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The Effects of Egg Positioning on Broiler Breeder Eggs During Incubation on Hatchability and Chick Weight

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Abstract

In this experiment, two trials were conducted testing the relationship between egg positioning during incubation and hatchability and the relationship between egg positioning during incubation and chick weight. The experiment tested the effects on the hatchability and chick weight of broiler breeders when setting eggs large end up versus setting eggs on their side during the incubation period. Neither trial showed a statistically significant difference in hatchability or chick weight when eggs were set horizontally as opposed to setting them large end up. The results of this experiment are contrary to those of earlier and recent experiments that found that setting eggs horizontally reduced both hatchability and chick vitality.

Introduction

The effects of egg orientation during the incubation process on chick hatchability have been investigated numerous times through numerous studies. Ideally, both in nature and in a commercial setting, the egg is incubated with the large end up, allowing for the embryo's head to have access to the air cell. This results in proper pipping position during the final days of incubation, allowing the chick to emerge from the large opening created by the air cell (Parkhurst and Mountney, 1988). Incubating eggs in other positions, most notably small end up or horizontally, often results in embryonic malpositions and decreased hatchability (Byerley and Olsen, 1936).

The history of egg incubation dates back thousands of years to the ancient Chinese. This civilization developed the first artificial incubation process using a barrel shaped device made of mud and heated by charcoal. In this process the eggs were turned and rotated by hand. The Egyptians furthered this process of artificial incubation by creating large brick incubators heated by fires in the same room. These enormous early incubators held up to 90,000 eggs, quite a feat for a civilization thousands of years old. These incubators were operated on a toll basis for growers. For every three eggs brought in, the depositor was given three chicks (Parkhurst and Mountney, 1988). These ancient incubator models were further developed over thousands of years and have become what large commercial operators use today to incubate millions of eggs.

Modern research done under natural conditions has shown that a hen may turn and move the egg up to 96 times in a 24 hour period (Landauer, 1967). The bowl shape of the natural nest assists the hen in the incubation process by helping to keep the egg slightly elevated with the large end up (Parkhurst and Mountney, 1988). In commercial

settings research has shown that hatcheries must mimic the natural process of egg turning and positioning in order to maintain acceptable hatchability. Thus, in modern commercial hatcheries, eggs are ideally set with the large end up and rotated several times a day. Commercial incubation procedures have yielded an 87% total hatchability rate for standard meat-type breeder hens, like those used in this experiment (North and Bell, 1990).

Despite the enormous amounts of studies and experiments done on egg orientation in the past, especially during the 1930's, interest in the topic has been renewed due to new, innovative processes that involve puncturing the shell of the egg. Modern techniques such including transgenics and adding substances to the embryo involve the penetration of the egg using needles, resulting in a punctured egg shell. Many methods to seal this hole have been used including putting porfrin, tape and wax over the hole. These methods have proved unreliable and have resulted in many leaky or otherwise unacceptable eggs. Many researchers have found the only way to insure that a punctured egg will not leak is to turn it on its side or put the egg in an otherwise unsuitable position. Thus, many of these eggs have been set horizontally or with the small end up.

If studies can show that there is little or no effect on hatchability and chick quality by setting eggs in alternative positions, then modern techniques that require alternative incubation positions may become viable for commercial operations. Understanding the effects of these orientations on hatchability then becomes essential in understanding the new studies themselves and their viability in commercial settings.

Literature Review

Eggs Set Small-End-Up Versus Those Set Large End Up

Studies conducted setting eggs small-end-up (SEU) with a control of eggs set large-end-up (LEU) have shown that hatchability is reduced considerably in the eggs set SEU. Fasenko, et. al. (2000) showed in the most recent study done that in eggs set SEU hatchability fell 7 percent from the ideal hatchability exhibited by LEU set eggs. (Eggs set SEU showed 86.2% hatchability while those set LEU showed 93.2% hatchability). The study also concluded that setting eggs SEU resulted in increased mortality duing the period of 15-21 days of incubation, increased numbers of embryos that had not externally pipped, increased numbers of upside down embryos that had pipped, and an increased number of chicks culled due to naval problems. Thus, the study concluded that hatchability as well as chick quality were lowered considerably when eggs were placed small-end-up as opposed to large-end-up.

Eggs Set Horizontally Versus Those Set Large End Up

The effects of setting eggs horizontally or on their side show the same effects on lowering chick hatchability and decreasing chick vitality as setting them SEU. However, studies show that the effects are not as detrimental when eggs are set horizontally. Like eggs set SEU, horizontally placed eggs do exhibit an increase in the number of upside down embryos (Hutt and Pilkey, 1934). However, further research shows that this increase is not as great in horizontally incubated eggs as in those set SEU (Byerly and Olsen, 1931,1932,1933). Embryonic malpositions that occur most frequently when eggs

are set horizontally are upside down embryos and embryos with the beak away from the air cell (Byerly and Olsen, 1936 #3).

Embryonic Malpostitions and Their Effects on Hatchability

Eggs oriented in positions other than large-end-up effect hatchablity negatively because the embryos inside the disoriented eggs often exhibit embryonic malposition. According to Byerley and Olsen (1936) approximately one-fourth of all fertile eggs that fail to hatch are a result of embryonic malpositions. In this study, six different malpositions were studied and the lethality of each were determined. Of the two malpositions most noted in eggs set horizontally and small-end-up, being embryos with the head in the small end (malposition II) and those with the head away from the air cell (malposition IV), the one considered most lethal is malposition IV. Thus, the effects of an embryo oriented away from the air cell seems more lethal that the effects of an embryo oriented upside down.

Embryonic Malpositions, the Air Cell and Respiration

The outer layer of the egg shell contains many funnel-shaped pores formed by incomplete calcium crystallization. These pores allow for the exchange of oxygen, carbon dioxide and water and are vital to the respiration of the embryo (Johnson, 2000). These pores are more frequent in the external area above the air cell. Thus, more gas and water exchange occurs in this area than in the rest of the egg. This is the reason for the need of the embryo to be properly positioned during incubation with the head toward the

air cell. As noted above, this positioning also helps with the hatching process as the chick can exit the shell through the largest and easiest opening.

Most literature on the subjects of egg positioning during incubation, embryonic malpositioning and the effects of these on hatchability is found in publications from the 1930's when commercial incubators were in the early development and production stages. This research was conducted in order to develop the ideal machine that would efficiently mimic the natural process of incubation by a laying hen. These studies found that incubating an egg large end up was the ideal positioning for an incubating egg. This experiment uses two modern variations of commercial incubators that call for the setting of eggs large end up. As noted above, new procedures being conducted on unhatched eggs may call for eggs to be incubated in positions other than large-end-up. Thus, the question becomes whether new machines should be developed that are better suited for incubating eggs in orientations other than large-end-up. Modern practices may make the uses of newly designed, non-traditional incubators a must for laboratories and commercial productions alike.

Materials and Methods

Trial One:

Experimental Design

In the first trial 60 Ross Broiler Breeder eggs were numbered and weighed to the nearest 0.1 gram on a Mettler scale (model BD 601). The eggs were then divided into two initial treatment groups of 30 eggs with each initial treatment group subdivided into three replications of 10 eggs. In total, 30 eggs were kept as a control group, meaning the eggs were set throughout incubation in the generally accepted ideal position of large-end-up (LEU). The remaining group of 30 eggs were set on their side in a horizontal position and were left in this position throughout incubation.

Incubation and Candling

The eggs were placed in numerical order in setting trays and were placed in their designated position into a Humidaire Barrel-type incubator at 37.5 degrees Centigrade and 60% humidity. After seven days of incubation, the setting trays were removed and the eggs were candled using a hand-held candling device. At this time, all infertile and dead embryos were removed from the setting trays and then broken out to confirm infertility. After candling, the eggs were returned to the incubator until the 18th day when they were transferred into pedigree baskets for hatch. Each egg was hand placed, in numerical order, into the pedigree baskets with a divider between each egg. These baskets were then placed into the 39.6 degree Centigrade and 75% humidity Natureform NOM-45 hatcher for the remaining time of incubation.

Hatch, Records and Data Computation

After 21 days of incubation the chicks were removed from the hatcher and weighed individually. Record was kept of the egg number, chick weight, and when an egg remained unhatched, the presence of an intact egg or a pip.

Spreadsheets were created noting egg number, initial egg weight, presence or absence of a hatched chick, and chick weight. Statistical analysis was performed using the Statistical Analysis System (SAS) using a randomized block design. An analysis of variance (ANOVA) was done at a probability level of .05.

Trial 2:

The second trial was almost identical to the first in its methods. The only difference was the number of eggs observed, the resulting division of treatment groups, and the make of the incubator used. The second trial incubated 360 Ross Broiler Breeder eggs. These eggs were initially divided into two groups of 180 per treatment. These two initial groups were then subdivided into six replications of 30 eggs per treatment. In this trial 180 eggs were kept as control while another 180 were set on their side as the horizontal experimental group. These eggs were incubated in a Natureform incubator for the same period and were candled identically to the first trial. Furthermore, the eggs of the second trial were broken out, transferred, and numbered as in the first trial. All statistical analysis was done using the same analysis systems as the first trial.

Results

Trial 1:

Mean egg weight for the LEU control group in Trial 1 was 58.3 g. The mean weight for the experimental group of eggs set horizontally was 58.2 g. The mean chick weight for the LEU group was 39.6 while the mean chick weight for those eggs place horizontally was 39.4 g. This resulted in a chick to egg weight ratio of .6785 in the LEU control group and .6771 in the experimental horizontally placed group. After statisitical analysis, egg weight, chick weight, and chick to egg weight ratio was shown not to be significantly affected by egg position during incubation in this trial (Table 1).

Table 1. Mean egg weight, chick weight, and the ratio of egg to chick weight of broiler breeder eggs as effected by egg position during incubation (Trial 1).

Treatment	Mean Egg Weight	Mean Chick Weight	Egg to Chick Weight Ratio
Eggs Set Large End Up	58.3	39.6	.6785
Eggs Set Horizontally	58.2	39.4	.6771
P>F	.89	.71	.77

Percent fertility for eggs set LEU was 91.7 while in the horizontally set eggs this value was 88.3. The percent unhatched eggs for the LEU group was 5.0 while this value was 6.7 for the horizontal group. Percent pipped eggs for the LEU group was 3.3 while this value was 1.2 for the horizontally placed group. Percent fertile hatched eggs for the LEU group was 90.9 while this value was 90.6 for the horizontal group. Finally, the percent total hatch for the LEU group was 83.3 while this value was 80.0 for the

horizontal group. Like the data for egg weight, chick weight and weight ratio above, after statisitical analysis fertility, percent unhatched eggs, percent pipped eggs, percent fertile hatch and percent total hatch was shown not to be significantly affected by egg position during incubation in this trial (Table 2).

Table 2. The percentage of fertile eggs, unhatched eggs, unhatched pipped eggs, fertile hatch, and total hatch for broiler breeder eggs as affected by egg positioning during incubation (Trial 1).

Treatment	% Fertile	% Unhatched Eggs	% Pip	% Fertile Hatch	% Total Hatch
Eggs Set Large End Up	91.7	5.0	3.3	90.9	83.3
Eggs Set Horizontally	88.3	6.7	1.2	90.6	80.0
P>F	.61	.84	.73	.84	.71

Trial 2:

The results of Trial 2 were almost identical to those of Trial 1 for the data for mean egg weight, mean chick weight, and egg to chick weight ratio. The eggs in Trial 2 weighed more than those used in Trial 1. However, the relationship between the values both with those set LEU and those set horizontally were the same. Furthermore, like in the first trial, after statisitical analysis egg weight, chick weight, and chick to egg weight ratio was shown not to be significantly affected by egg position during incubation in this trial (Table 3).

Table 3. Mean egg weight, chick weight, and the ratio of egg to chick weight of broiler breeder eggs as effected by egg position during incubation (Trial 2).

Treatment	**Mean Egg Weight**	**Mean Chick Weight**	**Egg to Chick Weight Ratio**
Eggs Set Large End Up	60.5	40.3	.6653
Eggs Set Horizontally	60.7	40.1	.6610
P>F	.73	.70	.71

The results of Trial 2 were equally identical to those of Trial 1 for the data for fertility, percent unhatched eggs, percent pipped eggs, percent fertile hatch and percent total hatch. Once again, after statisitical analysis fertility, percent unhatched eggs, percent pipped eggs, percent fertile hatch and percent total hatch was shown not to be significantly affected by egg position during incubation in this trial (Table 4.)

Table 4. The percentage of fertile eggs, unhatched eggs, unhatched pipped eggs, fertile hatch, and total hatch for broiler breeder eggs as affected by egg positioning during incubation (Trial 2).

Treatment	**% Fertile**	**% Unhatched Eggs**	**% Pip**	**% Fertile Hatch**	**% Total Hatch**
Eggs Set Large End Up	87.8	6.7	3.9	88.0	77.2
Eggs Set Horizontally	88.9	8.3	2.8	87.5	77.8
P>F	.65	.35	.41	.68	.69

Discussion

The results of this experiment are contrary to those earlier studies cited including Byerly and Olsen (1936). In both trials of this experiment setting the eggs in a horizontal position instead of the accepted ideal position of large end up had no effect on chick weight or hatchability. This is important in order to verify the viability of modern techniques discussed above that may call for the puncturing of the egg shell and therefore require the egg to be set horizontally during incubation to avoid leakage and contamination.

If the results of this experiment hold true for all eggs set horizontally during incubation, then experimental techniques such as transgenics could be made commercially viable. The lack of any statistically substantial effect on hatchability or chick weight by setting eggs in a horizontal position means that setting punctured eggs in this position should be just as practical an option for hatcheries as setting them LEU. Thus, modern techniques that require puncturing the egg can be performed, these eggs can be set on their side to avoid spillage and/or contamination, and there should be no statistically substantial effect on chick hatchability or chick weight.

Summary and Conclusion

The results of this experiment show that when eggs are incubated horizontally instead of large end up there is no significant difference in hatchability or chick weight. The results of this experiment are contrary to earlier findings that suggested that incubating eggs in any position but large end up does reduce hatchability and chick weight. Due to the discrepancy in these studies more research should be conducted on the subject. However, if the findings of this study hold true, then new techniques that may require eggs to be set on their side during incubation for contamination reasons should be conducted freely as there would be no effect on hatchability or chick weight.

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