4-29-1999

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A Thesis

Submitted to the faculty of
Louisiana State University and
Agricultural & Mechanical College
in partial fulfillment of the
requirements for graduation with
College Honors

in

Animal, Dairy, and Poultry Sciences

by

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Honors 3992
April 29, 1999

# Relationship of Egg Position During Incubation to Embryonic Growth and Mortality, Hatchability, and Chick Weight of Broiler Breeder Eggs

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**ABSTRACT** An experiment was conducted to study the effect of egg position during incubation on early embryonic growth and mortality, hatchability, and chick weight. Eggs were either incubated horizontal (FLAT) for 7, 10, 14, or 18 days before being reset large end up (LEU).

Results demonstrated that incubation position had no effect on 7 or 14-day embryonic weight, but significantly decreased early embryonic mortality. Hatchability was significantly greater among eggs set FLAT 7 days, while significantly lower among eggs incubated FLAT for periods longer than 10 days. Chick weight was not significantly affected by incubation position.

This study demonstrated that the FLAT egg incubation position used during the early stages of incubation (7-10 days) can decrease early embryonic mortality and increase hatchability, but use of the FLAT position during the latter stages (10-18 days) of incubation will result in decreased hatchability.

## INTRODUCTION

During natural incubation, where, in most cases, the hen acts as the incubator, eggs are incubated in a relatively horizontal position. Today, the large-end up (LEU) position is used exclusively during artificial incubation, due to its performance in hatchability over other incubation positions. However, during the early development of artificial incubation, the horizontal (FLAT) position of hatching eggs was recommended (Wood, 1905). Normally, the embryo is situated with its body parallel to the long axis of the egg with its head in the large end, beak under the right wing and toward the air cell. Several well-defined deviations from the normal position, referred to as malpositions have been established for uniformity. More complete descriptions of these malpositions, data on their frequencies, and discussions concerning their relation to embryonic mortality have been given by Sanctuary (1925) and Hutt (1929). Byerly and Olsen (1931) found that eggs incubated LEU gave a greater proportion of chicks in Malposition III (beak under left wing) than was given by eggs incubated FLAT. Byerly *et al.* (1938) incubated turkey eggs LEU for 12 days, then reset treatments of them FLAT at 12, 15, 18, 21, 24, and 25 days of incubation. Those reset FLAT prior to 24 days of incubation had greater hatchability. However, Eycleshymer (1907) demonstrated that eggs incubated in the oblique position produced a superior hatch to that obtained when eggs were incubated FLAT. Also, Funk and Forward (1960) found that hatchability is greater when eggs are incubated in the LEU position, compared to those incubated FLAT.

Most research on incubation since has focused on the LEU position versus the SEU position due to the frequent occurrence of eggs inadvertently set SEU in commercial

hatcheries. Benoff and Renden (1980) reported that embryonic mortality during the first 10 days of incubation was significantly lower in eggs set SEU, but higher during the latter incubation period when compared with those set LEU. However, El-Ibiary *et al.* (1966), Cain and Abbott (1971), and Takeshita and McDaniel (1982), found no such effect on early embryonic mortality. Bauer *et al.* (1989) found that hatchability of eggs incubated SEU was 16 to 27% lower than for eggs set LEU, and that the SEU position produced more non-viable chicks. Talmadge (1977) incubated eggs SEU for 8, 9, 10, and 17 days before turning them LEU. Chick embryos set SEU for 8 days hatched normally, with head in the broad end. A significant number of embryos incubated SEU for 9, 10, and 17 days became locked in Malposition II (head in small end of egg).

Takeshita and McDaniel (1980) showed that eggs incubated in the SEU position exhibited significantly lower hatchability and chick weights than those incubated LEU or FLAT. Eggs incubated in either the SEU or FLAT position exhibited pips earlier and lost less weight during incubation than those incubated LEU. In 1982, Takeshita and McDaniel found that eggs incubated in the FLAT position had consistently heavier 7-day embryo weights, as well as an earlier appearance of the pipping tooth indicating a more advanced anatomical state of development than those in the SEU and LEU positions. Also, eggs incubated FLAT resulted in significantly earlier pips than in the LEU position, indicating that incubation in the FLAT position not only facilitated superior embryonic development during early stages of incubation, but also toward the end. Chicks from eggs in the FLAT and SEU positions required less time to exhibit initial pips, but required more time to emerge from the shell and had a significantly greater number of initial pips away from the air cell. This demonstrated that the FLAT egg position resulted in the greatest embryonic development during the early stages of incubation but produced no advantage over the other egg positions at hatch.

Since FLAT is the position utilized during natural incubation, and based on the research of Takeshita and McDaniel that there is significance in embryonic growth of eggs incubated FLAT, work relating to this incubation position was necessary. The primary objective of the present study was to determine whether the FLAT position, used during the early stages of incubation, in combination with the traditional LEU position during the latter stages of incubation, significantly affected hatchability, embryonic growth and mortality, and chick weight.

## MATERIALS AND METHODS

Seven hundred twenty Ross X Avian Farms broiler breeder eggs were randomly divided into 5 treatments, consisting of 144 eggs each. Each egg was then numbered on the large end (1-720), and weighed on a Mettler PE12 scale. Eggs were then placed in setting trays, in the following treatments: 1) LEU for 18 days, serving as the control; 2) FLAT for 18 days; 3) FLAT until Day 14, then LEU; 4) FLAT until Day 10, then LEU; and 5) FLAT until Day 7, then LEU (Table 1). Setting trays were placed in a Robbins model 14I setter. The setter temperature was maintained at 37.5 degrees C with 60% relative humidity, and monitored daily.

TABLE 1. Initial Incubation positions and day reset LEU per treatment.

| Treatment | Initial Position | Day Reset LEU |
|---|---|---|
| LEU | LEU | N/A |
| FLAT 18 | FLAT | N/A |
| FLAT 14 | FLAT | 14 |
| FLAT 10 | FLAT | 10 |
| FLAT 7 | FLAT | 7 |

On Day 7, fertility was determined by candling for viable embryos. Eggs with apparently nonviable embryos were opened and examined macroscopically for evidence of embryonic development. Twelve eggs were randomly selected from each treatment, and viable embryos removed, excess moisture blotted using a wet paper-towel, and weighed on a Mettler AE100 scale.

On Day 14, eggs were candled for viability, and all dead embryos removed, opened, and day of death determined. Twelve eggs were randomly selected from each treatment, and viable embryos removed, blotted using a wet paper-towel, and weighed on a Mettler AE100 scale.

On Day 18, all eggs were transferred into pedigree baskets, in the conventional FLAT position, and trays placed in a Robbins H10 hatcher. Eggs were maintained at 36.9 degrees C with 80% relative humidity for the remaining 3 days.

On Day 21, all eggs and chicks were pulled, and each chick weighed on a Mettler PE12 scale. All pipped and unhatched eggs were opened to determine if malpositions were present.

The data were collected, and statistical analysis was performed using the Statistical Analysis System. When significant treatment effects were found, the means were separated using Duncan's Multiple Range Test (SAS, Barr *et al.*, 1985). All weight data were analyzed using ANOCOVA with egg weight as the covariate. All other data were analyzed using ANOVA (Ott, 1993).

## RESULTS AND DISCUSSION

The means for all fertility and hatchability data are given in Table 2. There was no significant difference in fertility among treatments. Percentage of fertile dead was significantly lower in FLAT 18 eggs (2.5%), when compared to the controls (7.5%). Fertile hatchability was significantly greater among FLAT 7 eggs, (81.7%), when compared to FLAT 14 and FLAT 18 eggs, (74.7 and 72.1%, respectively). Total hatchability was not significantly different among treatments. Percentage of unhatched eggs at Day 21 was significantly greater in FLAT 18 eggs (19.7%), when compared to FLAT 14 eggs (8.3%). There was no significant percentage difference in number of pipped eggs at Day 21 among treatments.

TABLE 2. Effect of incubation position on fertility and hatchability.

| Treatment | Fertility (%) | Fertile Dead (%) | Fertile Hatch (%) | Total Hatch (%) | Eggs (%) | Pips (%) |
|---|---|---|---|---|---|---|
| LEU | 93.1 a | 7.5 a | 77.2 ab | 71.4 a | 13.3 ab | 0.8 a |
| FLAT 18 | 95.0 a | 2.5 b | 72.1 b | 68.6 a | 19.7 a | 4.2 a |
| FLAT 14 | 94.1 a | 3.4 ab | 74.7 b | 70.6 a | 8.3 b | 11.7 a |
| FLAT 10 | 93.2 a | 5.0 ab | 77.9 ab | 72.3 a | 11.7 ab | 4.2 a |
| FLAT 7 | 91.6 a | 3.3 ab | 81.7 a | 74.8 a | 11.8 ab | 1.7 a |
| **p>F** | **0.84** | **0.01** | **0.059** | **0.11** | **0.05** | **0.55** |

*a,b Means within a column with different letters are significantly different.

Mean embryo and chick weight data are given in Table 3. There was no significant difference in initial egg weights. Embryo weights showed no significant differences among the treatments, either at Day 7 or Day 14. Chick weight was significantly greatest among the LEU eggs and those set FLAT 18, 14, and 7. Only eggs set FLAT 10 days decreased significantly in chick weight when compared to the control.

TABLE 3. Effect of incubation position on embryo and chick weight.

| Treatment | Egg Weight (g) | Day 7 Embryo Weight (g) | Day 14 Embryo Weight (g) | Chick Weight (g) |
|---|---|---|---|---|
| LEU | 67.4 | 0.821 | 14.1 | 45.3 a |
| FLAT 18 | 68.2 | 0.828 | 13.87 | 45.7 a |
| FLAT 14 | 67.4 | 0.827 | 14.3 | 44.5 ab |
| FLAT 10 | 66.8 | 0.767 | 14.19 | 43.2 b |
| FLAT 7 | 66.9 | 0.825 | 14.86 | 44.5 ab |
| **p>F** | **0.26** | **0.6** | **0.37** | **0.0017** |

*a,b Means within a column with different letters are significantly different.

Mean malposition data are given in Table 4. Malpositions at hatch were not significantly different among treatments, including percentage of total abnormal, Malposition I, Malposition II, and Malposition III.

TABLE 4. Percentage of total abnormal, Malpositions I, II, and III of unhatched and pipped eggs at Day 21.

| Treatment | Total Abnormal (%) | Malposition I | II | III |
|---|---|---|---|---|
| LEU | 2.9 | 0.8 | 0 | 2.1 |
| FLAT 18 | 7.9 | 0 | 7.1 | 0.8 |
| FLAT 14 | 10.7 | 0.8 | 8.9 | 0.9 |
| FLAT 10 | 4.4 | 0 | 1.8 | 2.6 |
| FLAT 7 | 4.3 | 1.8 | 0 | 2.5 |
| **P>f** | **0.93** | **0.73** | **0.95** | **0.62** |

The fact that embryonic weight was not significantly different among the treatments, either at 7 or 14 days of embryonic growth is inconsistent with results found by Takeshita and McDaniel (1982). This indicates that incubation positions may have varying effects on the embryonic growth of different strains of broilers. Since chick weight was not significantly different between eggs set LEU and those set FLAT 18, these results indicate that incubation position has no effect on chick weight, since the two extreme incubation positions exhibited similar mean weights at Day 21. This is consistent with what Takeshita and McDaniel concluded (1982). Percentage of fertile dead was significantly higher in eggs set LEU, when compared to those set FLAT, indicating that the FLAT position has a positive effect on the survivability of the embryo during the first 7 days of

incubation. In addition, fertile hatchability was significantly greater among FLAT 7 eggs when compared to FLAT 14 and FLAT 18 eggs, indicating that the FLAT position used during the early stages of incubation (7-10 days) may increase hatchability, but past this time period will likely produce significant negative effects on hatchability. These results are bolstered by the fact that the percentage of eggs on Day 21 was significantly greater among FLAT 18 eggs when compared to FLAT 14 eggs.

These results indicate that the FLAT position used during the first 7-10 days of incubation, in conjunction with LEU position used during the remaining incubation period decreases early embryonic mortality and improves hatchability. However, more research needs to be done to ascertain the relationship of egg position during incubation with embryonic development. In addition, extensive research must be conducted to ascertain the economic significance of these improvements in hatchability on industry production, since this alteration in the artificial incubation process would require a complete restructuring of commercial hatcheries and related equipment.

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