BIOCORE

International Journal of Biotechnology and Bioengineering

Volume 7 Issue 9, November 2021

Citation

Adnan Yousaf. (2021), Comparative Evaluation of Single stage versus Multistage Incubation Systems on the Performance of Hatching Eggs from ROSS-308 Broiler Breeders and Post Hatched Performance of Day Old Broile.Int J Biotech & Bioeng.7:9. 190-199

ISSN 2475-3432

Published by Biocore Group | www.biocoreopen.org/ijbb/archive.php

Research Article

Comparative Evaluation of Single stage VS Multistage Incubation Systems on the Performance of Hatching Eggs from ROSS-308 Broiler Breeders and Post Hatched Performance

[1]Adnan Yousaf, [1]Rahana Shahnawaz, [2]Sakandar Khan, [3]Muhammad Roidar Khan, [3]Arslan Said, [4]Mumtaz-ur-Rahman, [1]Junaid Hassan, [3]Ishaq, [3]Muhammad Faiq Said, [3]Asghar Subhani

[1]Sindh Agriculture University Tandojam, Pakistan
[2]University of Veterinary and Animal Science Lahore, Pakistan
[3]University of Agriculture Faisalabad, Pakistan
[4]University of Agriculture Peshawar, Pakistan

Corresponding author: Adnan Yousaf
Sindh Agriculture University Tandojam, Pakistan. **Tel No:** +923005662008,
E-mail: dr.adnan011@gmail.com

Article History: **Received:** September 30, 2021;
Accepted: October 09, 2021;
Published: November 15, 2021.

Abstract

Hatchery productivity is determined by hatchability as well as the quantity of high-quality day old chicks (DOC) produced. The hatchery industry has been looking for innovative ways to improve incubation conditions, such as using different incubation MS or SS machines. The goal of this study was to evaluate findings as of two incubator systems—MS and SS—for all hatchery criteria such as broiler performance, hatchability and chicks quality. Chicks Performance hatch window, Hatchability and water loss variables were all subjected to a completely randomized experimental design with two treatments (MS and SS). A 2 x 2 factorial configuration was used to study performance characteristics (incubator type x chick sex). MS-incubated eggs lost more weight between incubation and transfer ($P<0.05$). Hatchability of eggs incubated in SS was maximum ($P<0.05$), and the hatch window of chicks in SS was longer ($P<0.05$). Embryo diagnostic demonstrated increased end mortality ($P<0.05$) and greater ratios of living and dead piped and broken eggs ($P<0.05$) for embryos incubated in MS. SS chicks had higher physical quality ($P<0.05$). For performance results, there was no interface ($P > 0.05$) between the investigated parameters. Broiler performance is influenced by incubator type. SS In terms of absorption of yolk ages, incubator chicks outperformed MS chicks ($P > 0.05$), and male broilers outperformed female broilers ($P<0.05$). Although performance characteristics were unaffected by incubation type, the SS incubation system demonstrated to be superior to the MS in addressing during embryo development, with maximum hatchability and quality chicks.

Keywords Single-Stage, Multi-Stage, Incubtion, Hatchability, Chick Quality, Ross-308

Abbreviation: SS (Single Stage), MS (Multiple Stage), DOC (Day Old Chicks)

Declaration of Conflicting Interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Acknowledgements:

The authors express their gratitude to the Chief Executive Sadiq Poultry and all Hatchery Staff for their unwavering support, motivation, helpful suggestions, and encouragement throughout the research process.

Introduction

Artificial Incubation by machines is a production process that begins with the setting of fertile eggs and as a result with the biological transformation of the eggs into day-old chicks (DOC). (FAO, 2011; Yousaf et al., 2017). Hatchability and chick quality must be maximized in order to maximize broiler production efficiency (Yousaf et al., 2017). Hatchability is crucial when assessing the parent stock's performance (Jabbar et al., 2017). Because the initial stage in the broiler production chain is egg incubation, maintaining complete control over this industrial process is critical for healthy embryo development (Hussain et al., 2019). Egg fertility, setters, and hatchery management all impact incubation yield. (Araujo et al., 2016; Yousaf et al., 2019). Because the hatching process is so important, commercial hatcheries are always looking for methods to enhance production by increasing hatchability and enhancing DOC quality and consistency. (Yousaf et al., 2019; Araujo et al., 2020). Changing from a multistage (MS) to a single-stage (SS) incubation method may improve these results (Mesquita et al., 2021, Jabbar et al., 2019). MS incubators can incubate 5 or 6 loads of eggs every week, enabling for the incubation of a large number of eggs from numerous broiler breeder farms in a single machine with embryos at various stages of development. (Jabbar et al., 2019; Noivd et al., 2014). During incubation in MS, older embryos transmit heat to younger embryos, maintaining a thermal balance within the setter; nevertheless, this might cause the setter to overheat, leading in embryo death (Araujo et al., 2016, Araujo et al., 2019). As a result, the production of heat by embryos can reduce the amount of energy required to incubate newly generated eggs, making MS less expensive (Yousaf et al., 2019, Yousaf et al., 2018). In contrast, SS incubators are completely loaded with a single egg lot, guaranteeing that all embryos are at the same developmental stage and allowing temperature, humidity, and ventilation to be adjusted to the embryos' individual needs (Mesquita et al., 2021). It is advised to incubate the eggs of current high-yield broiler strains, whose embryos produce more heat than those of slow-growing strains (Yousaf, 2016, Boerjan, 2004). Because the hatching process is so important, commercial hatcheries are always looking for methods to enhance production by increasing hatchability and DOC quality and consistency. (Araujo et al., 2017).

Changing from a (MS) to a (SS) incubation method could improve these results. (Araujo et al., 2016, Boerjan, 2004). An SS also improves hygienic conditions by allowing for more thorough washing and disinfection because the machine gets completely empty at some time. When opposed to MS, using SS may help DOC hatchability and physical condition. (Araujo et al., 2016). The adoption of a high-quality technical automation system is responsible for SS's higher incubation performance. Exploring the technological character of SS involves understanding of how to operate these incubators and their potential for productivity. Some variables, including as hatching time and incubation circumstances, have an impact on chick quality (Jabbar and Yousaf, 2017). The hatchery's operation and administration are critical to the production of high-quality day-old chicks.

The purpose of this study was to examine the physical quality and performance of chicks from SS and MS hatcheries.

Method And Materials:

Experimental Site

In Sadiq Group of Companies (Pvt) Limited's two hatcheries, several trials were carried out. Two artificial egg incubation systems were used to compare all of the variables (MS and SS). The single-stage broiler hatchery is located in Chakri, Rawalpindi. The hatchery is equipped with the most up-to-date heating, ventilation, and air conditioning (HVAC) automation, which has been approved by ISO (International Standard Organization) 1900-2000. SS incubation system with 48 setters and 24 trolleys, each with a capacity of 134640 eggs and 165 eggs per tray. This is Pakistan's largest egg hatchery, which uses a single-stage incubation technology to produce the highest quality chicks (Avida G4, Chick Master USA). The SS was outfitted with infrared sensors that continuously monitored eggshell temperature, as well as setter control, to maintain the optimal temperature for each embryo growth stage. An egg-weighing system, a dehumidification system, and CO2 level control were also included in the SS. In SS, profile incubation was utilized, during the entire incubation phase, temperature, humidity, air renewal, and O2 levels were adjusted in accordance with embryo progress. The dry bulb temperature was kept constant at 99.5 0F and the relative humidity (RH) was kept at 60% for MS. Egg turning was done once an hour in both the SS and MS groups. The multi-stage broiler hatchery, on the other hand, is 18 KM from Sheikhupura on the Faisalabad-Sheikhupura highway. Using a multi-stage incubation technique, the hatchery is generating high-quality chicks (Gensis4, Chick Master USA). Each setter could hold 96600 eggs in the MS incubation system.

Breeds Selection

The current study used broiler breeders (Ross-308) with eggs of four different ages.

The following ages of eggs were used in incubation trials: (33, 37, 41, 46-wk-old).

Eggs Selection

The hatching eggs were chosen because they had acceptable quality shells with no ridges or small lumps of calcified material (pimples). All the hatchable eggs were graded using the MOBA 9A egg grading machine based on their quality and weight. Only oval-shaped and good-quality eggs were chosen, with the poor shell, break, bloody stained, and elongated eggs being excluded (Khan et al., 2016). During the whole investigation, the egg room temperature and humidity were 75 0F and 65 0F, respectively, with fresh air at a rate of 2 CFM/1000 eggs.

Classification by Breed / Group

Eggs from Ross-308 breeders of various ages were used in the four incubation trials: 1st incubation (46 weeks), 2nd incubation (33 weeks), 3rd incubation (37 weeks), 4th incubation (46 weeks), and 5th incubation (46 weeks) (41-wk-old). Each experimental group had (n=5, 38,560) eggs in it, with four replicates (n=134,640) eggs in each group.

Size of Eggs

Before eggs setting weight of eggs for individual group was performed by the formula:

$$\text{Egg weight} \quad \frac{\text{Full tray weight at Setting- Weight of empty tray}}{\text{Total No of eggs in tray}}$$

Eggs Fumigation

Before, trial eggs were fumigated with 20 g KMnO4and 40ml formalin (40%) for 100ft 3 areas for 15 minutes through automatic fumigation process provided by Chick Master USA.

Regime of Incubation:

Eggs were pre-heated in SS incubators for 5 hours at 82°F. The setter started the incubation stage profile automatically after the pre-warming was completed (Recommended by Chicks Master USA). Incubation time in setters was 444 hours, 18.5 days in hatchers, and 62 hours in hatchers.

Eggs were pre-warmed in a closed chamber throughout multi-stage incubation, and chicks master USA did not give an age-specific incubation programme. For 18.5 days, Setter maintains a single fixed point of 99.5°F and 85 percent humidity (444 hours). Following the fertility analysis, the fertile eggs were transferred to hatchers for the next 62 hours. Due to the last stage of the embryo producing heat and increasing the humidity set point to 90%, the temperature set point in hatchers is reduced to 98.5 0F. This improves the piping of eggs.

Incubation Duration (Single Stage & Multi Stage Incubation)

The Single Stage incubation method had a well-defined incubation profile that began at 100.3 0F and rapidly decreased over time, completing full incubation in 19 stages. Every stage had a distinct humidity and temperature set point, therefore hatchers had a 62-hour incubation period divided into seven phases, each with a different temperature and humidity set point (Recommended by Chick Master USA). As a result, there is no specific incubation programme in Multi Stage incubation. For the past 444 hours, only one set point of temperature 99.5°F and humidity 85 percent has been running. When the temperature is adjusted to hatchers, the temperature drops to 98.50 degrees Fahrenheit, but the humidity rises to 90%. Six various durations of eggs were incubated in the Multi Stage machine.

Hatcher Hall & Setter Hall

Setter hall had a temperature of 75 °F and a relative humidity of 40 percent, whereas hatcher hall had a temperature of 75 °F and a relative humidity of 60 percent. Throughout the trial, the positive pressure in the setter and hatcher halls was 15 and 10 Pascal, respectively, while the negative pressure inside the setter and hatcher plenums was -25 Pascal.

Water loss in eggs

The eggs were weighed and labelled. Eggs were separately placed in trays fitted with air-permeable metallic dividers at the time of transfer after 18.5 days to allow hatching chicks to be associated with their specific egg. During incubation, the weight of the eggs decreases. Water loss was measured prior to transport to hatcheries. After 444 hours, the water loss was calculated using the following formula:

$$\text{Water Loss \%} \quad \frac{\text{Full tray weight at Setting- Full Tray Weight at Transfer x 100}}{\text{Full tray weight at Setting- Empty Tray Wight}}$$

Candling

For each tray, the percentage hatch in relation to the total number of eggs laid (total percentage hatch) and the % hatch in relation to viable eggs were assessed (Yousaf et al., 2017, Araujo et al., 2016). The

residual analysis (93.69 percent (SS) and 93.22 percent (MS)) was used to compute the number of viable eggs. After 444 hours in the setter, the eggs were transferred to hatchers. Only fertile eggs were transferred from the setter to the hatchers, and the fertility of the eggs was tested using candling tables.

Incubation Durations In hatchers

Incubation time in hatchers was 62 hours for a successful hatch.

Hatch Window

The hatch window is the time between the first chick hatching and the last chick hatching (Noiva et al., 2014). The hatch window has a range of 19-24 hours (Araujo et al., 2017). From 470 hours until hatch, the hatch window was monitored. The hatcheries were opened at regular intervals until all of the trays had been removed (506 hours), and the number of hatched birds was counted to determine the percentage hatch. The mean hatch window was calculated using the number of hours between the first and last chick hatched in each hatch tray.

Pulling Hatch

I. Hatch Pulling in the Traditional Way

Hatch's role in both groups was distinct. In Pakistan, the traditional method of hatch pulling was used for group Multi Stage hatch pulling. At 494 hours, the first pull was made (444 in setters and 50 h in hatchers). The remaining pips and unhatched eggs were relocated to the hatcher for the following 12 hours for the second hatch pull. After 12 hours, pluck the un-hatch eggs once more.

II. Pulling a single hatch

Incubation in a single stage is prohibited. After 506 hours, it was only pulled out once (444 h in setters and 62 h in hatchers). Inside the hatcheries, nothing was left behind. Hatch removal was accomplished using a shell separator (KUHL). Chick body weights were determined immediately following chick collection. To the best of our knowledge, a single hatch pull after 506 hours was conducted for the first time in Pakistan (Jabbar et al., 2017).

Chick Grading

Chicks were graded using an automatic grading table and a conveyer. After counting, only the best (shiny eyes, soft legs and nose, healed naval, and healthy chicks) were placed to the chick's box, while underweight, weak, and unhealed naval chicks were eliminated according to international standards as described by (Yousaf et al., 2017).

Chicks Quality

The hatchery was raided for chicks that had hatched from eggs at around 6 h intervals and individually weighed to measure chick body weight at hatching. After 506 hours of incubation, experimental trays were removed from hatcheries, and newborn chicks were weighed (chick body weight at pulling), measured for length (Wolanski et al., 2007), and assessed macroscopically for physical quality (Tona et al., 2003). After measuring the chicks, they were killed by cervical dislocation, and the yolk sac was retrieved and weighed.

Analysis of DIS (dead in shell)

A dead in shell (DIS) examination is required to investigate the cause of embryonic mortality inside the eggs. Table 1 shows the results of a study of unhatched eggs.

After 506 hours of incubation, all unhatched eggs in the experimental trays were retrieved and categorized (Araujo et al. 2016). For residual analysis, all unhatched eggs were tested.

Incubation Type	1st Week (0-7days)	2nd Week (8-14 days)	3rd Week (15-21 days
Single Stage	2.26±0.25a	0.57 ±0.16a	2.44±0.23a
Multi Stage	3.67±0.12b	1.27 ±0.12b	4.43±0.24b

a, b, Denotes significant difference in column (P<0.05)

Table 1: Dead in Shell (DIS) Analysis

Statistical analyses

Statistical Analysis System package software was used to evaluate all of the data (SAS version 9.2, SAS Institute Inc., Cary, NC, USA). Duncan's Multiple Range Test was used to compare all means, and the findings were presented as mean standard error of the mean (standard error of mean). If there was a $P<0.05$, the results were deemed significant.

Conditions in a Poultry Farm

A total of n=60000 broiler chicks (n=30000 males and n=30000 females) from the fourth incubation (41-week-old breeders) were chosen two incubation systems (SS and MS) and two sexes (male and females), for a total of four treatments with six replicates with 2500 birds per replicate. The chicks were delivered to poultry houses in Chakri Rawalpindi in environmental controlled vehicles (240C temperature and 65% humidity). At the farm, all of the chicks were given unlimited amounts of water and food. Throughout the duration of the study, continuous illumination was provided. Starter diets (3010 Kcal ME/kg, 22 percent crude protein) were fed to the chicks from 1 to 10 days, grower diets from 11 to 20 days (3175 Kcal ME/kg, 20 percent crude protein), and finisher diets from 21 to 35 days (3227 Kcal ME/kg, 18 percent crude protein). Using the WUFFDA formulation software application, the diet was created in accordance with the NRC's (1994) recommendations. Feed and water intake were measured on a daily basis, whereas body weight and total feed consumption were measured monthly. All experimental groups had the identical circumstances in the poultry house, as shown in Table 2. A ventilation system was installed by Viper Touch (Big Dutchman, Co., Germany).

Parameters	Weeks				
	1	2	3	4	5
Temperature (°C)	34-30	30-28	28-25	25-24	24-21
Humidity %	65	65	65	65	65
Ventilation (m^3 /hour/ bird)	0.07	0.25	0.40	0.59	0.87

Table 2: Environmental conditions of poultry house

Results and Discussion

The weight of the eggs in each group was similar ($P<0.05$), indicating that the sample was homogenous. Egg weight upon transfer did not differ between the two groups ($P<0.05$), although egg weight loss was higher ($P<0.05$) for eggs incubated in MS (Table 3).

Parameters	Single Stage	Multi Stage	3rd Week (15-21 days
Eggs Weight (setting time) g	65.3±0.8[a]	65.5±0.8[a]	2.44±0.23[a]
Eggs weight (after 18.5 days) g	57.60±0.6[a]	57.96±0.6[a]	57.96±0.6[a]
Egg weight loss %	11.86±0.15[a]	12.20±0.15[b]	12.20±0.15[b]

a, b, Denotes significant difference in rows ($P<0.05$)

Table 3: Effect of incubator type (multistage and single-stage) on egg weight loss between incubation and transfer

Incubation Type	Egg Weight (g) Day 1st	Crack eggs	Contaminated eggs %	Egg Waste %
Single Stage	65.3±0.8	0.5 ±0.17	0.52 ±0.16	19.75±0.4
Multi Stage	65.5±0.8	0.5 ±0.12	0.52 ±0.13	19.75±0.6

Table 4: Comparison of egg weight, Crack eggs, contaminated eggs and eggs waste %

While percentage hatch and percentage fertile hatch were greater ($P<0.05$) in SS (Table 5). Chicks from SS had a shorter hatch window ($P<0.05$). SS had a superior chick output with less water loss than MS, with an average hatch window of 22.50 hours (Table 5).

Incubation Type	Hatchability %	Fertility %	Chick Yield	Hatch Window (h)	Water Loss
Single stage	88.39±0.7[a]	93.69±0.05 [a]	68.54±0.4 [a]	19.50±0.5 [a]	11.86±0.15 [a]
Multi stage	86.09±0.5[b]	93.22±0.03 [a]	71.82±0.5 [b]	22.50±0.5 [b]	12.20±0.15 [b]

a, b, Denotes significant difference in column (P<0.05)

Table 5: Effect of incubator type (multistage and single-stage) on hatchability, Fertility, chick yield, hatch window and water loss

Both SS and MS had the same 506-hour incubation time. The hatching peak for SS (38.43%) happened at hour 17 (487 hours of incubation), whereas the peak for MS (48.46%) occurred at hour 21 (491 hours of incubation), indicating that SS hatches earlier. For the following categories of mal-formation, mal-position, dead pipped, and living pipped, residual analysis revealed a substantially (P<0.05) higher percentage for MS than for SS (Table 6.1 and 6.2).

Parameters %	Single Stage	Multi Stage
Cross beak %	0.03	0.3
Culling Chicks %	0.12	0.17
Dry eggs %	0.08	0.1
Ectopic viscera %	0.12	0.29
Extra Albminun %	0.09	0.2
Eternal Pips %	0.29	0.41
Brain Exposed %	0	0.25
Extra Eyes %	0	0.12
Extra Limb %	0.15	0.17
Hock Swelling %	0.1	0.2
Un heal Navel	0.11	0.34
Ascites	0	0.9
Cured Toe	0	0.8

Table 6.1 Effect of incubator type (multistage and single-stage) on Mal Formation

Parameters %	Single Stage	Multi Stage
Feet Over Head %	0.12	0.14
Feet Between legs	0.12	0.1
Head in narrow end of egg	0.09	0.7
Head touch to feet	0.11	0.14
Head turn to left	0.12	0.12
Head over right wing	0.45	0.49

Table 6.2 Effect of incubator type (multistage and single-stage) on Mal Position

A reduction in early and late embryo mortality usually leads to an enhanced hatch rate. Because of the enormous difference in how single stage and multi stage machines operate, when suitable profiles are followed, there is a documented decrease in dead in shell and pipped eggs. Multi-stage incubators work on averages (Silva et al., 2017), which means that all eggs are treated as averages rather than exact matches to their incubation requirements. Single-stage incubation can be tailored to provide the exact incubation conditions required for the developing embryo. In single stage incubation, when suitable profiles are followed, the incubator's efficiency is maximized, and the largest number of excellent quality chicks are produced. The data collected using single stage incubation consistently shows that all aspects of incubation are improving. The capacity to have complete control over the incubation process leads to better results, such as higher hatch rates and a larger number of chicks to sell or contract to growers. Increased hatch rates will lower the cost per chick, boosting the hatchery's efficiency. The dead in shell ratio findings in SS were better than MS in the first week, ranging from 2.26±0.25 to 3.17±0.12, 2nd week 0.57±0.16, 0.85±0.12 and third week 2.44±0.23, 3.11±0.24 (Table 1). As shown in Table 1, chick

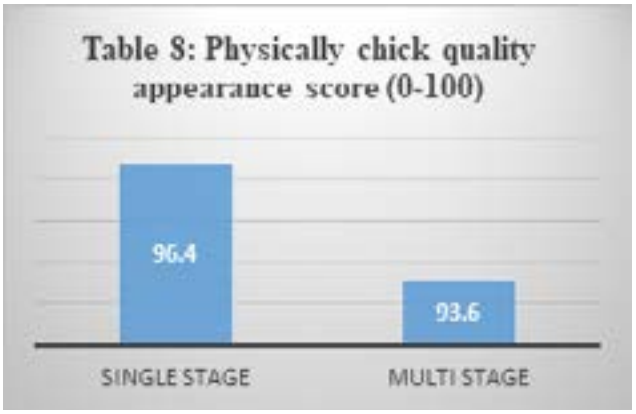
body weight at hatch and percentage of chick bodyweight at hatch in relation to egg weight were affected by the incubation system (MS or SS) (Table 7). Chick body weight at pulling, percentage of chick body weight at pulling in relation to egg weight, chick weight loss, and residual yolk sac weight were all higher for MS chicks than for SS chicks (P<0.05), as shown in the table (Table 7).

Incubation Type	Chick weight at time of hatch(g)	Chick weight loss up to delivery time (g)	Chick weight loss up to delivery time (%)
Single Stage	44.8±0.7 [a]	1.46±0.34 [a]	3.33±0.33 [a]
Multi Stage	46.8±0.6 [b]	1.59±0.35 [a]	3.75±0.88 [a]

[a, b,] Denotes significant difference in column (P<0.05)

Table 7: Chick weight at time of hatch, delivery and weight loss percentage

In comparison to SS, MS had a higher chick yield. Chicks incubated in SS had a larger (P<0.05) yolk-free body weight than chicks incubated in MS (Table 5). Furthermore, in compared to egg weight, SS had a higher percentage of yolk-free body weight (P<0.05). The leftover yolk sac weight was less (P<0.05) in SS incubated chicks, which explained the difference in yolk free body weight across treatments. Chicks incubated in SS were longer on average than chicks in MS (Araujo et al., 2017). The physical quality score of chicks incubated in the SS system was 96.40, which was higher (P<0.05) than chicks incubated in the MS system (93.60). (Table 8).



The relationship between the incubation system and broiler sex showed no effect during any of the time periods studied (P<0.05). Due to incomplete yolk absorption in MS, chicks' initial body weight was larger (P0.05) than in SS. Table 8 shows the results. Male chick body weight was higher (P0.05) in MS than SS due to higher chick output (Table 7). The two incubation methods had identical female beginning body weight (P<0.05), as seen in (Table 9). MS chicks had higher average weight and weight gain (P<0.05) than SS chicks due to incomplete yolk absorption in MS chicks, whereas yolk absorption in SS chicks was complete.

Incubation Type	Male (g)	Females (g)
Single Stage	44.75[a]	43.8 [a]
Multi Stage	46.84 [b]	45.6 [b]

a, b, Denotes significant difference in column (P<0.05)

Table 9: Male and Females chicks body weights (g) in two incubation type

Table 10 shows the findings of a 35-day study that included mortality, feed intake, weight increase, and FCR. Surprisingly, the effect of various incubation types on broiler performance was shown to be better for SS than MS. The SS incubation 3.18±0.77 considerably reduced mortality (P<0.05) compared to the MS incubation 4.87±0.63. When comparing SS 1955.66±21.82 to MS 1896.66±25.72, the weight gain (g/bird) was higher (P<0.01). When comparing SS (1.49±0.06) to MS (1.79±0.07), the feed conversion ratio (FCR) was determined to be considerably better (P<0.002). However, SS incubation affected feed intake (g/bird) 3048.43±155.84 against 3178.43 ±150.79 for MS incubation (P> 0.05).

Parameters	Single Stage	Multi Stage
Mortality	3.18±0.77[a]	4.87±0.63 [b]
Weight gain (g/bird)	1955.66±21.82 [a]	1896.66±25.72 [a]
Feed conversion ratio (FCR)	1.49±0.06 [a]	1.79±0.07 [b]
Feed intake (g/bird)	3048.43± 155.84 [a]	3178.43± 150.79 [b]

[a, b,] Denotes significant difference in rows (P<0.05)

Table 10: Post-hatch performance of broilers

The consumer expects food that is both safe and healthy (a high-quality final product) (Hussain et al., 2015). When the machines are correctly managed and maintained, both single stage and multi stage incubation can produce healthy chicks; however, single stage incubation has the advantage of being able to clean and sterilize the entire machine every 18.5 days. Cleaning of multistage incubators may only occur once a year or less, resulting in lower sanitation and cleanliness, as well as a higher risk of contamination, than single stage incubators. In comparison to multi-stage incubators, single-stage incubators allow you to properly disinfect the machine after each batch of eggs has been processed. While this form of sanitation has long been the industry standard for hatcheries, single stage operations now allow sanitation to be integrated into the setting process as well. It is well known that SS systems enable more exact control of physical parameters involved in incubation, particularly temperature, allowing for improved nutrition utilization and organ maturation by adhering more closely to the physiological requirements of the embryo (Araujo et al., 2016). As shown in this study, SS improved the physical quality of neonatal chicks significantly more than MS, as measured by yolk free body weight, chick length, and quality score. When it came to hatchability, the SS consistently outperformed the MS. In a comparison analysis of incubation yield in SS and MS, Mauldin et al. (2006) found similar results. The more efficient management of temperature, RH, and ventilation in SS explains the higher hatchability. Furthermore, discrepancies in eggshell weight, eggshell quality, and egg health are minimized in SS since eggs from the same batch are usually incubated together (Gonzales et al., 2012). As a result, physical elements can be tailored to the needs of embryos, ensuring more precisely homeostasis and, as a result, better development and quality. Despite the increased hatching rates, a cost-benefit study of SS deployment and management is required. In today's chicken industry, the word "biosecurity" is becoming more widely used and heard.

As poultry production grows more intense and genetic selection allows for the generation of faster-growing chicks, there is a risk that these hens will become more sensitive to disease. To avoid any potential contamination or disease, all aspects of the incubation and production process must establish advanced procedures to maximize the levels of sanitation and hygiene (Decuypere et al., 2001). Incubation in a single stage allows for accountability and traceability. Multi-stage incubators will have eggs in various stages of incubation at any given time (approximately 18.5 days). If there is a contamination problem, all of the eggs in the incubator will be exposed, which may necessitate their destruction. However, because all of the eggs in single stage incubators are the same age and are at the same stage of incubation, it may only be necessary to destroy one machine's worth of eggs in the event of contamination. The end user is looking for accountability, and single stage incubation can provide it.

Conclusion

To increase productivity, artificial incubation of fertile eggs from Ross-308 broiler breeders should be done in single-stage incubators. Not only did the single-stage system improve hatchability, but it also improved chick quality. The incubator system had no effect on broiler performance under ideal conditions.

Conflict of Interests

The authors declare that they have no conflict of interest with respect to the research, authorship, and/or publications of this article.

Refeences:

[1] Araujol ICS, Noleto RA, Martins JM, Ulhoa CJ, Guareshi GC, Reis MM, Leandro NSM (2019) Effect of vitamin E in ovo feeding to broiler embryos on hatchability, chick quality, oxidative state, and performance. Poult. Sci., 98, pp. 3652-3661

[2] Araujol ICS, Café MB, Mesquita MA, Caiado BN, Faria AM, Mello HHC, Tringhini JHS, Leandro NSM (2020) Effect of commercial product containing canthaxanthin for in ovo feeding to broiler embryos, on hatchability, chick quality, oxidation status and performance Poult. Sci.: 99, pp. 5598-5606

[3] Araujol ICS, Leandro NSM, Mesquita MA, Café MB, Mello HHC, Gonzales E (2016) Effect of incubator

type and broiler breeder age on hatchability and chick quality. Braz. J. Poult. Sci., 18, pp. 17-25

[4] Araujol ICS, Leandro NSM, Mesquita MA, Café MB, Mello HHC, Gonzales E (2017) Water vapor conductance: a technique using eggshell fragments and relations with other parameters of eggshell. Bras. Zootec., 46, pp. 896-902

[5] Noiva Rute M, Menezes António C and Peleteiro Maria C (2014) Influence of temperature and humidity manipulation on chicken embryonic development. BMC Veterinary Research, 10:234

[6] Jabbar A, Yousaf A, Hameed A, Riaz A and Ditta YA (2019). Influence of Fumigation strength on Hatchery Parameters and Later Life of Chicks. J Holistic vet Sci Ani Care 1(1): 101

[7] Yousaf A, Jabbar A, Rajput N, Memon A, Shahnawaz R, Mukhtar N, Farooq F, Abbas M and Khalil R (2019). Effect of Environmental Heat Stress on Performance and Carcass Yield of Broiler Chicks. World Vet. J. 9(1): 26-30

[8] Hussain J, Rabbani I, Aslam S, Ahmad HA (2015). An overview of poultry industry in Pakistan. World Poult. Sci. J. 71(4): 689-700.

[9] Yousaf A, Rajput N, Memon A, Naz Jagirani G, Shahnawaz R, RajparS, Sarwar M and Habib F (2019). Effect of hatch window upon intestinal development, chick quality, post hatch performance according to Ross-308 broiler breeder age. Online J. Anim. Feed Res., 9(1): 26-32

[10] Hussain A, Bilal M, Habib F, Gola BA, Muhammad P, Kaker A, Yousaf A, Khalil R (2019). Effects of low temperature upon hatchability and chick quality of Ross-308 broiler breeder eggs during transportation. Online J. Anim. Feed Res., 9(2): 59-67.

[11] Yousaf A, Tabasam MS, Memon A, Rajput N, Shahnawaz R, Rajpar S, Jamil T, Mushtaq M (2019).Prevalence of ascaridia galli in different broiler poultry farms of potohar region of rawalpindi-pakistan. J Dairy Vet Anim Res. 8(1):71–73.

[12] Jabbar A, Hameed A, Yousaf A, Riaz A and Ditta YA (2019). The Influence of Hairline Crack Eggs on Hatchery Parameters and Chicks Performance. World Vet. J. 9(2): 76-83

[13] FAO (2011). Per capita meat consumption declines by 1.7pc. Food and Agriculture Organization results. Brazil. J. Poult. Sci. 10: 17–22.

[14] Yousaf A, Shahnawaz R, Jamil T, Mushtaq A (2018). Prevalence of coccidiosis in different broiler poultry farms in Potohar region (distract Rawalpindi) of PunjabPakistan. J Dairy Vet Anim Res. 7(3):87–90.

[15] Hussain A, Yousaf A, Mushtaq A. (2018) Prevalence of mycoplasma gallisepticum in ross-308 broiler breeder through the contrast of serological assessments in Pakistan. J Dairy Vet Anim Res. 7(1): 00185.

[16] Tona K, Malheiros RD, Bamelis F, Careghi C, Moraes VMB (2003). Effects of storage time on incubating egg gas pressure, thyroid hormones, and corticosterone levels in embryos and on their hatching parameters. Poult. Sci. 82: 840–845

[17] Yousaf A, Jabbar A, Ditta Y.A (2017). Effect of pre-warming on broiler breeder eggs hatchability and post-hatch performance. J. Anim. Health Prod. 5(1): 1-4.

[18] Silva DA, Labas MV, Nys, Y and Rehault-Godbert S. (2017) Investigating proteins and proteases composing amniotic and allantoic fluids during chicken embryonic development. Poult. Sci. 96:2931–2941.

[19] Decuypere, E., Tona K, Bruggman V, and Bamelis F. (2001). The dayold chick: a crucial hinge between breeders and broilers. World Poult. Sci. J. 57:127–138.

[20] Yousaf A, Jabbar A, Laghari IH, Abbas M (2017). Effect of incubation duration on broiler breeder eggs hatchability and post-hatch performance. J. Anim. Health Prod. 5(4): 127-131. 12.

[21] Mesquita MA, Araujo ICS, Café MB, Arnhold E, Mascarenhas AG, Carvalho FB, Stringhini JH, Leandro NSM, and Gonzales E (2021) Results of hatching and rearing broiler chickens in different incubation systems. Poultry Science 100:94–102

[22] Gonzales, E. (2012). Estágio múltiplo vs único de incubaçaeo artificial de ovos. Revista Avicultura Industrial.

[23] Jabbar A, Yousaf A. (2017). Effect of age wise incubation programme on broiler breeder hatchability and post hatch performance. Online J. Anim. Feed Res., 7(1): 13- 17.

[24] Khan A, Rind R, Shoaib M, Kamboh AA, Mughal GA, Lakho SA, Malhi KK, Nizamani AR, Yousaf A (2016). Isolation, identification and antibiogram of Escherichia coli from table eggs. J. Anim. Health Prod. 4(1): 1-5

[25] Yousaf A. (2016). Impact of gender determination through vent sexing on Cobb-500 broiler performance and carcass yield. Online J. Anim. Feed Res., 6(6): 125-129.