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## Effects of warming end of lay broiler breeder eggs during the storage period on hatchability

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EFFECTS OF WARMING END OF LAY BROILER BREEDER EGGS DURING THE  
STORAGE PERIOD ON HATCHABILITY

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Master of Science

in

The Interdepartmental Program in  
The School of Animal Sciences

by  
Jennifer M. Dowden  
B.S., Louisiana State University, 2006  
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## **ABSTRACT**

Due to necessary storage of hatching eggs in commercial hatcheries, the embryo is being regressed. End of lay broiler breeder eggs have the poorest hatchability and are most affected by pre incubation storage. Warming these eggs is the only way the embryo can develop. The objective of this study was to study the effects of daily warming of end of lay broiler breeder hatching eggs during the storage period on embryo mortality and hatchability. Six trials were conducted, three trials warmed for three of the four day storage period and three trials warmed for five of the six days storage period. There were six warming treatments for each trial; 0, 30, 60, 90, 120, and 150 minutes daily. All eggs were from Hubbard Classic broiler breeders 50-58 weeks of age. Hatch time was recorded for trials three and six. Two hundred and eighty eight randomly selected males were used in trial five to study the effects of daily warming on chick growth. They were fed a starter broiler diet and grown for 13 days in a Petersime starter battery. In all hatchability trials percent fertility, percent fertile hatchability, percent total hatchability, percent early dead, percent mid-dead, percent late dead, percent pips, and percent total embryonic mortality was not affected ( $P>0.05$ ) by any of the daily warming treatments. Hatch time and chick growth were not affected by any of the daily warming treatments. Eggs could be warmed for as much as 150 minutes daily during storage without affecting hatchability which contradicts to management procedures. These results suggest that it is unnecessary for refrigerated trucks to transport eggs from the farm to the hatchery.

## **INTRODUCTION**

The broiler industry has evolved from millions of small backyard flocks to less than 50 highly specialized, vertically integrated agribusiness firms. In 1934, there were 11,405 facilities, which hatched all the chickens in the United States. Those hatcheries had an average incubator capacity of 24,244 eggs. As of 2001, there were 323 chicken hatcheries with an incubator capacity of 862 million eggs (National Agricultural Statistic Service, 2002).

Over the past few decades, the United States has seen a gradual increase in the demand for poultry. In 1945, broiler production was 1.11 billion pounds live weight, compared to 19.52 and 18.84 billion pounds live weight of cattle and hogs respectively. In 2001, broiler production was 42.45 billion pounds live weight, slightly higher than the 42.37 billion pounds of cattle and calves and well ahead of the 25.94 billion pounds of hogs and pigs (National Agricultural Statistic Service, 2002). Chosen for its low fat content and price, poultry is seen in a diverse set of food products that include wings, drumsticks, and tenders.

Commercial poultry production is one of the fastest growing capital-intensive animal industries in North America. The value of the United States broiler industry has grown from \$5.68 billion in 1985 to \$21.5 billion in 2007 (Crop Reporting Board, 1986; National Agricultural Statistics Service, 2008). Following this trend, each year an increase in the number of broiler breeder eggs have been set in commercial hatcheries in the United States. In 2005 over 11 billion eggs were set in commercial hatcheries compared with 5.6 billion eggs in 1985, a 98% increase (Schaal and Cherian, 2007).

Overall, broiler breeder companies are looking to ensure that the eggs set are fertile and will successfully hatch. After hatching, the speed of growth and amount of meat produced is important. Successful companies are able to supply large orders of breeding stock that perform competitively in the global market.



The American consumer consumption patterns show preference for convenience and breast meat; there has been a move from growing higher yielding to heavier live weight birds, thus reducing processing and preparation costs. Because the modern breeder is modified by population genetics, companies have selected certain traits to help produced heavier chicks. For male lines, these traits are growth rate, edible meat yield, and feed conversion ratio. For female lines, traits are the same except egg production is considered. These major traits are improved by positive selection, while minor traits like fertility, hatchability, and livability are affected by elimination of the worst families. These minor traits are considered to have low heritabilities, making it very difficult to select for these traits (Pollock, 1999).

A 1% increase in hatchability of broiler and turkey eggs would increase returns more than 23 million dollars. The total calculated impact associated with low hatchability for both broilers and turkeys is a 500 million dollar loss to the industry annually (Schaal and Cherian, 2007). Finding the optimum handling and incubation techniques has the potential of a huge economic impact on the industry.

## **LITERATURE REVIEW**

Over the last 20 years, hatchability has virtually stayed the same, ranging from 79-82% (Schaal and Cherian, 2007). The lack of improvements in hatchability is costing the poultry industry each year. As improvements are made in meat yield, growth rate, and feed conversions, a small amount of emphasis is placed on hatchability. Industry trends over the last five years show that egg production, fertility, and hatchability have been devalued in the choice of breeds in the U.S. The move towards yield will continue because of market requirements, and greater effort will be required in breeder management to maintain reasonable fertility (Pollock, 1999).

Broiler breeder operations use hatchability to monitor hatchery management and reproductive efficiency. There are many factors that can influence hatchability. These factors can be grouped into three main influences, which are as follows: breeder flock effect, post-oviposition pre-incubation holding environment, and incubational environment. The breeder flock effect includes the variables that can directly affect the parent stock prior to oviposition. Post-oviposition pre-incubation holding environment is the period of time after oviposition up until the time of incubation which consists of the storage time at the farm and hatchery. The incubational environment is a very controlled environment, depending on setter dependability. Incubation has many facets, which are as follows: temperature, relative humidity (RH), position of egg, turning angle, and turning frequency. Management of the farm and hatchery can control factors affecting hatchability after oviposition; therefore, these conditions can vary by operation and are easily manipulated.

### **Breeder Flock Effect**

Characteristics of the parent flock are important to understand because of their effect on the reproductive cycle. The physiological changes due to genetic selection can greatly affect the egg and embryo development. Coleman and Siegel (1966) found that populations of chickens

selected for low body weight had more advanced embryonic development at oviposition and an increased hatchability when compared to hens selected of high body weight. McNary *et al.*, (1960) also reported an advanced embryonic development in populations selected for low body weight. There is a negative correlation between body weight and reproductive success, so the effect may be confounded as birds become heavier with age (Creel and Maurice, 1998). Genetic selection has been found to be responsible for changes in the rate of growth and development. As selection continues towards high body weight, there could be severe consequences on reproductive efficiency.

### **Breeder Age and Egg Quality**

As breeder age increases, the eggs those breeders produce change as well; these changes can have an affect on hatchability. Creel and Maurice (1998) found that numerous factors affect hatchability, but the major determinant of hatchability is age. They reported that hatchability increases till it peaks at 87.3%, this peak occurs at 33 weeks of age. Hatchability then gradually declines until 49 weeks of age. At this breakpoint there is an abrupt increase in the rate of decline in hatchability. This rate is 1.6% a week, which is an eight-fold increase over the previous segment. This age-associated decline in both fertility and hatchability has both male and female components.

There are many female factors due to aging that influence hatchability and alter ovarian function. Female factors include internal or multiple ovulation, impaired capacity of the sperm storage tubules, retrograde transport, and faulty shell deposition (Creel and Maurice, 1998). As the hen ages, her clutch begins to shorten and this increases the number of first of sequence eggs. These first of sequence eggs are larger, have thinner shells, are more developed at oviposition, and are less viable (Creel and Maurice, 1998). The male effects on hatchability are alleviated with the commercial practice of spiking. Young roosters are selected for body conditions and

size, not for fertility, and placed in the hen house in hopes of increasing fertility (Parker and McDaniel, 2002).

The age of the breeders affects hatchability, because it is related to the quality of hatching egg, such as the internal egg composition or ratio, egg weight, and shell quality, whereby the incubation condition and the development of the chick embryo is influenced (Yassin *et al.*, 2008). As breeder age increases so does the weight of the egg and the percentage of yolk, while the percentage of shell declines (Tona *et al.*, 2004, Vieira and Moran, 1998). At oviposition the proteins of the albumen possess various anti-microbial defenses against organisms that may invade immediately after oviposition, before the drying of the cuticle, and before the structural changes in the shell membranes have been completed (Brake *et al.*, 1997). As egg weight increases with age, due to an increase in yolk deposition, the albumen quality (HU) significantly decreases (Tona *et al.*, 2004). Albumen liquefaction probably facilitates the movement of nutrients from the albumen to the blastoderm (Brake *et al.*, 1997) and may reduce the barrier to gaseous diffusion (Meuer and Baumann, 1988). This degradation causes the blastoderm to move into close proximity to the eggshell, so that early embryonic mortality results from dehydration during the early stages of incubation (Brake *et al.*, 1993).

Because the eggshell is a major barrier to gas diffusion, the rates of vital gas and water vapor diffusion through the shell pores influence the survival of the developing embryo. Roque and Soares (1994) found that thin shelled eggs displayed a significantly greater weight increase with breeder age. Eggshell quality is often measured by egg specific gravity, and the average egg specific gravity dropped below the industry's recommended level at 42 weeks of age; hatchability also declined 5% at this age (Bennett, 1992). Not only is the eggshell thinner but eggshell porosity also tends to be lowest at the beginning and the end of the laying period (Peebles and Brake, 1987). Thin eggshells increase the rate of water loss and eggshell

conductance (the ability to respire) compared with thick eggshells (Joseph and Moran, 2005). Low eggshell porosity and decreased oxygen availability can be a major limiting factor on embryonic growth (Burton and Tullett, 1983).

In conclusion, as the flock age increases, the size of the egg increases, due to an increase in yolk deposition, which may cause the decrease in shell thickness. The albumen quality decreases causing the blastoderm to be positioned closer to the eggshell which may result in embryonic mortality. Most likely the development of the chick is affected by a combination of these factors. One of the factors that strongly influence the outcome of the embryo is egg storage (Fasenko, 2007).

### **Post-Oviposition Pre-Incubation Holding Environmental Effect**

Post-oviposition the freshly laid egg is easily influenced by environmental factors. Due to hatchery demands, eggs are not incubated immediately after laying. They are stored at the breeder farm and the hatchery. Currently, eggs are stored on average four and a half days and maximum six days. Eggs are stored up to four days at the breeder farm and two days at the hatchery before set in an incubator for 21 days.

During storage, the length of storage period, temperature, humidity, gaseous environment, and the orientation of the eggs influence hatchability (Meijerhof 1992; Fasenko, 2007). Egg storage depresses albumen quality, affects embryonic viability in all flock ages and results in less percentage of good quality day-old chicks (Lapao et al., 1999; Tona et al., 2004). Hatchability is influenced by storage of eggs, because the quality of the egg deprecates, whereby the metabolic activity of the chick embryo is affected, which in turn influences the embryonic development of the chick (Yassin, 2008).

### **Length of Storage Period and Temperature**

Studies have shown that egg storage length is detrimental to the embryo and hatchability, especially when eggs are stored for longer than seven days. Hatchability of eggs from older flocks decreases more with increasing storage time (Kirk et al., 1980). Because of this, it has also been suggested that if eggs have to be stored, that eggs from younger breeders be stored rather than those from older breeders (Tona et al., 2004, Lapao et al., 1999, Reis et al., 1997).

As reviewed by Meijerhoff (1992), several studies have shown that hatchability may be reduced by 0.5% per day of storage. Mather and Laughlin (1979) reported the number of malformed embryos increased with storage time, probably due to blastoderm shrinkage. Albumen height also significantly decreased with storage time, while albumen pH increased (Lapao *et al.*, 1999). Long egg storage increases incubation length, adversely affects day-old chick quality (Tona et al., 2003), and increases embryonic mortality (Kuurman *et al.*, 2002). In older hens viability of eggs not submitted to storage was higher by three to six percentage points than that of stored eggs (Reis *et al.*, 1997). However, researchers have noted that long term storage effects can be alleviated by exposure to higher incubation temperature (Christensen *et al.*, 2003).

Hatching eggs are held at temperatures that cause developmental arrest; the temperature where embryogenesis ceases is called physiological zero. Butler (1991) reviewed the literature and found that this exact temperature has been widely debated for many years. He concluded that physiological zero lies between 25 and 27 °C. Farm egg coolers are typically set between 17 and 20°C but lower storage temperatures are recommended if length of egg storage should increase (Bourassa *et al.*, 2003). Ruiz and Lunam (2002) observed an improvement in hatchability of fertile eggs with a reduction in temperature to 10°C for eggs stored for long periods (>9 days). However, an increase in storage temperature to 20°C for short storage (1-3

days) did not affect hatchability of fertile eggs. Bourassa *et al.* (2003) found that holding broiler eggs for one to four days at 23°C compared to 19°C did not alter hatchability or incidence of embryo or chick abnormalities. Because rate of weight loss was similar during incubation in both stored and non-stored eggs, high RH during storage is recommended to prevent dehydration of the egg content by evaporation through the pores, but without causing condensation (Mayes and Tekeballi, 1984).

### **Incubational Environment**

The modern broiler's embryonic period now composes 30-40% of its total lifespan, making it a very important component of the production cycle (Ricks *et al.*, 2003). The environmental conditions that result in the highest hatching percentage of fertile eggs were largely determined a half a century ago. There are four factors that can be precisely controlled during incubation, which are as follows: temperature, humidity, egg turning and egg orientation.

During incubation eggs should be set large end up, so they can be turned around the short axis. Eggs are turned 24 times per day at a 45° angle. Failure to turn will result in reduced hatchability due to adhesion of the embryo to the inner shell membrane. Adhesion causes embryonic death and can cause a rupture of the yolk's vitelline membrane. The most crucial period for turning is three to seven days of incubation, with little, if any benefit after day 13 (Wilson, 1991a).

Temperature is the most critical of the four factors that can affect hatchability. Optimum incubation temperature is 37.8°C and should not vary more than 0.3°C (Wilson, 1991a). High incubation temperatures at the beginning (Lourens *et al.*, 2005) and end (Leksrisompong *et al.*, 2007) of incubation have been shown to reduce body weight when compared to normal incubation temperatures. According to French (1997), embryos absorb heat from the surrounding environment during the first part of incubation due to egg temperature being slightly

lower than air temperature. As embryos age they must lose heat because their metabolic rate and heat production increase. This is why on day 18 eggs are transferred to hatching baskets and into the hatcher that operates at a lower temperature (37.0°C).

## **Pre-Incubation Warming**

### **Embryonic Development at Oviposition**

The blastoderm is fertilized 15 minutes after ovulation. Shortly after fertilization meiotic and mitotic divisions occur while the egg moves through the oviduct. At the time of oviposition, a fertile egg will be composed of 20,000 viable cells (Bell and Weaver, 2001). Embryos in eggs laid by older birds are developmentally more advanced at oviposition than those from younger birds. This may be due to eggs spending longer time in oviduct, either because the oviduct is longer or because the rate of passage of the egg is reduced (Mather and Laughlin, 1979). Since older breeders have a lower hatchability this could be because of the stage of the embryo at oviposition. A young breeder will lay a fertile egg containing an embryo that has developed to the gastrulation stage. Eyal-Giladi and Kochav (1976) labeled this inactive developmental stage as Stage X. If an older breeder lays an egg developmentally more advanced the embryo may be going through a more active stage of development therefore reducing its resistance to storage. Warming older breeder eggs during storage may increase the development stage to an inactive stage helping it withstand storage (Fasenko, 2007). The embryo must be exposed to incubation temperature (37.5°C) to successfully develop.

### **Embryonic Developmental Changes Due to Storage**

The biological age of an embryo stored for 14 days lags behind that of an embryo stored for four days, even though their chronological ages were the same (Fasenko and Robinson, 1998). Meijerhof (1992) reported that pre-incubation storage leads to morphological changes in the blastoderm and malformations in the embryo with increase in cell necrosis and a lower



growth rate of the embryo. Hays and Nicolaides (1934) were the first to recognize that hens with higher hatchability had a more advanced blastoderm at oviposition. Fasenko (2007) suggests that there are particular embryonic developmental stages that are better able to survive storage. Embryos that have completed hypoblast formation may be at a relatively inactive stage and may better withstand developmental arrest. Eyal-Giladi and Kochav (1976) labeled hypoblast formation as Stages XI to XIV. Stage XIV corresponds to about six to seven hours of incubation (Ricks et al., 2003; Fasenko, 2007)).

Storage temperature influences the loss of carbon dioxide, and therefore, results in an increase in the albumen pH (Meijerhof, 1992). The optimal pH for the developing embryo is 8.2 and 8.8, but pH increase to 9 at four days of storage (Brake *et al.*, 1997; Lapao *et al.*, 1999). Meijerhof (1992) reported that metabolic activity of cell of the early embryo produces carbon dioxide which influences the pH, thus creating a more suitable environment. He suggests temporary heating of eggs to incubation temperature during storage will induce metabolic activity, therefore, lowering the pH.

Researchers studying the effects of warming on short-term storage have seen an increase in hatchability when warming for five hours (Becker and Bearse, 1958). Kosin (1956) studied the daily brief warming of eggs stored for 1-14 days. Eggs were exposed to one hour of warming at 37.6°C each day. Hatchability of fertile eggs was improved by 7% when compared to the control. This treatment was effective in raising the hatchability of chicken and turkey eggs. Kan *et al.* (1962) also found that daily warming improved hatchability for eggs stored up to three weeks but was detrimental to eggs stored between three and four weeks. He concluded that warming eggs the day after they are laid proved to be the most effective time for pre-incubation.

A more recent study conducted by Fassenko *et al.* (2001a), found that when turkey eggs were stored for four days, the warming prior to storage had neither a detrimental or beneficial affect on hatchability when compared to no warming. However Fassenko *et al.* (2001b) found that the hatchability of eggs warmed for six hours prior to storage improved significantly when compared to no warming, but, 18 hours of warming was detrimental to hatchability. This study was conducted on broiler breeder eggs stored for 14 days. He also found that six hours of warming advanced the broiler embryo to the stage of development at which hypoblast formation is complete. At 18 hours of warming the majority of embryos were at a developmental stage, where primitive streak formation is complete. This agrees with hypotheses that there is a certain stage of embryo development is more susceptible to storage.

Eggs of hens with poor hatching records are most likely to profit from pre-incubation warming (Becker and Bearse, 1958; Lancaster and Jones, 1986). Colman and Siegal (1966) have reported that hen selected for low body weight at eight weeks of age produced eggs with greater embryo development at oviposition as well as higher hatchability than hens selected for higher body weight. They also found heating eggs from high body weight lines for four hours to obtain a comparable stage of embryo development as the eggs from low body weight lines improved hatchability of these eggs. The modern broiler breeder is a product of high body weight selection (Pollock, 1999; Schaal and Cherian, 2007), thus the modern broiler may benefit from pre-incubation warming.

A decline in reproductive performance due to high body weight, which could be confounded by age, is a great concern for scholars due to the economic losses. It was found that eggs from hens 49 weeks of age or older have an abrupt decline in hatchability (Bennett, 1992). There is not much information on changes in post-peak hatchability or the factors that influence their occurrence (Creel *et al.*, 1998). It is important to research how to increase hatchability of

end of lay broiler breeder eggs because they have the lowest level of hatchability and are more affected by storage and incubation variations.

In our lab, there has been previous research on warming broiler breeder eggs prior to storage with no beneficial results (Wiggins, 2008) so it was decided to study daily warming during the storage period. This type of warming would be more like what the hen does naturally. Also, there are no current studies on daily pre-incubation warming affects on hatchability. This research was conducted to test the hypothesis that daily incubation warming of end of lay broiler breeder eggs would advance embryo development and, therefore, allow the embryo to withstand storage resulting in an increase in hatchability. This study used two different storage lengths to examine the effect of storage length. The objectives in this research were to look deeper into poultry incubation management practices and understand how daily warming during the storage period could affect the embryo and hatchability.

## **MATERIALS AND METHODS**

### **Three Days of Warming**

Fourteen hundred and forty eggs (trials 1 and 2) and 1,080 eggs (trial 3) were collected from two commercial breeder farms around 10 A.M. and transported for about four hours. Hubbard Classic broiler breeder eggs were used in trials 1, 2 and 3 at 58, 56, and 51 weeks of age respectively. Eggs were randomized and assigned to treatment groups and then numbered 1 to 240 for each warming treatment of 0, 30, 60, 90, 120, and 150 minutes, except for trial 3 which was only numbered 1 to 180. After randomizing and numbering, eggs were placed in a cooler operating at 15.5°C and 60% relative humidity and kept there overnight.

On the first day of storage, the eggs were placed in egg trays in a Natureform setter (#2000, Jacksonville, FL, 32202). The incubator was set at 37.5°C with a relative humidity of 60%. The control (0 minutes) was kept in the cooler during the entire storage period. After the warming treatments eggs were kept in the egg trays and placed directly back into the same cooler. This was repeated on the second and third day of storage. On the fourth day, one day of transporting and three days of storage, eggs were set in the Natureform setter (#2000, Jacksonville, FL, 32202). The incubator was set at 37°C with a relative humidity of 60% and eggs were turned 24 times per day for 18 days in a randomized block design. The block in all experiments was the level in the setter and hatcher. There were eight levels and six positions used for the treatments (Figure A1). Each of the six positions on a level was filled with 30 eggs from each treatment. Only eight of the eleven levels were used; the bottom three levels were filled with non-treatment eggs. This was done so airflow would be equal across all eggs in the setter. Only eight levels were used because the hatcher can only hold eight trays, each tray represented each level from the setter. Because of an increase in cull eggs, trial 3 only used six of the eleven levels and the bottom five levels were filled with non-treatment eggs. On the

seventh day, eggs were candled and infertile, and early fertile dead embryos were removed. These eggs were broken to confirm infertility and to determine embryonic mortality. After 18 days of incubation, the eggs were transferred to pedigree baskets by treatments. The baskets were placed into a Natureform hatcher (#NOM-45, Jacksonville, Fl, 32202) operating at 37.0°C and 65% relative humidity. A Tinytag DataLogger© temperature recorder was used to monitor temperature in the setter and hatcher.

At the end of the incubation period (21 days) the chicks and all unhatched eggs were removed. At our lab these eggs were then broken to determine the age of embryonic mortality and pips were recorded. All dead embryos were classified as early dead (died 1-7 days), mid-dead (died 8-14 days) and late dead (died 15-21 days). Pips were defined as chicks that broke through the shell but do not fully hatch. The dependent variables are as follows: percent true fertility, percent fertile hatchability, percent total hatchability, percent early dead, percent mid-dead, percent late dead, and percent pips. To study the effects of daily warming on hatch time, eggs from trial 3 were pulled from the hatcher every six hours starting at 408 hours (20 days) of total incubation until 504 hours (21 days) of total incubation. At each pull chicks were counted and removed. The percentage of total hatch at each pull was recorded.

### **Five Days of Warming**

Fourteen hundred and forty eggs were collected from two commercial breeder farms around 10 A.M. and transported for about four hours. The eggs used in trials 4, 5 and 6 came from two flocks of Hubbard Classic broiler breeder eggs at 50, 55, and 51 weeks of age respectively. In these trials were warmed for five days. The procedures for all trials were the same as trials 1-3. The dependent variables were also the same as the previous trials. A Tinytag DataLogger© temperature recorder was used to monitor temperature in the setter and hatcher. To study the effects of daily warming on hatch time, eggs from trial 6 were pulled from the

hatcher every six hours starting at 408 hours (20 days) of total incubation until 504 hours (21 days) of total incubation. At each pull chicks were counted and removed. The percentage of total hatch was measured at each pull.

Male chicks were randomly selected from trial 5 to study weather daily warming during storage would affect broiler chick growth. After hatching chicks were sexed, wing banded, weighed and recorded then placed in a pen consisting of six chicks. The six daily warming treatments had eight reps randomly allotted to each pen. They were fed a broiler starter diet recommended by Hubbard (Table 1) provided ad libitum as well as water. On day 13 the broilers were weighed and final weight was recorded. After the trial these variables were measured; initial weight (INWT), final weight (FWT), average daily gain (ADG), and gain to feed ratio (G:F).

The analysis of variance procedures using the GLM procedure of SAS (SAS, 1996) was used. All treatments were represented and randomized on each level. A flat of 30 eggs was the experimental unit for all hatchability trials. Means from the hatchability and hatch time trials were converted by arcsine of the square root the dependent variables. In all hatchability and hatch time trials there were significant effects by level, the block. There was no significant trial by treatment interactions so trials 1-3 were combined and trials 4-5 were combined. The model for analyzing hatchability data included trial, treatment, and level. If main effects were significant, least significant difference comparisons were used to determine which means were different. During the battery trial a pen of six broilers was the experimental unit and was arranged in a completely randomized design. The model for the battery trial included treatment. The model for hatch time included level and treatment.

Table 1. Percentage composition of the broiler starter diet.

Ingredient	(%)	Calculated Analysis	
Corn	55.188	ME, kcal/kg	3,025
Soybean meal	37.735	Crude protein (%)	22.96
Poultry fat	2.370	Calcium (%)	1.00
Monocalcium phosphate	1.547	NonPh Phos (%)	0.46
Limestone	1.423	Lysine (%)	1.28
Salt	0.5	Met + Cys (%)	1.01
DL-Methionine	0.377	TSAA (%)	0.81
Biolys	0.25		
Mineral premix <sup>1</sup>	0.25		
Vitamin premix <sup>2</sup>	0.25		
L-Threonine	0.061		
Choline chloride	0.05		

<sup>1</sup> Provided per kilogram of diet: copper (copper sulfate), 7 mg; iodine (calcium iodate), 1 mg; iron (ferrous sulfate•H<sub>2</sub>O), 50 mg; manganese (manganese sulfate), 100 mg; selenium (sodium selenite), 0.15 mg; zinc (zinc sulfate), 75 mg.

<sup>2</sup> Provided per kilogram of diet: vitamin A (retinyl palmitate), 8,002.78 IU; vitamin D<sub>3</sub> (cholecalciferol), 3003.80 IU; vitamin E (DL- $\alpha$ -tocopheryl acetate), 25.00 IU; menadione (menadione sodium bisulfite), 1.50 mg; vitamin B<sub>12</sub>, 0.02 mg; d-biotin, 0.10 mg; folacin (folic acid), 1.00 mg; niacin, 50.00 mg; d-pantothenic acid, 15.00 mg; pyridoxine (pyridoxine•HCl), 4.00 mg; riboflavin, 10.00 mg; thiamin (thiamin•HCl), 3.00 mg.

<sup>3</sup> Contains 750,000 mg/kg of choline.

## RESULTS AND DISCUSSION

### Three Days of Warming

True fertility was not a dependent variable in these experiments because fertilization happens within the hen and before the treatments were applied. True fertility is important to determine, because it helps measure the reproductive success of the breeder flock. The average range for true fertility for trials 1, 2 and 3 was 89.2-94.8% (Table 2). Total hatchability cannot be affected by the treatments because this variable includes fertility. Total hatchability for trials 1 (70%) and trial 2 (69%) agreed with the hatchability model from Creel and Maurice (1998). Trial 3 (49%) was low because these flocks were reported as experiencing low hatchability. Since there was no significant trial by treatment interaction, data from these trials were combined. All dependent variables were significantly ( $P < 0.05$ ) affected by the main effect of trial. Since the trials were conducted separately, the trial effect is most likely due to the difference in ages and flocks.

The average temperature, among eggs in trial 1, in the setter and hatcher was 38.5°C and 38.0 °C respectively, which agrees with observations made by French (1997) (Table A1). He observed that data from both chicken and turkey incubators show that the temperature surrounding the egg could significantly differ from the temperature indicated on the incubator control. The increase in late dead embryos during trial 2 could be due to the increase in hatcher operating temperature (Bell and Weaver, 2001). Even though breeders used in trial 3 were the youngest, they experienced the lowest fertility. An increase in embryo mortality at all stages resulted in an increase in total embryonic mortality in trial 3. This was expected because these two flocks had been reported as experiencing low fertility and hatchability.

Fertile hatchability was not significantly affected by any of the daily warming treatments (Table 3). This disagrees with Kosin (1956) results of daily warming of setting eggs. These



Table 2. Main effect of trial on true fertility, fertile hatchability, total hatchability, early dead, mid-dead, late dead, pips, and total embryonic mortality using end-of-lay Hubbard Classic broiler breeder eggs warmed (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period.<sup>5</sup>

Dependant Variable	Trial 1 <sup>1</sup>	Trial 2 <sup>2</sup>	Trial 3 <sup>3</sup>	SEM	P > F <sup>6</sup>
	------(%)-----				
True Fertility	92.7	94.8	89.2	1.6	<.0001
Fertile Hatchability	75.6	72.7	54.3	1.5	<.0001
Total Hatchability	70.0	69.0	49.0	1.4	<.0001
Early-Dead	7.3	4.3	8.5	1.5	0.0005
Mid-Dead	1.2	1.1	6.3	0.3	<.0001
Late-Dead	10.5	16.8	23.2	1.0	<.0001
Pips	4.3	4.5	6.6	0.5	0.0233
Total Embryonic Mortality	19.0	22.3	38.7	1.2	<.0001

<sup>1</sup>Eggs used in trial 1 were 58 week old Hubbard Classic

<sup>2</sup>Eggs used in trial 2 were 56 week old Hubbard Classic

<sup>3</sup>Eggs used in trial 3 were 51 week old Hubbard Classic

<sup>4</sup>Not a dependent variable, fertilization happened before treatment

<sup>5</sup>Values are means

<sup>6</sup>P-value for main effect trial

Table 3. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on fertile hatchability and total hatchability using end-of-lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined)<sup>1</sup>

Daily Warming Treatments (Min)	True Fertility	Fertile Hatchability	Total Hatchability
	------(%)-----		
0	93.1	70.7	65.9
30	92.5	67.7	62.7
60	92.1	67.7	62.4
90	93.0	66.7	62.5
120	91.9	70.1	64.8
150	92.5	70.3	65.3
P-value	0.74	0.27	0.53
SEM	0.415	1.08	1.10

<sup>1</sup>Values are means

results do agree with a more recent study suggesting that turkey eggs stored four days or shorter is not significantly improved or reduced by pre-incubation warming (Fasenko, 2001a). The lack of a significant effect due to the daily warming treatments when compared to the control disagrees with Bell and Weaver (2001) and Meijerhof *et al.* (1994). They recommend that eggs be placed directly in the cooler after collection and are held at a constant temperature without any fluctuations. Also, eggs from older breeders have increased sensitivity to non-optimal pre-incubation treatments.

Early dead, late dead, total embryonic mortality, and pips were not significantly affected by treatment. Mid-dead embryonic mortality was significantly affected ( $P=0.09$ ) by treatment (Table 4). Using a least significant difference comparison, it was determined that daily warming for 30, 90, and 150 minutes (2.51%, 1.80%, and 1.68% respectively) significantly reduced ( $P<0.10$ ) mid-dead embryonic mortality when compared to warming for 60 minutes (4.41%). There was no difference when compared to the control or 120 minutes (2.56%, and 2.72% respectively). This suggests that the stage of the embryo at 30, 90, and 150 minutes better withstood storage when compared to the embryo stage at 60 minutes of daily warming.

Hatch time was not significantly different between any of the daily warming treatments and the control (Table 5). However, half (49.11%) of all chicks hatched before 480 hours (20 days) of incubation (Figure 1). These results agree with North and Bell (1990), which says pre-incubation at near normal incubation temperatures shortens the regular incubation period. The lack of significance from warming treatments and the control could be explained by the age of the flock. As a hen ages, the oviduct becomes longer or transport may slow down (Creel and Maurice, 1998); the longer an egg is held in the body the greater the early embryonic growth (Bell and Weaver, 2001). Therefore, hatch time can decrease as much as 10 hours as a hen ages (Brake, 1997). These results disagree with Kirk *et al.* (1980) and Mather and Laughlin (1977), which found that storage adds up to 40 minutes onto incubation time with every day of storage,

Table 4. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on early dead, mid-dead, late dead, pips and total embryonic mortality using end-of-lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined)<sup>1</sup>

Daily Warming Treatments (Min)	Early Dead	Mid-Dead	Late Dead	Pips	Total Embryonic Mortality
	------(%)-----				
0	6.2	2.5	14.7	5.6	23.5
30	7.3	2.5	17.2	4.3	27.1
60	6.2	4.4	16.8	5.0	27.5
90	8.0	1.8	18.7	4.4	28.1
120	5.7	2.7	16.2	4.5	25.0
150	5.7	1.6	14.5	6.2	22.3
P-value	0.84	0.09	0.50	0.49	0.12
SEM	0.452	0.355	0.768	0.342	1.02

<sup>1</sup>Values are means

Table 5. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on hatch time using end-of-lay Hubbard Classic broiler breeder eggs. (Trial 3)

Daily Warming Treatments (Min)	480 Hrs.	486 Hrs.	492 Hrs.	498 Hrs.	504 Hrs.
	------(%)-----				
0	52.3	19.4	12.5	10.1	5.0
30	42.1	21.3	22.8	5.1	8.5
60	45.0	27.6	13.1	9.3	4.7
90	56.7	20.4	12.3	6.5	3.9
120	43.7	35.4	12.8	4.0	4.1
150	55.1	20.5	11.0	9.5	3.7
P-value	0.61	0.29	0.45	0.33	0.69
SEM	3.37	2.22	1.87	1.09	0.92

<sup>1</sup>Values are means

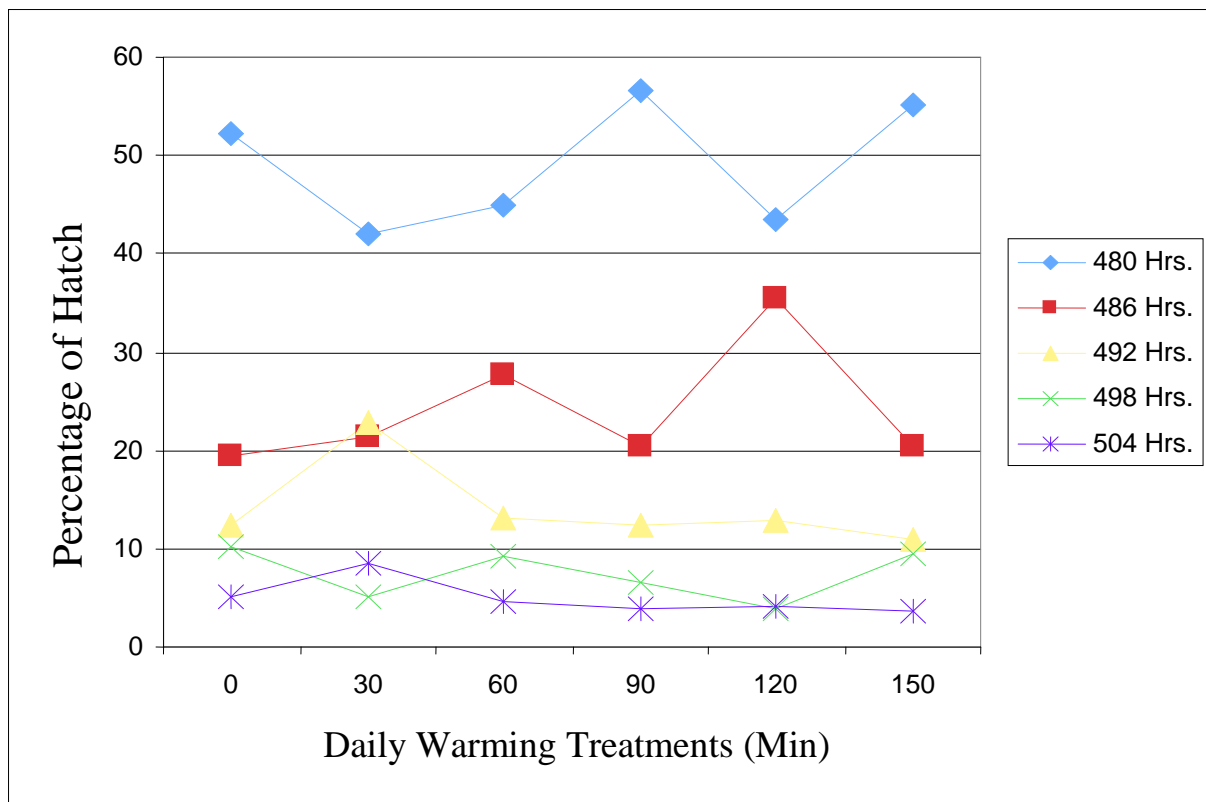


Figure 1. Effect of daily warming (0, 30, 60, 90, 120 and 150 minutes) during three of the four day storage period on hatch time using end-of-lay Hubbard Classic broiler breeder eggs. (Trial 3)

and that this retardation becomes greater as hens age. These results suggest that four days of storage may not regress the embryo enough to affect hatch time.

Fasenko (2007) suggested that certain embryonic developmental stages can better withstand storage. Embryos that have completed hypoblast formation may be at an inactive stage and may withstand developmental arrest better than embryos that are undergoing active periods. In this experiment daily warming treatments 0, 30, 60, 90, 120, and 150 minutes were warmed for three days totaling 0, 1.5, 3, 4.5, 6, and 7.5 hours respectively. The lowest fertile hatchability was observed at 90 minutes of daily warming. Also the highest early dead, late dead, and total embryonic mortality were observed at 90 minutes of daily warming. This data also showed an increase in fertile hatchability as well as a decrease in embryonic mortality after 90 minutes of daily warming (Figure A2-6). Eggs warmed for 120 and 150 minutes daily were warmed for a total of 6 and 7.5 hours respectively which corresponds with completed hypoblast formation (Ricks *et al.*, 2003; Fasenko, 2001).

### **Five Days of Warming**

Shortly after the eggs from trial 6 were set, the turner mechanism malfunctioned for as much as a day. This malfunction may have significantly reduced embryo mortality at all stages as well as hatchability, so this trial was not used except for hatch time data. There was no significant trial by treatment interaction so trials 4 and 5 were combined. True fertility ranged from 87.0-96.4%. As in trials 1-3, true fertility was not a dependent variable because fertilization happens within the hen and before the treatments were applied. Total hatchability for trial 4 (85.4%) agreed with Creel and Maurice (1998), trial 5 (59%) and trial 6 (36.3%) were lower. As with trials 1-3, these flocks were reported as experiencing low hatchability. All dependent variables were significantly affected by the main effect trial ( $P < 0.001$ ) (Table 6). The high mean percentage of total embryonic mortality in trials 5 (32.3%) can explain the decrease in fertile hatchability. In trial 5 the high mean percentage of late dead embryos (18.9%) is

Table 6. Main effect of trial on true fertility, fertile hatchability, total hatchability, early dead, mid-dead, late dead, pips, and total embryonic mortality using end-of-lay Hubbard Classic broiler breeder eggs warmed (0, 30, 60, 90, 120, 150 minutes) five out of the six day storage period.<sup>5</sup>

Dependent Variable	Trial 4 <sup>1</sup>	Trial 5 <sup>2</sup>	SEM	P-Value <sup>6</sup>
	------(%)-----			
True Fertility <sup>3</sup>	96.4	92.1	1.6	<.0001
Fertile Hatchability	88.6	63.9	1.5	<.0001
Total Hatchability	85.4	59.0	1.4	<.0001
Early Dead	3.6	7.4	0.4	<.0001
Mid-Dead	1.1	5.8	0.2	<.0001
Late Dead	5.7	18.9	1.0	<.0001
Pips	0.8	3.5	1.2	<.0001
Total Embryonic Mortality	10.4	32.3	1.5	<.0001

<sup>1</sup>Eggs used in trial 4 were 50 week old Hubbard Classic

<sup>2</sup>Eggs used in trial 5 were 55 week old Hubbard Classic

<sup>3</sup>Not a dependent variable, fertilization happened before treatment

<sup>5</sup> Values are means

<sup>6</sup>P-value is for the main effect of trial

responsible for the increased number of total embryonic mortality. An increase in late dead embryos in trial 5 could be due to the increase in the temperature among the eggs in the hatcher (Table A2).

Fertile hatchability was not significantly affected by any of the daily warming treatments (Table 7). Early dead, mid-dead, late dead, total embryonic mortality and pips were not significantly affected by treatment (Table 8).

Hatch time was not significantly different between any of the daily warming treatments and the control (Table 9). The mean of fertile hatch at 480 hours of incubation (36.4%) and 486 hours (36.9%) was not different in the control (Figure 2). This lack of difference was unlike what was seen in the eggs stored for four days (Figure 1). These results agree with Kirk *et al.* (1980) and Mather and Laughlin (1977), which found that storage retards incubation time with every day of storage. These results suggest that six days of storage does regress the embryo enough to affect hatch time.

In this experiment, daily warming treatments 0, 30, 60, 90, 120, and 150 minutes were warmed for three days totaling 0, 2.5, 5, 7.5, 10, and 12.5 hours respectively. The lowest fertile hatchability was observed at 90 minutes of daily warming. Also the highest early dead, late dead, and total embryonic mortality was observed at 90 minutes of daily warming (Figure A7-10). The same daily warming treatment (90 minutes) in all trials lowered the dependant variables but there was a difference in the total warming times. This may be due to the increase in storage time. As eggs are stored, the embryonic development proceeds at a slower rate during the first portion of incubation (Fasenko, 2007; Mather and Laughlin, 1977), thus resulting in a slower embryo growth rate during warming treatments.

The initial weight (INWT) of chicks selected for grow out was not significantly affected by treatment (Table 10). Hubbard's performance objectives only give an average of males and



Table 7. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on fertile hatchability and total hatchability using end-of-lay Hubbard Classic broiler breeder eggs. (Trials 4, and 5 combined)

Daily Warming Treatments (Min)	True Fertility	Fertile Hatchability	Total Hatchability
	----- (%)-----		
0	95.3	75.6	72.3
30	93.5	76.8	72.4
60	94.5	76.4	72.5
90	92.6	72.9	68.0
120	93.9	77.5	73.1
150	95.4	77.7	74.2
P-value	0.58	0.76	0.51
SEM	0.4	1.5	1.6

<sup>1</sup>Values are means

Table 8. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on early dead, mid-dead, late dead, and embryonic mortality using end-of-lay Hubbard Classic broiler breeder eggs. (Trials 4 and 5 combined)

Daily Warming Treatments (Min)	Early Dead	Mid-Dead	Late Dead	Pips	Total Embryonic Mortality
	----- (%)-----				
0	5.2	4.0	12.1	2.8	21.4
30	4.8	2.9	13.5	1.8	21.3
60	5.1	2.9	11.9	2.4	19.9
90	8.0	3.4	13.5	2.0	25.0
120	4.2	2.9	12.3	2.9	19.5
150	5.7	4.4	11.0	1.1	21.1
P-value	0.28	0.64	0.86	0.21	0.83
SEM	0.4	0.4	0.9	0.3	1.4

<sup>1</sup>Values are means

Table 9. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on hatch time using end-of-lay Hubbard Classic broiler breeder eggs. (Trials 6)

Daily Warming Treatments (Min)	480 Hrs.	486 Hrs.	492 Hrs.	498 Hrs.	504 Hrs.
	------(%)-----				
0	36.4	36.9	17.5	5.4	3.6
30	51.4	26.7	13.0	6.9	1.8
60	55.9	21.8	13.4	6.5	2.1
90	57.0	25.7	6.6	6.8	3.6
120	52.8	19.3	16.4	7.4	3.9
150	55.8	20.6	12.4	8.7	2.2
P-value	0.22	0.13	0.59	0.98	0.96
SEM	2.53	2.17	1.16	1.13	0.69

<sup>1</sup>Values are means

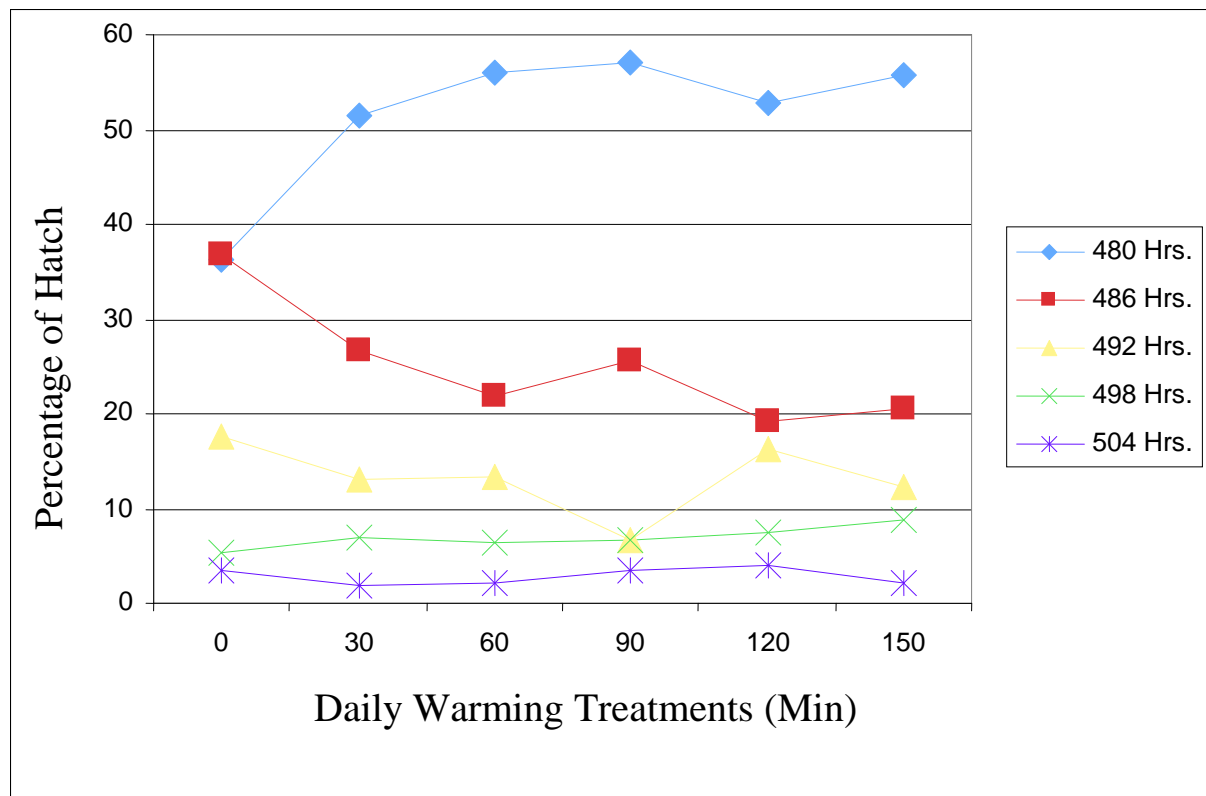


Figure 2. Effect of daily warming (0, 30, 60, 90, 120 and 150 minutes) during five of the six day storage period on the acceleration of hatch time using end-of-lay Hubbard Classic broiler breeder eggs. (Trial 6)

Table 10. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five days of a six day storage period on initial weight (INWT), final weight (FWT), average daily gain (ADG), and gain to feed ratio (G:F) using end-of-lay Hubbard Classic broiler breeder eggs.<sup>1</sup> (Trial 5)

Dependent Variable	Daily Warming Treatments (Min)						SEM	P > F
	0	30	60	90	120	150		
INWT	45.35	45.38	45.68	45.89	46.47	46.09	0.25	0.26
FWT	386.6	404.1	403.6	381.9	398.4	404.7	3.62	0.54
ADG	26.25	27.59	27.56	25.85	27.07	27.62	0.27	0.62
G:F	0.8026	0.8223	0.8164	0.8728	0.8118	0.8257	0.01	0.28

<sup>1</sup>Values are means

females for the first 14 days of age; this average was used for comparison. The INWT of all treatments exceed Hubbard's performance objectives for the Classic broiler (40g). This is expected for older broilers because their eggs are larger therefore producing larger chicks (Wilson, 1991b). Average daily gain (ADG), gain to feed (G:F), and final weight (FWT) were not affected by treatment. ADG and G:F was not given in the Hubbard Classic performance objective averages so it was calculated. ADG for the control (26.2g) and daily warming for 90 minutes (25.8g) were slightly below the average performance objectives for 13 day old broilers (27.7g). This is be due to a higher IWT but a low FWT in both of these treatments. G:F for all treatments meets the Hubbard Classic performance objectives (0.8022). FWT for the control and daily warming for 90 minutes (386.6g and 381.9g respectively) were slightly below the average performance objectives (401g).

## **SUMMARY**

This study was conducted to determine the effects of daily warming for 30, 60, 90, 120, and 150 minutes during each day of storage on percentage fertile hatchability, percentage total hatchability, embryonic mortality, and pips of eggs from post peak Hubbard Classic broiler breeders. This study used two different storage periods--four and six days. This study was also conducted to determine the effect of daily warming for 30, 60, 90, 120, and 150 minutes for five of the six day storage period on initial weight, final weight, average daily gain, and gain to feed ratio of chicks from post peak Hubbard Classic broiler breeders.

Percent fertile hatchability, total hatchability, early dead, late dead, and total embryonic mortality were not affected by any of the daily warming treatments during either of the storage periods. Percent mid-dead were reduced by daily warming for 60, 90, and 150 minutes when compared to 30 minutes of warming during the four days of storage. Average hatch time was not affected by any daily warming treatments during four or six days of storage. Initial weight, final weight, average daily gain, and gain to feed ratio was not affected by daily warming treatments.

## **CONCLUSIONS**

Daily warming during the storage period did not have a beneficial or detrimental affect on fertile hatchability of eggs stored for four or six days. Daily warming for 60 minutes during the four day storage period increased mid-dead when compared to other daily warming treatments. However, daily warming during the four day storage period did not affect other stages of embryonic development. All stages of embryonic mortality were not affected by daily warming during the six day storage period. Hatch time was not affected by daily warming during four or six days of storage. Growth performance of male broilers raised for 13 days was not affected by daily warming during six days of storage.

These results contradict the current management practice of immediately placing hatching eggs in a cooler and not altering the temperature during the storage period. During both storage periods it was observed that eggs could be warmed 150 minutes a day without affecting hatchability. It may be possible to save cost on transportation from the farm to the hatchery by eliminating refrigerated trucks.

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## APPENDIX: SUPPLEMENT DATA

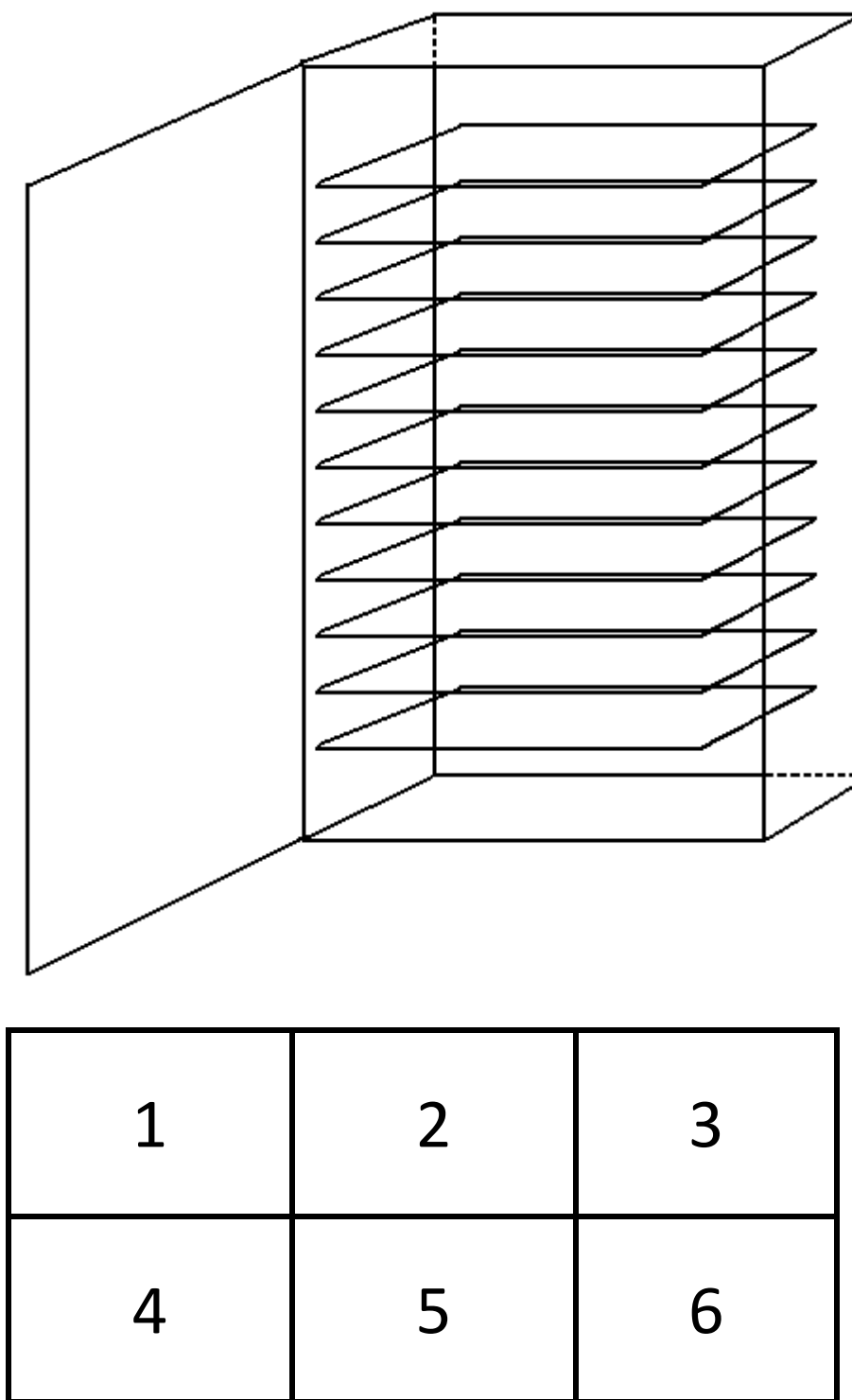


Figure A1. Natureform setter #2000 showing eleven levels, and position of experimental eggs within a level. (Wiggins, 2008)

Table A1. Temperatures recorded by a Tinytag DataLogger© thermometer during each trial.

3 Days of Warming	Operating Temperature	Temperature among eggs <sup>1</sup>	
		Mean	Maximum
------(C°)-----			
Trial 1			
Setter	37.5	38.5	38.7
Hatcher	37.0	38.0	38.9
Trial 2			
Setter	37.5	37.5	38.0
Hatcher	37.0	38.6	39.9
Trial 3			
Setter	37.5	38.5	38.7
Hatcher	37.0	37.6	38.1

<sup>1</sup>Tinytag DataLogger© temperature recorder was placed on level 5 in the setter and hatcher

Table A2. Temperatures recorded by a Tinytag DataLogger© thermometer during each trial.

6 Days of Warming	Operating Temperature	Temperature among eggs <sup>1</sup>	
		Mean	Maximum
------(C°)-----			
Trial 4			
Setter	37.5	38.5	38.4
Hatcher	37.0	38.0	39.1
Trial 5			
Setter	37.5	37.9	38.1
Hatcher	37.0	38.6	38.8
Trial 6			
Setter	37.5	38.5	38.7
Hatcher	37.0	37.6	38.1

<sup>1</sup> Tinytag DataLogger© temperature recorder was placed on level 5 in the setter and hatcher

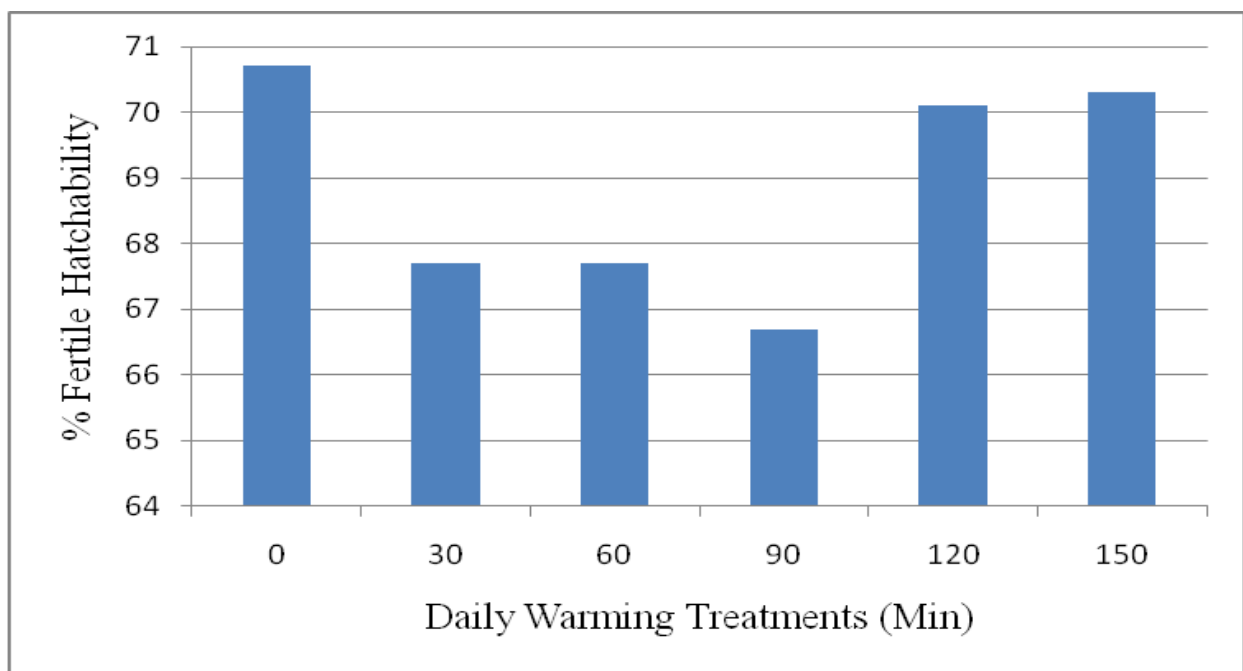


Figure A2. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on fertile hatchability using end of lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined). Pooled SEM = 1.08

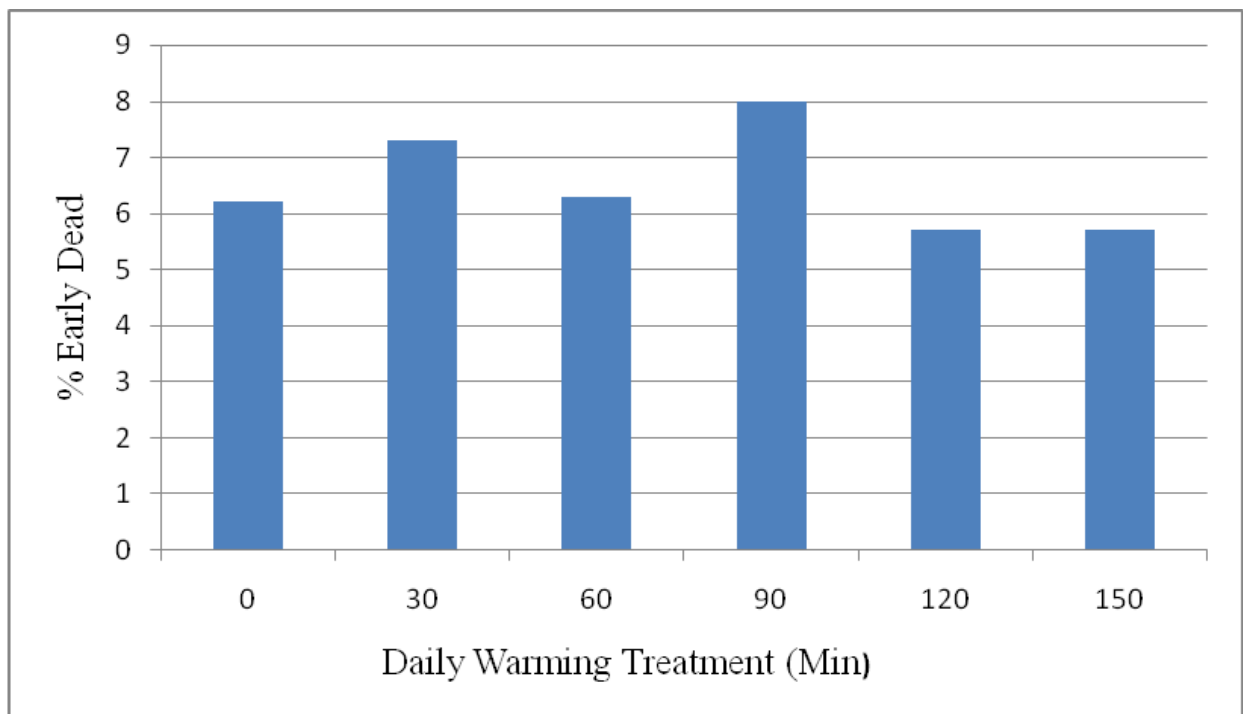


Figure A3. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on early dead using end of lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined). Pooled SEM = 0.452

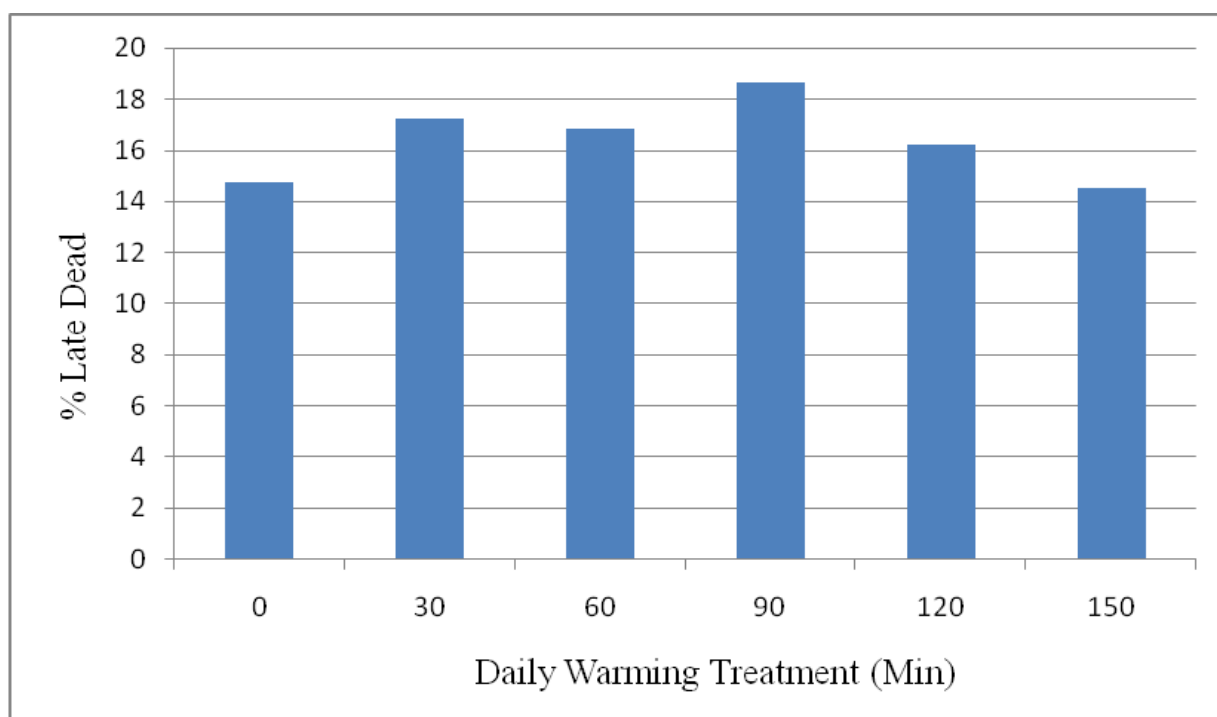


Figure A4. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on late dead using end of lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined). Pooled SEM = 0.768

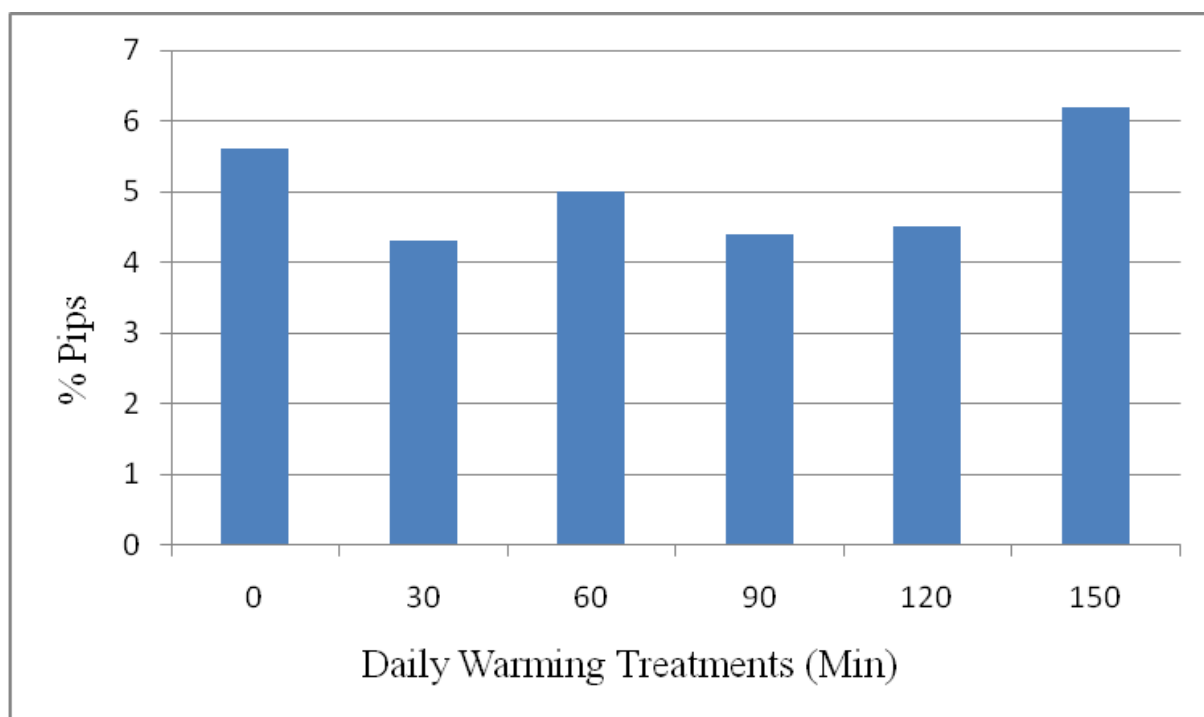


Figure A5. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on pips using end of lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined). Pooled SEM = 0.342

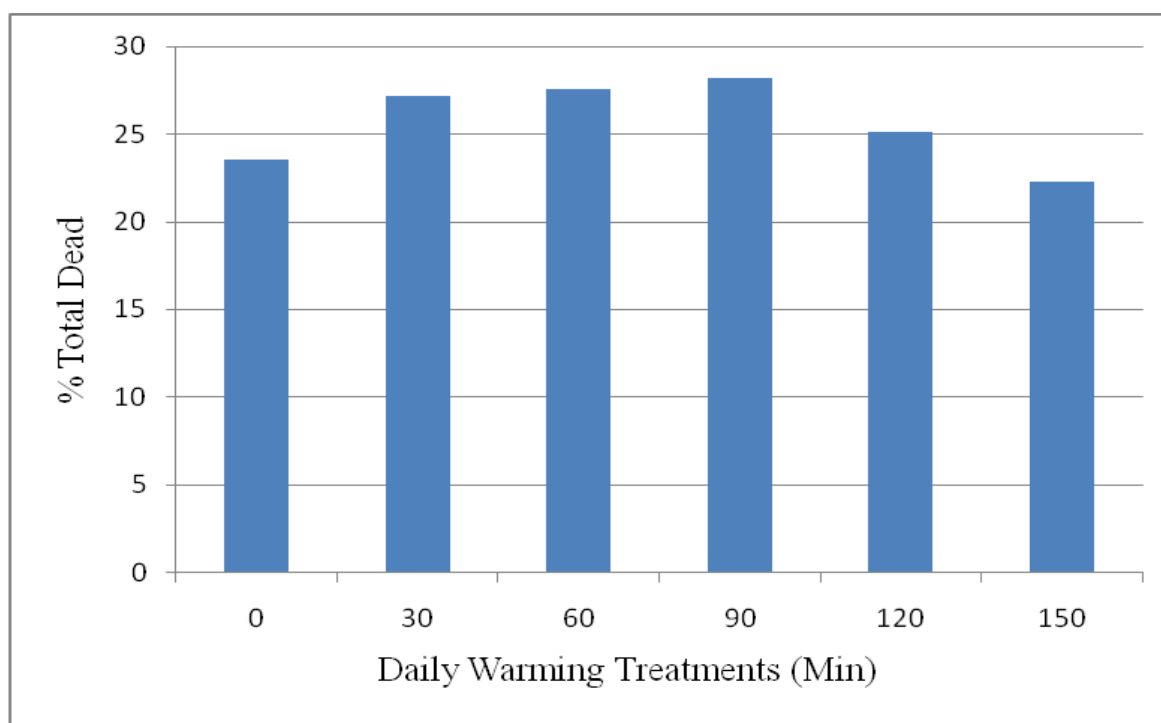


Figure A6. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during three of the four day storage period on total dead using end of lay Hubbard Classic broiler breeder eggs. (Trials 1, 2, and 3 combined). Pooled SEM = 1.02

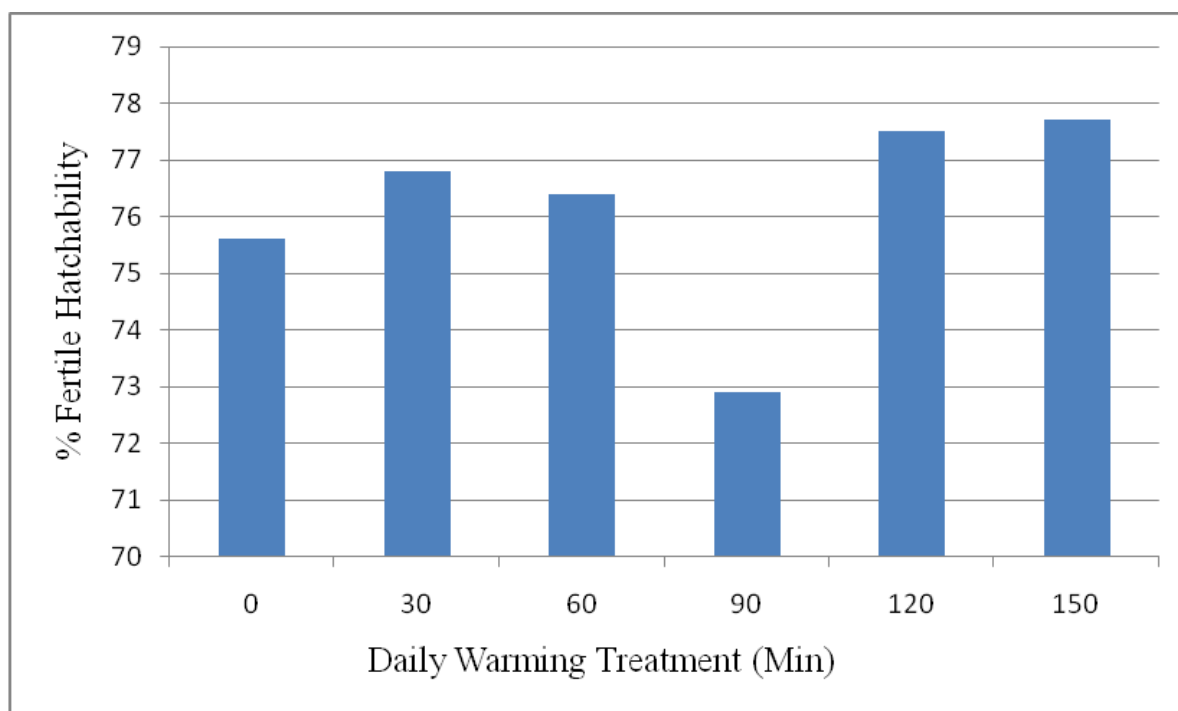


Figure A7. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on fertile hatchability using end of lay Hubbard Classic broiler breeder eggs. (Trials 4, 5, and 6 combined). Pooled SEM = 1.5

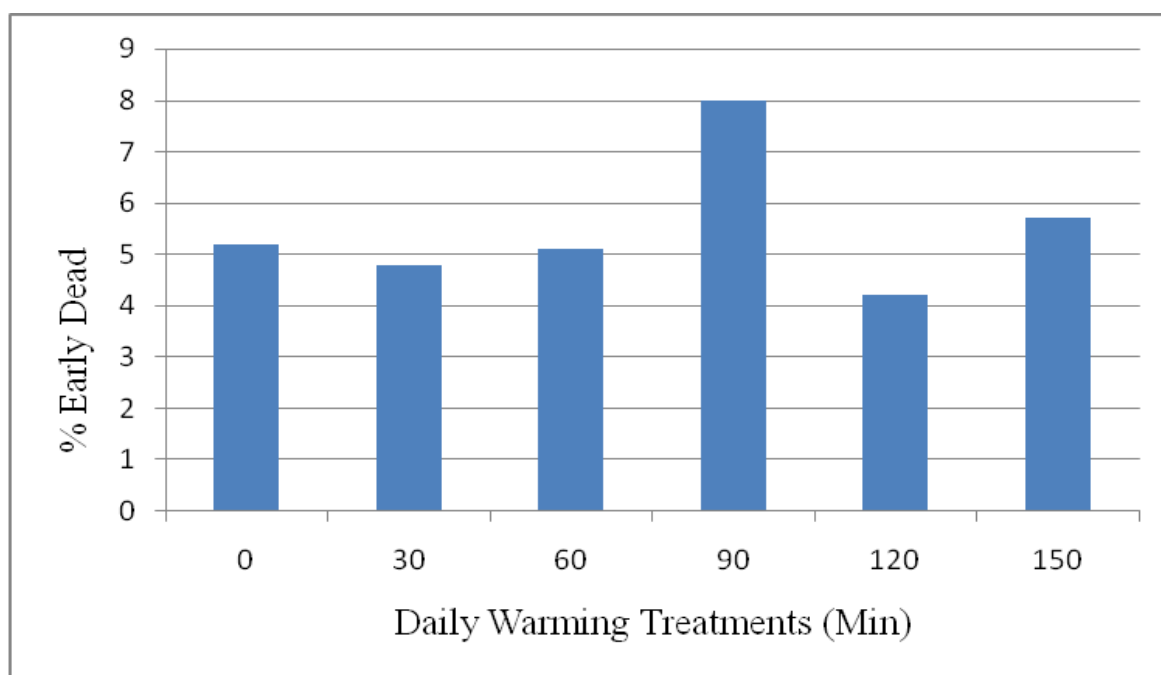


Figure A8. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on early dead using end of lay Hubbard Classic broiler breeder eggs. (Trials 4, 5, and 6 combined). Pooled SEM = 1.6

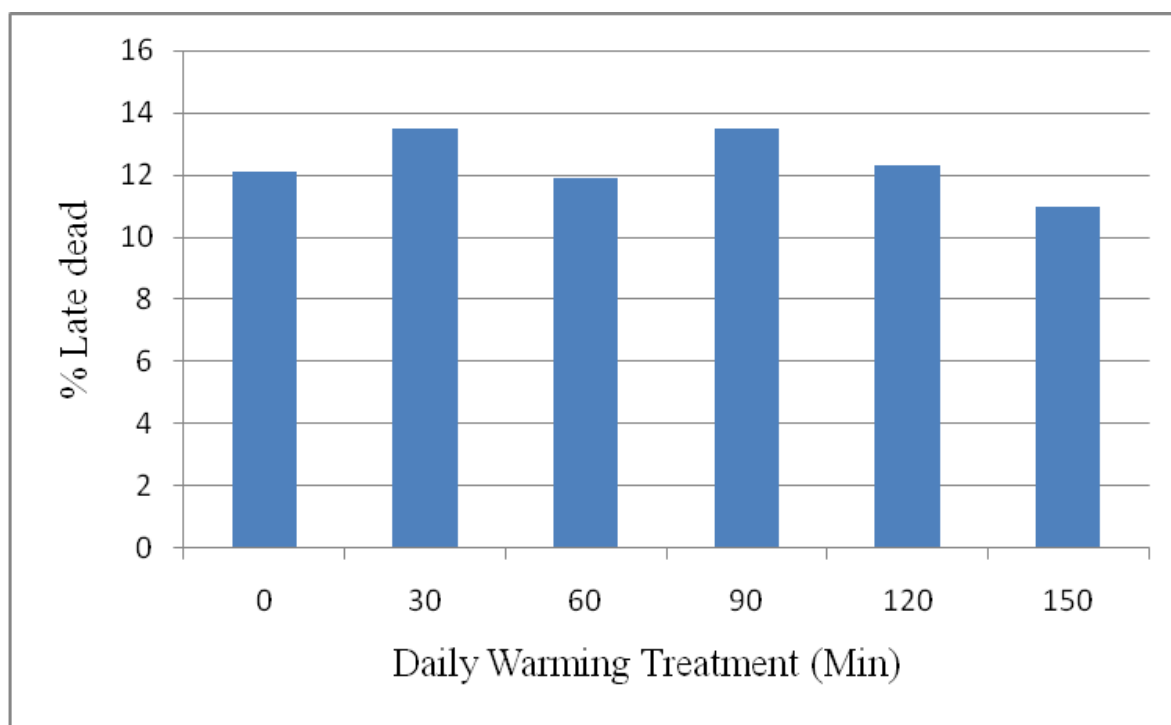


Figure A9. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on late dead using end of lay Hubbard Classic broiler breeder eggs. (Trials 4, 5, and 6 combined). Pooled SEM = 0.9



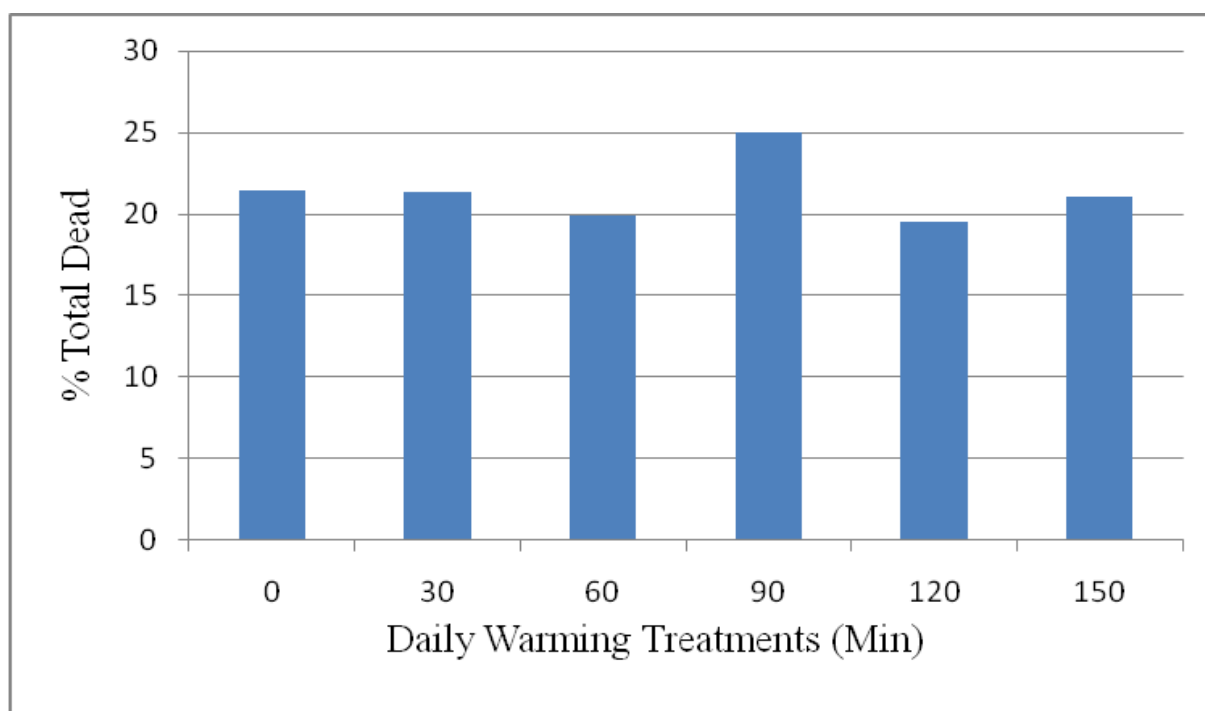


Figure A10. The effect of daily warming (0, 30, 60, 90, 120, and 150 minutes) during five of the six day storage period on total dead using end of lay Hubbard Classic broiler breeder eggs. (Trials 4, 5, and 6 combined). Pooled SEM = 1.4

## VITA

Jennifer Michelle Dowden was born in Leesville, Louisiana, in February of 1984. She is the oldest daughter of Chuck and Angie Dowden, and has a younger brother Trey. She attended Leesville High School where she was an active member in 4-H, Character Counts and danceline. While involved in 4-H, she was asked to be a member of the poultry judging team and compete at the state level. She placed third overall and was able to compete at the national level. After graduation, Jennifer attended Louisiana State University where she was an active member and Vice President in Kappa Alpha Theta sorority. As a freshman, she was asked to be a member of the Louisiana State University poultry judging team. Her sophomore year she was the overall high individual in the United States poultry and egg national judging contest held at Louisiana State University. Thereafter, she has been assistant teaching and coaching the poultry judging team. In December, 2006, she graduated from Louisiana State University with a bachelor's in animal, dairy, and poultry sciences. In 2007, she entered graduated school at Louisiana State University under the direction of Dr. Dennis Ingram. She is now a candidate for the degree of Master of Science in the combined department of animal, dairy, and poultry sciences.