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# The Effect of *In ovo* Glucose Injections on Hatchability, Chick Weight, and Subsequent Body Weight

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**Abstract** This experiment investigated the effect of *in ovo* glucose injections on the 19th day of incubation into the yolk sac of broiler chick embryos. Two trials were run. In the first trial, there were five different treatments: Non-inject (NI-1), water-inject ($H_2O$-1), 6.25 mg of glucose (low-1), 12.5 mg of glucose (med-1), and 25.0 mg of glucose (high-1). The results showed that the injection of low levels of glucose into chicken eggs on the 19th day of incubation has no significant effect on chick weight at week 1 or the ratio of egg weight to chick weight. However, statistically significant differences were found in chick weight as well as week 2 weight. From this trial we were able to ascertain that the lowest level of glucose had the highest hatchability among all groups and had the best chick weight among the glucose injected treatments. The lowest level of glucose seemed to have the best effect among the glucose injected treatments, but did not, however, have a more beneficial effect over either of the two controls.

In trial 2, there were five different treatments: Non-inject (NI-2), water-inject ($H_2O$-2), 1.5625 mg of glucose (low-2), 3.125 mg of glucose (med-2) , 6.25 mg of glucose (high-2). We found that 3.125 mg of glucose (med-2) had statistically significant higher weight in week 1 and week 2. Although week three didn't prove to be statistically significant, it still followed the same weight pattern of treatment 4 weighing the highest and the rest of the treatments falling in the order of treatment 5, treatment 3, treatment 2, and treatment 1. From the results of our experiment, we found that low level glucose injections into eggs at the 19th day of incubation significantly increases the weights of broiler chickens at week 1 and 2.

## Introduction

Today's growing poultry industry is becoming a highly competitive market, and only the strong survive. The industry is looking for new ways to grow larger chickens while keeping costs to a minimum. A low cost method that would increase performance would be of great interest to the poultry industry. Since glucose is the most basic source of energy for all living things, this research is being conducted to determine if *in ovo* glucose injection can actually influence hatchability and subsequent body weight.

The poultry industry has developed methods and machines to inject eggs with vaccines and an assortment of beneficial compounds. This is done to save time of vaccinations as well as the expense associated with further handling of the live chicks. This injection process that is now in use has been shown to be cost effective and does not adversely affect the hatching egg performance.

Research in the past has been done to determine the effect of automated injections on livability and growth of turkey poults (Robel and Christensen, 1994). This was a replication of a previous large investigation in the industry. Automated injections were shown to have no effect on livability or growth. The large scale injections of eggs is therefore a safe method of introducing beneficial compounds that would be beneficial to hatching egg performance.

During incubation, the embryo stores the traces of glucose found in the yolk and albumen as glycogen during the early part of incubation. The embryo depends on this buildup of glycogen

reserves during the prenatal period to serve as an energy resource. This reserve is depleted during the chick's emergence from its shell (Freeman and Manning, 1971; Freeman, 1969).

Moran and Reinhart (1981) investigated the effects of dipping eggs in a glucose solution. They divided hen eggs into three groups. One group served as the control while the others were dipped into a Spectam (3000 ppm) quaternary ammonia 500 ppm solution, containing 10% glucose for one group and none for the other. The researchers found that "an improvement in body weight appeared with the inclusion of glucose."

In another experiment by Moran, the effects of glucose intake after hatching was observed (Moran, 1989). While the control group received no glucose and were not handled, the experimental group received a .5-ml dose of 50% glucose in saline, either orally or by injection into the neck. Both the control and the group that was not administered glucose were further divided into two groups that were either brooded with feed and water or fasted. The poults that fasted lost weight, and glucose had no effect. However, in the group that was brooded, "Those poults given glucose had greater weight gains and feed consumption than controls."

Another study was done to determine the effects of varied energy allotments given to broiler breeder hens (Attia et al, 1995). This study determined that as energy allotments were decreased the percentage of hens that did not lay dramatically increased. This would seem to indicate that energy is essential to broiler breeders if they are to be productive.

Rosebrough (1979), et al found that chicks that consumed a 4% glucose solution had more liver and carcass glycogen. In addition, Rosebrough found that "Providing the chick with supplemental carbohydrates during the post-hatch period potentates the chicks ability to synthesize carcass and liver glycogen."

Because of depleted glycogen reserves in chick embryos during the prehatch period, resulting from the need for a high amount of energy during the hatching process, John et. al. (1988) considered it possible that supplementary glucose could enhance hatching success. The researchers dipped eggs in an antibiotic solution (spectinomycin 3,000 ppm), one group with 10% glucose and the other without. It was found that the glucose improved overall glycogen levels, leading to better hatchability.

This experiment aims to further investigate the benefits of *in ovo* glucose injection on hatchability, chick weight, and subsequent body weight. If a level of glucose was found that would be beneficial to the overall hatch or performance of the broiler, then it would be of great benefit to the poultry industry because a minute increase in hatchability or chick weight could mean millions of dollars to the industry. However, two things must be proven before this method would be put into place: 1) the solution injected must be cost-effective; and 2) A benefit to the birds must be shown. In this study we investigated the latter.

## Materials and Methods

<u>Trial 1</u>

Forty-two randomly selected fertile Arbor Acres broiler breeder eggs were used per treatment. The eggs were incubated in a Robbins 14-I incubator, transferred and treated at 19 days of

incubation, and hatched in a Robbins 14-I hatcher.

The eggs were weighed on day one of incubation on a Sauter Gmbh scale, and the weights were recorded. At day 19 of incubation the eggs were either injected with either a glucose solution, injected with water, or not injected (treated without engraving a hole) , as in the case of (H2O-1). An electric engraver was used to place a small indentation directly above the air cell as to not break the eggshell while injecting. A 1 ml syringe was used to place .1 ml of each level or treatment into the albumen of the egg. The hole was then sealed with paraffin wax.

Treatments 1 and 2 served as the controls with treatment 1 (NI-1) being the non-injected group and treatment 2 (H2O-1) being the water -injected group. Beginning with 25 mg dextrose (EM Science)/.1 ml, the amount of glucose injected was divided in half in each successive lower level as illustrated in Table 1.

Upon hatch, the chicks were weighed with a Sauter Gmbh scale and wing-banded. After hatch, the chicks were fed a standard corn/soybean starter ration *ad libitum* and placed in a brooder battery for grow-out. The chicks were then further weighed at the ends of weeks 1 and 2. The data were collected, analyzed by SAS, the variance was analyzed using ANOVA, and the means were separated using Duncan's Multiple Range Test.

Trial 1 Treatments

| | |
|---|---|
| Treatment 1 (NI-1) | non-inject |
| Treatment 2 (H2O-1) | .1 ml sterile H2O |
| Treatment 3 (high-1) | 25 mg glucose / .1 ml |
| Treatment 4 (med-1) | 12.5 mg glucose / .1 ml |
| Treatment 5 (low-1) | 6.25 mg glucose / .1 ml |

**Table 1**

Trial 2

Sixty randomly selected fertile Arbor Acres broiler breeder eggs were used per treatment. The eggs were weighed using a Sauter Gmbh Scale, marked, and placed into a Robbins 14-I Incubator on Day 1. The treatments were as follows: a non-inject control (NI-2); a water-injected sham control (H2O-2); the highest level at 6.25 mg of Dextrose (high-2); 3.125 mg level (med-2); and 1.5625 mg (low-2) (Table 2). The procedure stayed the same from trial 1 to trial 2 except that the birds were grown out to 3 weeks in trial 2 instead of 2 weeks in trial 1. The chicks were once again given a standard corn/soy starter ration *ad libitum*.

Trial 2 Treatments

| | |
|---|---|
| Treatment 1 (NI-2) | non-inject |
| Treatment 2 (H2O-2) | .1 ml sterile H2O |
| Treatment 3 (high-2) | 6.25 mg glucose / .1 ml |
| Treatment 4 (med-2) | 3.125 mg glucose / .1 ml |
| Treatment 5 (low-2) | 1.5625 mg glucose / .1 ml |

**Table 2**

**Results**

Trial 1

The data for chick weight proved to be statistically significant with a p value of .0448. These data showed (table 3) that the low-1 glucose injection had the highest chick weight among the glucose injected treatments in trial 1. However, med-1 had the highest weight at week 2 even though there was no statistical significance found for this data set. The lowest level, low-1, did have the highest hatchability (table 3). Data for week 1 weight and ratio of egg weight to chick weight were statistically insignificant and proved to be inconclusive in trial 1.

Trial 2

Significant data were found for the first and second weeks of growth. After one week (Table 4) med-2 chicks (3.125 mg-inject) weighed significantly more than NI-2 and H2O-2 chicks (non-injects and water), while high-2 chicks were significantly heavier than those of NI-2 but not H2O-2. At week 2, med-2 weights were again significantly higher than NI-2 and H2O-2 weights, and high-2 and low-2 chicks were significantly heavier than NI-2 but not H2O-2 (Table 4).

Hatchability, shown in Table 4, was 73.3%, 63.3%, 76.7%, 61.8%, and 63.3% for Treatments 1-5 respectively. In addition the mortality rates over the trial 2 were 16.7%, 13.3%, 6.7%, 6.7%, and 10.0% respectively for treatments 1-5 (Table 4). The data for chick weight at hatch and chick weight on the third week of growth were not significant. Upon hatch there was no difference in chick weight among the treatments (Table 4), and on the 3rd week of growth the only difference in chick weight was that Treatment 4 chicks were heavier than Treatment 1 chicks (Table 4).

The data indicate that mid range glucose injection positively affected chick weight on weeks 1 and 2. The sequence of mean weight for the treatments, running from heaviest to lightest, was med-2, high-2, low-2, H2O-2, and NI-2 for both weeks. At week 3, even though the data for it was not significant, the trend of a the previous two weeks prevailed: med-2, high-2, low-2, H2O-2, and NI-2.

## Discussion

Because glucose is the most basic form of energy for most living things, it would stand to reason that an infusion of glucose into a developing embryo would increase its performance. More precisely, a glucose injection should decrease the need for glycogen mobilization. When a chick hatches, the chick uses a large amount of energy-all of the blood glucose and most if not all of its liver and muscle glycogen stores. The addition of glucose to the developing embryo would allow for two important things: 1) the addition of glucose would give the chick more glucose to further build its glycogen stores and 2) the increased glucose would give the chick more readily available energy in the form of blood glucose so that the chick wouldn't need to use as much glycogen when emerging from the shell. If either of these two things are true, then this means that the chick can spend its first few days after hatch gaining weight and growing instead of restoring its glycogen reserves.

These data indicate that the key to a beneficial glucose injection seems to be a balance. The results of trial one indicated that low-1 was the most beneficial injection. We then decided to further reduce the amount that we injected. This further reduction showed that it was not the 6.25 mg that was the best but a level lower than that, namely 3.125 mg. It seems that this level is a good, but not yet perfect, balance between the harm that the glucose causes and the benefit that it brings.

The data seem to indicate that a higher level of glucose, at 6.25 and above was detrimental to the weight gain and hatchability. When high levels of glucose are injected into the albumen, one would suspect that a hypertonic situation is created outside of the chick's cells. This results in the movement of water out of the cell as the system strives toward equilibrium. Loss of water causes damage since water is necessary for cell function. This simple fact has emerged as being one

of the most, if not the most, important consideration in this research.

In trial 2, the higher level of glucose had the lowest weights. This would seem to indicate that the glycogen benefit was overcome by the damage caused by osmosis. Thus, the mid level seemed to find the balance that would give the highest performance. The low level could possibly have not given enough help to the chick's glycogen stores to give the best result and thus the extra energy that it needed.

Another positive result of glucose injections is a decrease in mortality rates. In trial 2, med-2 along with high-2 had the lowest mortality rate. Even low-2, the smallest glucose injection, had a lower mortality rate as compared to the control and water-injected groups.

There are a couple of reasons why further research is needed. First, med-2 chicks had the lowest hatchability and high-2 had the highest hatchability. An injection between 6.25 mg. and 3.125 mg. would seem to be best; further research would fine tune the level needed. Secondly, the weights were only taken for the first 3 weeks. The statistical difference nearly disappeared and was found to be statistically insignificant in week 3. A possibility could be that the chicks with depleted glycogen stores at hatching eventually catch up to the ones injected with glucose.

In conclusion, glucose injections into eggs can increase chick weights during at least the first 3 weeks and decrease mortality rates. Further research is needed to determine the amount of glucose to inject to maximize weight and hatchability while also minimizing mortality. If a productive concentration of glucose was to be found, the poultry industry would easily be able to use such a solution through the method already in use for vaccination and vitamin distribution.

Although these data would indicate small margins of deviation resulting from glucose injections, the large scale application of such information would prove quite significant. For example, in trial 1 the hatchability was 7% higher in low-1 when compared to NI-1. This may seem insignificant on a small scale, but in industry, a 7% increase in hatchability would mean millions upon millions of dollars of increased profit due to the increased hatchability alone. Therefore, if the profit resulting from the treatment would outweigh the expense of the glucose itself this treatment would be very beneficial to the industry.

## Trial 1, results

| | % Hatch | Chick wt. | Week 1 wt | Week 2 wt | egg wt:chick wt |
|---|---|---|---|---|---|
| **NI-1** | 83.3 | 45.66g (A) | 138.31g | 271.66g | .68 |
| **$H_2O$-1** | 83.3 | 42.81g (BC) | 139.93g | 269.59g | .64 |
| **high-1 (25 mg)** | 73.8 | 41.75g (C) | 138.19g | 267.04g | .64 |
| **med-1 (12.5 mg)** | 81.0 | 42.94g (BC) | 141.71g | 273.14g | .66 |
| **low-1 (6.25 mg)** | 90.5 | 44.80g (AB) | 137.93g | 265.59g | .67 |
| **p values** | | .0448 | .6336 | .7606 | .2427 |

**Table 3**

## Trial 2, results

| | % Hatch | % Mortality | Chick wt. | Week 1 wt | Week 2 wt | Week 3 wt |
|---|---|---|---|---|---|---|
| **NI-2** | 73.3 | 16.7 | 44.2g | 114.9g (C) | 270.5g (C) | 528.5g |
| **$H_2O$-2** | 63.3 | 13.3 | 44.0g | 115.9g (BC) | 272.2g (BC) | 536.3g |
| **high-2 (6.25 mg)** | 76.7 | 6.7 | 44.2g | 123.0g (ABC) | 290.4g (AB) | 538.5g |
| **med-2 (3.125 mg)** | 61.8 | 6.7 | 43.5g | 125.8g (A) | 297.9g (A) | 570.0g |
| **low-2 (1.5625 mg)** | 63.3 | 10 | 44.9g | 124.2g (AB) | 291.1g (AB) | 552.5g |
| | | **p values** | .4921 | .0340 | .0110 | .1788 |

**Table 4**

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