

Comparative Analysis of Temperature External and Internal and Relative Humidity of Electric Egg Incubator

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Abstract. This study aimed to determine the ratio of external and internal temperatures and the humidity of the electric egg incubator. This research was designed in three stages. The first stage is the manufacture of an egg incubator, followed by the testing and analysis stage. Based on the data from the measurement and analysis results, it was found that the temperature and humidity in the incubator greatly influenced the quality of the hatching of native chicken eggs. This study used an experimental method and was carried out twice. The first stage of testing and measurement data obtained an average external temperature of 28.5°C, internal 38.2°C, and the humidity of the air in the hatchery room was 56.0%. In contrast, the second stage of testing and measurement obtained data on an average outside temperature of 28.42°C, inside 38,0°C, and humidity in the hatchery room 56.0%. It can be concluded that the ratio of outside and inside temperatures in the incubator must be balanced until the 21st day of hatching. In this case, if the outside temperature rises, the temperature inside the incubator must decrease, with the same relative magnitude. Likewise, the humidity inside must have relatively the same ratio to obtain a perfect hatching process, which is between 50% - 60%.

Keywords: External and internal temperature, humidity, egg incubator

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INTRODUCTION

Egg incubators using light bulb heaters have been widely used both by industries on a small and large scale and by the general public. The success of hatching chicken eggs is strongly influenced by temperature and humidity, where a suitable temperature for hatching chicken eggs ranges from 36°C to 40°C, with a relative humidity between 50% and 60%. However, not all users of chicken egg incubators know very well about the temperature and humidity of the air by the eggs you want to hatch so that the hatching process runs well and naturally. However, to get an even temperature and good humidity for hatching, it is necessary to place a measured and even heat source in the hatchery room. Temperature and humidity are closely related to the heat changes that occur both inside and outside the incubator. The higher the temperature outside will significantly affect the temperature inside the incubator. Several literature studies have been carried out related to hatching chicken eggs, especially those outside and inside temperatures and humidity in the chicken egg incubator. The incubator's temperature and humidity must be stable to maintain the right conditions for the eggs during the hatching process. The eggs will hatch a lot if they are at temperatures between 36-40 ° C. The embryos are intolerant of drastic temperature changes.

The humidity in the incubator should be kept in the range of 50 - 60%. Very high temperature will cause the death of the embryo or abnormality of the origin, while humidity affects the embryo's expected growth. Changes in outside temperature and relative humidity in hatching free-range chicken eggs will significantly affect the egg hatching process, so research is needed to examine the influence of external and internal temperatures and relative humidity in an electric-powered egg incubator made of plywood with a thickness of 9 millimeters.

Hatching eggs

Birds species make efforts to maintain their population are by laying eggs. The eggs are then hatched, either naturally or artificially, to give birth to new individuals.

a. Types of artificial incubators.

The various incubators can be divided into two incubators based on how they are used, namely:

1). Conventional Hatch Tools.

The conventional hatchery is an incubator that uses a heat source from the sun with heat storage in husks. This tool has long been known in the community. History is said that egg incubators first used this tool in Bali, which then spread to various places.

2). Hatching Machine / Egg Incubator

This hatching machine is a medium in the form of a chest, cupboard, or box with construction so that the heat in it is not wasted. The temperature in the crate/cupboard/box can be adjusted based on the degree of heat needed during the hatching period. The working principle of hatching eggs with this hatching machine is the same as for the mother

poultry. The success of hatching eggs with a hatching machine will be achieved by following these treatments:

- The eggs are placed in the hatching machine in the right position.
- The heat (temperature) in the incubator room is always maintained as needed.
- Eggs are turned three times a day during the incubation process.
- The ventilation must be suitable for proper air circulation in the incubator.
- The humidity of the air in the hatching machine is always controlled so that it is suitable for developing the embryo in the egg.

By paying attention to these several treatments, incubating machines/incubators can be divided into several types as follows:

- 1). Based on the cause of the heat in the room.
 - Incubator with hot air.
 - Incubator with hot water.
- 2). Based on the source of the heating device.
 - Electric incubator (electric heater).
 - Incubator with an oil lamp.
 - Combined incubator (with electric heater and oil lamp).
- 3). Based on the way the air humidity is regulated.
 - Dry incubator (not equipped with a water bath).
 - Incubator with the wet method (fitted with a water bath).
- 4). Based on how to provide space for laying eggs.
 - Box-space type incubator (using one egg rack, limited eggs that can be hatched).
 - Cabinet space type incubator (uses multiple shelves to accommodate a large number of eggs).

Egg hatching conditions:

a. Temperature and Embryo Development

Embryos in poultry eggs will develop rapidly as long as the egg temperature is at the right conditions and will stop growing if the weather is less than required. The temperature required to hatch eggs for each bird is different. The temperature for embryo development in chicken eggs is between 38.33° - 40.55°C (101°-105°F), ducks 37.78° - 39.45° C (100° - 103° F), quail 39.5° C (102° F), and wattle 32,22° - 31° C (90-96° F). Before the eggs are put into the hatching box, the room temperature must be under what is needed.

b. Humidity.

During the hatching process, humidity is needed following the embryo's development and growth, such as temperature and humidity, typical for hatching eggs for each poultry type. The humidity at the beginning of hatching is different from the next days. Humidity for eggs at the start of hatching is around 52% -55% and before hatching about 60% -70%, ducks in the first week 70% and the next week 60% -65%, quail the first week 55% -70% then 65% and swallow 65% -70% each week [3].

c. Ventilation

In normal development, the embryo needs oxygen (O₂) and excretes carbon dioxide (CO₂) through the eggshell's pores. For this reason, in making egg incubators/hatching machines, it is necessary to pay attention to amount of sufficient oxygen in the box/room. If there is not enough oxygen in the box/room, there is a concern that the embryo will fail to develop. [3].

d. Egg Hatching Time.

Hatching eggs usually take about 20-23 days to hatch completely (healthy). The time-division can be described as follows: In the process of hatching chicken eggs with an incubator, it usually takes between 21-22 days with the following steps: The first day: In the morning, put the ready egg on the machine at an angle of about 40 °, the taper is below, and the blunt is above and closes the door meetings up to the 2nd day. Day 3: Turn the eggs three times a day in the morning, afternoon, and evening (Do not remove the eggs from the machine). Day 4: Open the ventilation ¼ part for 15 minutes to cool the eggs and then turn them. Day 5: Open the ½ part vent and start turning the eggs. Day 6: Open the vent ¾ part and turn the egg. Day 7: Turn the eggs over and open the vents entirely and start sorting the empty eggs. Day 14: Turn the eggs and sort the dead seeds again (Dead roots will show fluid or blood, while those alive will see branched spots). 8th to 13th: Turn eggs and chill. Day 15 to 17: Turn the eggs and cold. Day 18: Turn the eggs over and make sure the machine is still closed. Day 19: When the eggs start to crack, start adding humidity to the hatching machine by hanging a wet cloth around the eggs (Do not drip the heat delivery pipe). Day 20: When the eggs have started to hatch, cover the surveillance glass with black paper or cloth. Day 21: Remove the tub and fabric from the machine because the eggs have hatched. Day 22: Begin transferring the hatched chicks to the artificial broodstock.

Egg Incubators Thermostat

There are two types of thermostats commonly used in egg incubators: Capsule Thermostat and Digital Thermostat.

a. *Capsul /WaferThermostat*

The majority of egg incubators use this type of thermostat because it is very affordable (cheap) and easy to operate. This simple thermostat works electro-mechanically, which takes advantage of the principle of expansion of the ether liquid in a capsule. Figure 1 shows capsule as a black circular object. When the temperature starts heating up, the capsule will expand and press the microswitch (Limitswitch) to turn off the heating lamp. And conversely, when the temperature begins to cool down, the capsule will deflate and then trigger the microswitch to turn on the heating lamp again.



Figure 1. Capsule / WaferThermostat

To work at the desired temperature, setting this thermostat is very easy. Turn the screw slowly to adjust the distance between the capsule and the microswitch. If the capsule moves closer to the microswitch, the temperature will be set low, and vice versa. The temperature will be set high when the capsule starts moving away from the microswitch. For one capsule thermostat package consists of:

- Frame / standCapsules
- Microswitch (Limitswitch)
- Cable

b. Digital Thermostat

This thermostat is in the form of a module that works digitally with probe functions as a temperature sensor. The advantage of this thermostat is that it is equipped with a thermometer and can be used in heating or cooling mode, as shown in Figure 2. Below. Meanwhile, this egg incubator thermostat requires a 12 volt DC voltage from the adapter to activate it.



Figure 2. Digital Thermostat

1.1 Incandescent Lamps

a. Characteristics

This type of lamp is commonly called an incandescent lamp. The lamp will emit light when an electric current passes through the filament of the filament and then heats the filament. The manufacture of incandescent lamps is also based on several factors, namely the temperature of the filament, the gas mixture that is filled, efficacy (lm / W), and the lamp's life. The tungsten filament resistance will be higher if the temperature rises so that

the increase in voltage will increase resistance, which will also result in a slight increase in the current flowing. The filament resistance is approximately one-fourth of the average temperature state in cold conditions. One thing that needs to be considered in this incandescent lamp's characteristics is the effect of voltage changes on the light.

b. Work Principle

The incandescent lamp's working principle is to short circuit the carbon filament (C) so that a short circuit occurs, which results in heat. The heat that arises is made up to a specific temperature to give off light

c. Construction

This type of lamp is better known as the DOP lamp, including the light first invented by Tomas Alva Edison. The incandescent lamp consists of several main parts: the bulb, the base lamp, and the filament.

RESEARCH METHOD

This type of research is experimental research. Thus the data to be studied are data obtained from measurement results through laboratory experiments. The results of this study aim to get a broad picture of the ratio of outside and internal temperatures and relative humidity in the electric-powered egg incubator to obtain the maximum egg hatching process (all eggs are hatched). There are 2 variables used in this study, namely, temperature. Outside / inside and relative humidity in an electric-powered egg incubator. This study's data collection techniques are: The data to be used in this study are temperature and relative humidity data obtained directly through measurement results, and literature study is a technique used to obtain data or sources related to the topic under study. The data analysis technique used in this research is descriptive analysis, which analyzes the data by describing the data obtained from the measurement results in the laboratory through experiments.

RESULTS AND DISCUSSION

The research was conducted using a chicken egg incubator, where the incubator is made of 9 mm plywood. The box has size 30 x 40 cm with three incandescent lamps, each with 5 Watt power to hatch 50 eggs. Based on the research, the research results obtained are as follows: Table 1 to Table 4.

Table 1. Measurement Data Day-1

Time (hours)	Temperature (C°)		Humidity (%)
	Out	In	
7.00	26,5	36,5	79
8.00	27,1	36,8	75
9.00	28,1	37,8	70
10.00	29,0	38,5	62
11.00	29,9	38,8	61
12.00	30,4	38,8	62

13.00	30,7	39,0	58
14.00	30,9	39,0	60
15.00	30,9	38,5	55
16.00	31,0	39,0	56
17.00	30,0	39,0	58
18.00	30,1	39,0	60
19.00	29,9	39,0	64
20.00	29,5	39,0	66
21.00	29,1	39,0	67
22.00	28,8	39,0	68
23.00	28,0	39,0	69
24.00	27,8	38,5	70
1.00	27,0	38,5	71
2.00	26,8	37,5	72
3.00	26,0	37,0	73
4.00	25,8	36,0	73
5.00	25,7	36,0	74
6.00	25,5	36,0	74
Average	28,5	38,2	56

Table 2. Measurement Data Day-9

Time (hours)	Temperature (C°)		Humidity (%)
	Out	In	
7.00	26,1	36,3	78
8.00	26,9	36,5	74
9.00	27,1	37,2	70
10.00	28,8	38,1	61
11.00	29,0	38,4	62
12.00	30,0	38,7	61
13.00	30,5	39,0	58
14.00	30,7	39,1	57
15.00	30,8	38,3	55
16.00	30,9	39,0	56
17.00	30,0	39,1	58
18.00	30,1	39,0	59
19.00	29,5	38,8	62
20.00	29,5	38,8	64
21.00	29,0	38,9	66
22.00	28,5	38,9	67
23.00	28,0	39,0	68
24.00	27,3	38,5	69

1.00	27,0	38,5	70
2.00	26,4	37,1	71
3.00	26,1	37,0	72
4.00	25,5	36,1	72
5.00	25,1	36,0	73
6.00	25,0	35,9	74
Average	28,24	38,00	56,50

Table 3. Measurement Data Day-18

Time (Hours)	Temperature (C°)		Humidity (%)
	Out	In	
7.00	26,0	36,6	79
8.00	27,0	36,7	75
9.00	28,0	37,5	70
10.00	29,0	38,6	62
11.00	29,3	38,9	61
12.00	30,0	38,9	62
13.00	30,1	39,1	58
14.00	30,5	39,0	60
15.00	30,7	38,1	55
16.00	30,9	38,2	56
17.00	31,0	38,4	58
18.00	30,8	38,6	60
19.00	30,4	38,8	64
20.00	29,0	38,9	66
21.00	29,1	39,0	67
22.00	28,5	39,1	68
23.00	28,0	38,8	69
24.00	27,4	38,5	70
1.00	27,1	38,1	71
2.00	26,5	37,1	72
3.00	26,1	37,0	73
4.00	25,5	36,1	73
5.00	25,6	36,0	73
6.00	25,6	36,0	73
Rata-rata	28,42	38,00	56

Table 4. Average Measurement Temperature and Humidity

Temperature(C °)		Humidity (%)
Out	In	
28,38	38,5	55,8

This research was conducted using a unique chicken egg incubator with a capacity of 50 eggs per hatch. However, not all incubator users know very well about the temperature and humidity under the eggs they want to hatch so that the hatching process runs well and naturally. The success of hatching chicken eggs is strongly influenced by the temperature outside and inside and humidity. The right temperature for hatching chicken eggs ranges from 36°C to 40°C, with relative humidity ranging from 50% to 60%. However, to get an even temperature and good humidity for hatching, it is necessary to place a measured and even heat source in the hatchery room. Temperature and humidity are closely related to the heat changes that occur both inside and outside the incubator. The higher the temperature outside, of course, it dramatically affects the temperature inside the incubator. Several literature studies have been carried out related to hatching chicken eggs, especially about outside and inside temperatures and humidity in the chicken egg incubator. The incubator's temperature and humidity must be stable to maintain suitable conditions for the eggs during the hatching process. A high number of eggs will hatch if they are at temperatures between 36-40 ° C. The embryos are intolerant of drastic temperature changes. The humidity in the incubator should be kept at 56%. Too high a temperature will lead to embryo death or abnormalities of the embryo, while humidity affects the embryo's expected growth. According to Hartono (2010), the natural hatching temperature ranges from 37 ° C-38 ° C. Air humidity for chicken eggs at the beginning of hatching is about 50% -55% and before hatching around 55%-60%. In this study, the first thing to do was to make an egg incubator from 9 milli plywood and then test it by inserting ten free-range chicken eggs, where the theoretical time needed to hatch eggs is about 20-23 days to hatch perfectly (healthy). The division of time can be described as follows:

The first day: In the morning, put the ready egg on the machine at an angle of about 40 °, the taper is below, and the blunt is above and closes the door tightly until the 2nd day. Day 3: Eggs are turned three times a day in the morning, afternoon, and evening (Do not take the eggs out of the machine). Day 4: Open the ventilation ¼ part for 15 minutes to cool the eggs and then turn them. Day 5: Open the ½ part vent and start turning the eggs. Day 6: Open the vent ¾ part and turn the egg. Day 7: Turn the eggs over and open the vents entirely and start sorting the empty eggs. Day 14: Turn the eggs and sort the dead seeds again (Dead seeds will show fluid or blood, while those alive will see branched spots). 8th to 13th: Turn eggs and chill. Day 15 to 17: Turn the eggs and cold. Day 18: Turn the eggs over and make sure the machine is still closed. Day 19: The eggs begin to crack, and you have to increase the humidity of the hatching machine by adding more water to the cooling gutter under the egg

rack. Day 20: The eggs have hatched. Day 21: Eggs are removed from the incubator and transferred to an artificial broodstock.

Based on the hatching process above in this study, to obtain a perfect hatching process (all eggs can hatch) healthily and adequately, a stable temperature condition is also required. Namely, it obtained an average of 38.5 ° C and air humidity in the incubator. Eggs obtained an average of 55.8%. The egg incubator is given temperature and humidity in the incubator from the first day to the 21st day (hatching the eggs), namely the temperature of 38.5 ° C and humidity of 55.8%, where the temperature outside is an average of 28.38 ° C. The most crucial time that needs attention is when the hatching process enters the 17-18th day when this time requires a stable temperature and humidity so that the embryo (Dot) can hatch adequately and healthy. Suppose the temperature exceeds the theoretical limit (36-40 ° C). In that case, the embryo is easy to break the eggshell to come out, but the danger or impact is that it is easy to die from overheating, resulting in dehydration. Likewise, if the humidity exceeds the theoretical limit (55-60%), the embryo can die inside before leaving because the eggshell is too hard for the embryo to break. After all, it is too moist to make the shell hard (hard to crack). So a good and perfect hatching process is influenced by three main factors, namely: 1). Eggs must be good (healthy seeds), 2). The temperature must be stable (36-40 ° C), and 3). The humidity must also be stable (55-60%). Of course, to get good (healthy) eggs, you have to sort by knowing healthy eggs' characteristics.

CONCLUSION

Based on the research process, where this study tested (conducted two experiments), the first experiment was ten eggs, and the second was also ten eggs, the following conclusions were obtained:

1. To obtain a perfect hatching process (all eggs can hatch) healthily and adequately, a stable temperature condition is also needed; namely, an average of 38.5 ° C is obtained, and the humidity in the egg incubator is 55.8 %.
2. The egg incubator is given temperature and humidity in the incubator from day one to day 21 (hatching eggs), namely a temperature of 38.5 ° C and humidity of 55.8%, where the temperature outside is an average of 28.38 ° C. So the ratio (ratio) of temperature and humidity is acceptable according to the results.
3. That the hatching process enters the 17-18th day, where at this time, temperature and humidity are stable so that the embryo (dot) can hatch adequately and healthily. If the temperature exceeds the theoretical limit (36-40 ° C), the embryo is easy to break the eggshell to come out. Still, the danger or impact is that the embryo can quickly die from overheating, resulting in dehydration. Likewise, if the humidity exceeds the theoretical limit (55-60%), the embryo can die inside before leaving because the eggshell is too hard for the embryo to break. After all, it is too moist to make the shell hard (hard to crack).

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