability". Optimal hatchability and chick quality can be achieved by providing

optimum conditions between laying and setting in the incubator. Hatching potential of fertile eggs can be maintained at best. Hatching potential will quickly deteriorate with the mishandling of eggs (Cobb, 2010). Hatchability does not always correlate positively with the best post hatch viability and performance of the chick. The evaluation of chick quality is important in the hatchery as a quality parameter in the production process. Quantitative or qualitative traits are used for the measurement of chick quality. The qualitative traits include chick weight, chick yield and chick length while vitality of the chicks, the quality of their navel, their beaks and joints are considered as qualitative traits (Decuypere and Bruggeman, 2007).

There are numerous ways in the poultry hatchery to increase the productivity such as possibility of increasing hatchability, number of day-old chicks and their quality by improving chick uniformity. Thus, broiler companies are in the process of evaluating the possibilities of moving from the air cooling incubator towards the water cooling type incubator. The main objective is to maximize hatchability with a great number of high-quality and saleable chicks. Currently, the commercial market have two different types of multi-stage incubators such as air cooling (AC) and water cooling (WC). Both air and water cooling incubators are used by commercial hatcheries, to meet the competition and demand of the current market. Therefore, establishment of an efficient egg incubator is a must to produce good quality day old chicks. This study was carried out to compare and determine the performances of two different types of multi stage incubators on hatchability of eggs and chick quality parameters.

MATERIALS AND METHODS

Experimental location and collections of eggs

The experiment was conducted at the commercial hatchery, Bairaha Farms PLC at Pasyala, Sri Lanka. A total of 1200 eggs were obtained from commercial Cobb500 broiler breeder parent stock (MX Male*Cobb500 Female) at 35-36 weeks of age. Eggs weighing between 58.0g and 64.0g were selected for the study. The experimental was composed with two different types of multistage incubators (air and water cooling incubators) each with four replicates and each replicates consisted with 150 eggs. Eggs were incubated in air (AC) and water cooling (WC) incubators, separately.

Arrangement of the multi stage incubators

The hatching eggs were obtained from the breeder farm. One hundred and fifty eggs were set in one setter tray. Eggs were numbered from 1 to 150 and initial egg weights were taken using a balance. Setter trays of WC and AC incubators were tagged as A1, A2, A3, A4 and W1, W2, W3 and W4, respectively. These trays were placed in AC and WC setter trolleys separately and eggs were stored for 3-5 d at 19^0C. Thereafter, setter trays were taken out from the cool room and eggs were fumigated for 20 minutes with formaldehyde gas before the incubation. Para-formaldehyde powder was used to fumigate the eggs. Fumigated trolleys were located into AC setter machines and WC setter machines separately. Incubation conditions were provided according to the incubator manufacture's recommendations.

Temperature and relative humidity were maintained at 99^0F and 86%, respectively. Temperature, relative humidity and egg turning were recorded hourly. Egg turning was recorded as left and right. On the 10^{th} day of incubation, eggs were individually candled in the transfer- room (around 24^0C and 60% relative Humidity), using a hand held candling lamp. "Clear" eggs were removed and broken out for macroscopic examination, in order to determine early-dead embryos (<7 day) and those that are infertile.

On day 18 of incubation, AC and WC incubated eggs were transferred from setter to hatcher baskets separately. Incubation conditions were provided according to the incubator manufacturer's recommendations. At day of 18, individual eggs were weighed according to their respective numbers and weight losses of eggs were calculated. Temperature and relative humidity were recorded in the checklist. At the end of 21^{st}

day, the hatch was pulled out and live hatched chicks were counted and recorded separately. Hatch residuals were collected separately. Un-hatched eggs were opened and observed and examined macroscopically. Dead chicks were recorded separately.

Collection of data

The initial egg weight, egg weight at transfer, hatchability were collected at the incubation period. A total of 100 chicks from each replicate were randomly selected to measure the chick weight, chick length and Pasgar score which is a standardized scoring system used to analyze the chick quality (Boerjan, 2002; Tona *et al*., 2003; Preez, 2007). Chick weight was measured individually by 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 measuring tape and recorded in centimeters (cm). Egg breakout analysis was carried out to find out the reasons for the failure to hatch.

Data analysis

The experiment was conducted as a Completely Randomized Design (CRD) and treatments were arranged with four replicates per each. Four replicates for each multi stage incubator type were used and each replicate consisted with 150 eggs. 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.

Moisture Loss (%) = (Egg setting weight − Egg transfer weight) x 100 %

Egg setting weight (Petek *et al*., 2010)

Hatchability % = Number of sealable chick x 100%

Number of eggs (Petek *et al*., 2010)

RESULTS AND DISCUSSION

Evaluation of incubation parameters

The change of egg weight reduction and hatchability between two types of incubators is shown in the Table 1. Egg weight reduction and hatchability were significantly different (P<0.05) between two types of incubators. The highest egg weight reduction (9.77%) and hatchability (90.49%) were observed in WC incubators. The most common cause of poor hatchability is due to incorrect incubator temperature. A setting that is either too high or too low for a sufficient length of time interferes the normal growth and development of the embryo. High temperatures are especially serious and lead to early hatches of weaker chicks. Consistently cooler temperatures tend to produce late hatches. In both cases, the percentage of chicks hatched is reduced. Effective air circulation and correct room temperature are essential to achieve the necessary even pre-warming of eggs (Elmehdawi, 2013). Poor incubation conditions cause insufficient embryo development and lower hatchability (Meijerhof, 2003). Chick quality and hatchability can only be optimal when the eggs are lost about 12% of their fresh egg weight to pipping. Change in incubation temperature from the optimum level (37.5^0C) has a major impact on hatchability. The impact on hatchability is determined by magnitude of temperature deviation, duration of the deviation, and age at application during the incubation period (Elmehdawi, 2013). Joseph *et al*. (2006) reported that exposure of broiler eggs to 36.6^0C during the first 10 days of incubation reduced hatchability; increased body weight and chick yield and reduced first week body weight gain compared with the control temperature of 37.8^0C. Moreover, it has

Table 1: Change of egg weight reduction and hatchability between two types of incubators

Parameters	*WC Incubators	§AC Incubators
Hatchability (%)	90.49 ± 0.47^a	71.19 ± 2.92^b
Egg weight Reduction (%)	9.77 ± 0.10^a	9.45 ± 0.08^b

Values are means ± SE. *WC; Water cooling §AC; Air cooling

[a,b] means within same row with different superscript are significantly different (p<0.05).

Table 2: Change of chick quality parameters between two types incubators

Parameters	*WC Incubators	§AC Incubators
Chick length (cm)	18.14 ± 0.05^{a}	17.89 ± 0.07^{b}
Chick weight(g)	42.45 ± 0.02^{a}	41.96 ± 0.05^{b}
Pasgar score	9.71 ± 0.09^{a}	9.31 ± 0.03^{a}

Values are means ± SE.

*WC; Water cooling §AC; Air cooling

[a, b] means within same row with different superscript are significantly different (p<0.05)

been reported that good hatchability does not positively correlate with a high percentage of good-quality chicks and that maximal hatchability is not always linked with the highest post hatch quality and growth of the chick (Decuypere and Bruggeman, 2007)..

Evaluation of chick quality parameters

Table 2 shows the change of chick quality parameters between two types of incubators. Chick length and weight were significantly differed (P<0.05) between two types of incubators while pasgar score didn't show any significant different (P>0.05) between two incubators. However, highest pasgar score (9.7), highest chick weight (42.45 g) and highest chick length (18.14 cm) were observed in the WC incubator.

Incubation factors such as temperature, humidity, turning and ventilation influence the quality of day-old chick in the form of chick weight, body length, activity, yolk sac uptake, navel closure on hatching day and post-hatch growth performance (Meijerhof, 2003; Willemsen *et al*., 2008). Incubation temperature is one of the most important factors to assure optimum chick quality and also for post-hatch broiler performance [Lourens, 2003; Willemsen *et al*., 2008; Ipek *et al*., 2014). Embryos with high growing rates are sensitive to temperature fluctuations, and small deviations from optimum ranges have negative effects on hatchability and hatchling quality (Molenaar *et al*., 2010). Fluctuations in setter or hatcher temperatures have negative impacts on chick quality, and it also causes major economic losses because of the negative effects on post-hatch performance and slaughter yield (Wilson, 1991; Shafey, 2004).

Normal incubation temperature (37-38^{0}C) is the most critical environmental factor that controls chicken embryo development and can either accelerate or delay embryogenesis and hatching (French, 2002). Under commercial conditions, correct hatching time is associated with chick yield and the weight of the hatched chick is positively correlated with egg size (Wilson, 1991). A low incubation temperature of 36.6^{0}C during the first 10 days of chicken embryogenesis increases the body weight at hatch, whereas high incubation temperature of 39.5^{0}C from day 18th to day 21st reduces the chick weight in comparison to chicks hatched from eggs incubated at 37.8^{0}C (Joseph *et al*., 2006).

Chicks incubated at high temperature hatched with white color down, probably due to poor absorption of yolk pigments, and exhibited short feathers, red hocks, unhealed navels, cross beaks, weakness and unsteady gait (Leksrisompong *et al*., 2007). There are limited findings about the relationship chick length and their effects on growth performance of broiler. If pasgar score and chick length was compared, it can be observed a rather low correlation between Pasgar score and chick length and this correlation is sometimes even negative. 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 (Meijerhof, 2006).

Evaluation of egg breakout analysis

Breakout analysis showed that higher rate of embryonic mortality and piped egg percentage observed (membranes, 3-7 days, 7-14 days, piped, dead chick) in AC type incubator (Figure 1). High amount of infertile eggs percentage was observed in WC type incubator. Infertility is pre-incubation factor which affects on hatchability. But infertility depend on the breeder flock performance. It doesn't depend on incubation condition.

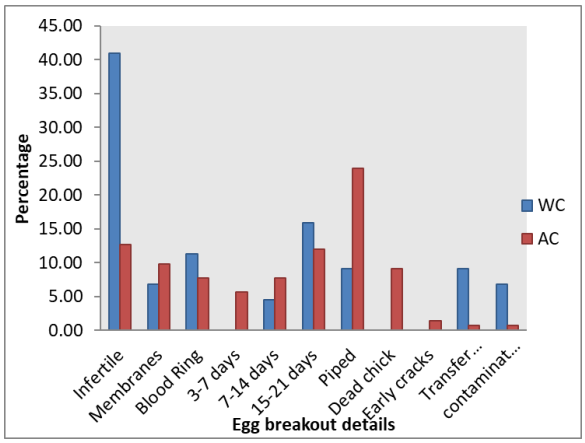

Figure 1: Effect of incubators on egg breakout

The hatch day breakout analysis involves sampling unhatched eggs from breeder flocks, and classifying them into the various causes of reproductive failure (Joseph *et al*., 2006). In a breakout analysis, candled and unhatched eggs are opened to determine why the embryo did not develop or hatch. The egg contents will reveal whether an egg was infertile, if contamination with bacteria or molds occurred, or at which stage of development embryonic mortality occurred. A properly performed breakout analysis identifies whether the problem lies in seasonal variation, breeder flock issues, or hatchery and machine performance. However, many traditional breakout analysis programs make crucial mistakes that reduce the amount of information that can be obtained from the breakout (Carla, 2014).

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. In a good hatching flock there are two main periods of embryo mortality. There are 3 – 10 days and 25 – 27 days pip eggs. 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. A chronic problem, such as slight overheating, may result in mortality later in incubation. Specific embryo abnormalities can be associated with specific problems (nutritional, incubation, toxins and disease) but it is important to note that the same abnormality can be the result of more than one problem. Experience of hatch breakouts with good hatching flocks is important for understanding what is normal and abnormal.

CONCLUSION

Water cooling incubator performs better than air cooling incubator. Therefore, WC type incubator could be recommended for commercial broiler hatcheries to produce good quality day old chicks.

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