PERFORMANCE EVALUATION AND MODIFICATION OF A KEROSENE FUELED TABLE INCUBATOR

B. A. ADEWUMI AND F. R. FALAYI
Agricultural Engineering Department, Federal University of Technology, Akure.
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ABSTRACT

A laboratory scale kerosene fueled incubator made of locally available materials was evaluated and modified in order to improve its performance. It has capacity for 30 eggs. The defects identified with the incubator during the initial tests were rectified and the incubator was modified. The original design operated within a temperature and relative humidity range of 36.8 - 38.3°C and 56.5 - 66.5% respectively and had an average percentage hatchability of 75% for domestic fowl eggs. The modified incubator had an average percentage hatchability of 88.4% and operates within a temperature and relative humidity range of 37.0° - 38.0°C and 58.0 - 70.0% respectively. The percentage hatchability of the original design compares favourably with the various types of commercial incubators found in literature while the modified incubator performed better. The incubator is recommended for small scale chick production in the tropical region and could be enlarged for medium/large scale chick production.

Keywords: Egg, Chick, Incubator, Hatchability, Temperature, Relative Humidity

INTRODUCTION

Incubation essentially is the management of fertilized eggs to ensure the satisfactory development of embryo to normal chicks (Oluyemi and Robert, 1979). Artificial incubation is possible in birds since the fertilised ovum does not have a physical connection with the mother and embryo development occurs outside the body of the mother, unlike in mammals. Embryonic developmentof chicks include the pre-oviposition and post-oviposition developments. The former starts much earlier than the egg is laid and it includes the blastocyst and gastrula stages (Singh, 1990). However, the major embryonic developments take place during the post oviposition after the egg is laid.

A number of biological factors are identified to affect the hatchability of eggs. These factors include egg fertility, storage condition, egg size, nutrition of dam, condition of egg shell and genetic constitution (Leenstra and Pit, 1987; Labisky and Jackson, 1969; Hinkson *et al*, 1970; March and Macmillian, 1990; Siegal and Dunmination, 1987; and Scragg *et al*, 1987). The environmental factors that equally affect egg hatchability include incubation temperature, relative humidity, ventilation, and heat source (Deuypere, 1979; Barrott, 1937; Landaver, 1967; Geer and Tanghe, 1937; and Ralph, 1987).

Incubators could be electrical, biogas, solid fuel, fossil oil or solar types based on the source of energy. Kerosene fueled incubators mostly have small capacity and free convection air circulation. They are easy to handle and cheap (Adewumi, 1998). The paper reports the performance evaluation and modification of a kerosine fueled table incubator with the aim of improving the performance of the incubator.

MATERIALS AND METHODS

The incubator used for the study is the free convection kerosene fueled table incubator (Adewumi, 1988). It is a laboratory scale incubator and has a capacity of 30 eggs. Fig. 1 shows the diagram of the original design. It is composed of components such as the frame, egg tray, turning mechanism, aluminium filter, chimney, water pan and a lantern heat source. The incubator was subjected to preliminary tests (test 1 and 2) in order to identify the defects of the equipment and effect necessary modifications. After the modification of the equipment, tests 3 and 4 were conducted to evaluate the performance of the incubator in order to assess the effectiveness of the modification.

The average daily wet bulb and dry bulb temperature in the incubator were monitored and recorded. The relative humidity in the incubator was obtained using the psychrometric chart. The first and second candling were done on the 7th and

18th day respectively to determine egg fertility and the development of the chicks respectively. Egg turning was done five times daily. Hatchable eggs of domestic fowls were used for the evaluation of the incubator. The percentage fertility and hatchability of the eggs were determined for all the tests.

Defects of the original design and modifications

After the preliminary tests were conducted, a number of defects were identified.

These include:

(i) inadequate filtration of the sooth from the lantern by the aluminium filter.

(ii) inadequate discharge of the exhaust materials through the chimney. Carbon particles are occasionally found on egg shell.

(iii) improper air circulation because of inadequate ventilation ports.

(iv) inadequate turning of the eggs because of some defects in the construction of the turning mechanism.

The defects identified were corrected and the following modifications were made on the incubator.

(i) An adequate filter made of fins with a thin - foam - sandwich was provided to replace the aluminium filter.

(ii) An adjustable slide gate with a maximum dimension of 50 X 60mm was provided at the top of the incubator in place of the chimney for effective discharge of the exhaust gases. The

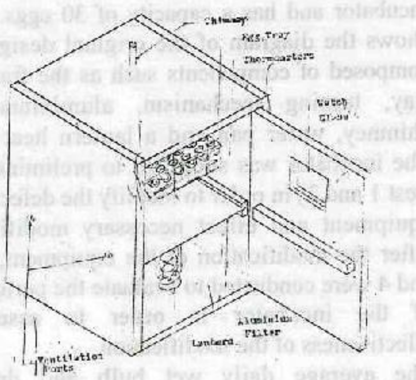

Fig.1.Isometric view of the Original Incubator

slide gate equally assist in regulating the temperature in the incubator. In the night when the ambient temperature is low, the gate opening is reduced.

(iii) A rectangular opening of 80 X 100mm protected with filter material was constructed at the lower side of the incubator to supply air in adequate combustion.

(iv) An hatcher box of dimension 300 X 300 X 60mm with wire mesh floor was incorporated to the shaft of the turning mechanism to provide stability. The egg tray is now accommodated in the hatcher box. The egg tray could be removed toward the hatching period while the eggs are placed in the hatching tray. The tray accommodates the chick at emergence and prevents them from falling on the filter.

A rectangular sliding gate with a dimension 250 X 160mm was provided at lower part of the incubator door to allow easy manipulation of the lantern. Hence, it is not necessary to open the door of the incubator in order to fuel and adjust the lantern. fig. 2 shows the isometric view of the modified incubator.

RESULTS AND DISCUSSION

Table 1 shows the average daily temperature and relative humidity for tests 1 - 4.

Table 2 shows the percentage fertility and hatchability for tests 1-4. Tests 1 & 2 were conducted before the incubator was modified while test 3 & 4 were conducted after the

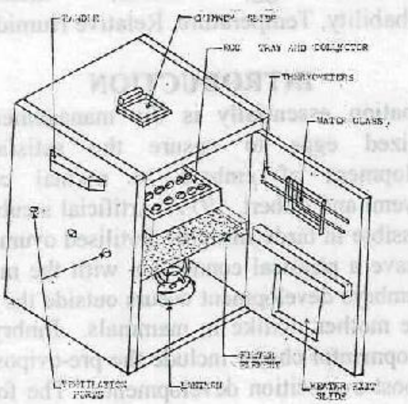

Fig .2. Isometric view of the Modified Incubator

TABLE 1: AVERAGE RELATIVE HUMIDITY AND TEMPERATURE DURING EVALUATION FOR TESTS 1 - 4.

Day	Relative Humidity (%)				Temperature (%)			
	Test1	Test2	Test3	Test4	Test1	Test2	Test3	Test 4
1.	62.5	56.5	60.5	59.5	37.5	38.0	38.5	38.8
2.	61.5	61.5	58.0	61.5	61.5	37.8	38.5	37.8
3.	59.0	63.0	60.0	58.0	59.0	38.0	38.5	38.5
4.	66.5	59.0	58.0	60.5	37.8	38.0	38.0	38.0
5.	88.0	62.5	59.5	59.0	38.0	37.5	37.8	38.0
6.	64.0	60.0	58.0	62.5	38.0	37.8	37.5	38.3
7.	64.5	59.5	58.0	59.5	37.5	37.8	37.8	38.5
8.	59.5	62.0	64.0	59.0	38.5	38.0	38.3	38.0
9.	58.0	60.0	60.0	58.0	38.4	37.5	38.0	38.4
10.	59.0	60.0	60.0	64.0	38.0	37.8	37.8	38.0
11.	66.0	60.0	61.5	61.0	36.8	38.0	38.0	38.8
12.	62.0	61.5	64.0	63.5	38.0	38.0	38.3	38.0
13.	64.0	58.0	61.0	59.5	38.3	38.0	37.8	38.3
14.	59.5	56.0	59.0	61.5	38.3	37.8	38.0	38.5
15.	63.0	61.5	61.0	62.5	38.0	37.8	38.3	38.8
16.	66.5	66.0	60.5	61.5	37.3	36.8	38.5	38.5
17.	61.5	64.0	57.5	59.5	37.8	38.3	38.8	38.3
18.	66.5	59.0	62.0	66.5	37.5	38.0	37.5	37.5
19.	65.0	64.5	64.0	69.0	37.3	36.8	38.3	37.0
20.	56.5	58.0	62.5	70.0	38.0	38.0	38.0	37.0
21.	61.5	59.5	61.5	69.0	38.0	38.0	38.3	37.0
Mean:	63.55	60.57	60.48	62.14	37.86	37.80	38.12	38.10
Std. Dev.	6.34	2.55	2.05	3.66	0.42	0.38	0.35	0.57

modification. The temperature range in the incubator before and after the modification are 36.8 - 38.3°C and 37.0 - 38.8°C respectively while the relative humidity ranged between 56.5 - 66.5% and 58.0 - 70.0% respectively. The mean value of temperature in the incubator before and after the modification are 37.8°C and 38.1°C respectively while the value recorded for the relative humidity are 62.0% and 61.3% respectively. The incubator therefore was able to maintain adequate temperature and relative humidity favourable for egg incubation, both before and after the modification. The incubator operates within the recommended range of temperature and relative humidity specified by previous authors and researchers (Barrot, 1937; and Ayivor and Hellins, 1986).

It was observed that after the modification, combustion of kerosene was adequate and minimal sooth was produced by the lantern. Combustion products were effectively converged out of the incubator and sooth particles were no more found on the egg shell during incubation. This is responsible for the increase in the percentage hatchability of the eggs after the modification.

An average percentage hatchability of 75% was recorded before the modification while an average of 88.4% was recorded after the modification, an increase of 13.4%. The record of the percentage hatchability in the incubator both before and after the modification is a success record since an average efficiency of 70% was recorded for both electric and oil heated incubators (Nico and Johan, 1990). Also, the hatchability of the electric incubators introduced by Peterson incubator company was 55 - 65%, which was rated good (Jull, 1943). The hatchability record of the incubator is better than a range of 57.66 - 60.66% (± 2/50) for imported incubator available in Nigeria (Aremu and Shiawoya, 1993). The modified incubator performed better than the Jamesway Big J incubators with an average hatchability of 80%, which makes them the best in the world of incubator making (Anthony, 1990).

Since the performance of the modified incubator is better than those available in literature, the incubator is recommended for use in the tropical regions. The incubator is cheap and the construction material and heat source are readily available. It is particularly suitable for domestic and small scale chick production in the developing countries where the supply of electricity is not regular. It is suggested that the equipment should be enlarged for medium and large scale production of chicks.

TABLE 2: % FERTILITY AND HATCHABILITY FOR TESTS 1 - 4

	Experimental trials			
Parameters	Test 1	Test 2	Test 3	Test 4
No. of eggs loaded	15	10	15	30
No. of infertile eggs	9	1	5	15
No. of fertile eggs	6	9	10	15
No. of eggs hatched	5	6	9	13
% Fertility	40%	90%	66.7%	50%
% Hatchability	83.3%	66.7%	90%	86.7%

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Current Address: Departmetn of Public Health And Animal Production, Faculty of Veterinary Medicine, Usmanu Danfodiyo University,Sokoto,Sokoto, Nigeria