

## THE DEVELOPMENT AND EVALUATION OF A FLAT-TYPE WOODEN INCUBATOR

A.O. OLORUNNISOLA<sup>1</sup> and T.A. EWEMOJE

Agricultural Engineering Department, University of Ibadan, Nigeria

### Abstract

A flat-type, 60-egg capacity incubator was designed, constructed and tested. The incubator differs from existing designs in that the cabinet was made from a 3-ply, 4 mm thick interior grade plywood to reduce cost and at the same time enhance heat insulation. Also, two domestic kerosene lanterns were provided to supplement heat generation by three 40 W electric bulbs during electricity outages as commonly experienced in Nigeria. When tested with 30 eggs of a commonly sold chicken breed, incubated at average temperature of 38° C and relative humidity of 58%, the chicks were hatched within 20 days. Relatively high percentages of fertility and hatchability of 86.2% and 76% respectively, as well as a relatively low chick mortality rate of 18.5% were recorded.

Keywords: Development; Evaluation; Wooden incubator.

<sup>1</sup>Author for correspondence

### Introduction

Incubation is the management of fertilized eggs to ensure the satisfactory development of the embryos into normal chicks (Oluyemi and Roberts, 1988). For very small numbers of eggs, say 6-12, the easiest and usual way of hatching chicks is the natural method, whereby the broody hen is allowed to sit on the nest to provide the basic requirements for hatching, which are warmth, humidity, ventilation and regular turning of the eggs (Anon, 1982). However, for larger quantities of eggs, the common practice, which dates back to about 1000BC (Anon, 1982) is to resort to artificial incubation.

Modern incubators are basically closed heat-insulated boxes or chambers in which temperature and relative humidity are strictly controlled within the required range values of 36° C to 39° C and 58% to 70% respectively, and with adequate provision made for proper ventilation and egg-turning (Akinsanmi, 1977), Komolafe *et al.* (1981), Oluyemi and Roberts (1988). The various versions available can be broadly classified into two groups:

(i) the smaller models handling between 50 to 500 eggs and usually referred to as flat-type or still-air incubators; and (ii) the larger models handling 500 to many thousands of eggs which are called cabinet or forced draught incubators (Anon, 1982). Whilst the smaller incubators are usually designed as free-standing boxes or cabinets, the larger generally more sophisticated models, are often built into the structure of the hatchery and may have separate setting and hatching units (Anon, 1982). However, regardless of the type of incubator employed, successful hatching depends largely on the fertility of the egg, the age of the parent stock and the pre-incubation storage conditions regarding temperature, relative humidity, handling practices and storage duration (Oluyemi and Roberts 1988, Norwood, 1982; Walsh *et al.* 1995; Buhr, 1995).

Most small-scale poultry farmers in Nigeria today are unable to produce day old chicks in large numbers by artificial incubation due to the relatively high prices of the different types of imported incubators available in the market. The objective of this work therefore, was to develop an incubator that can meet the requirements of such farmers.

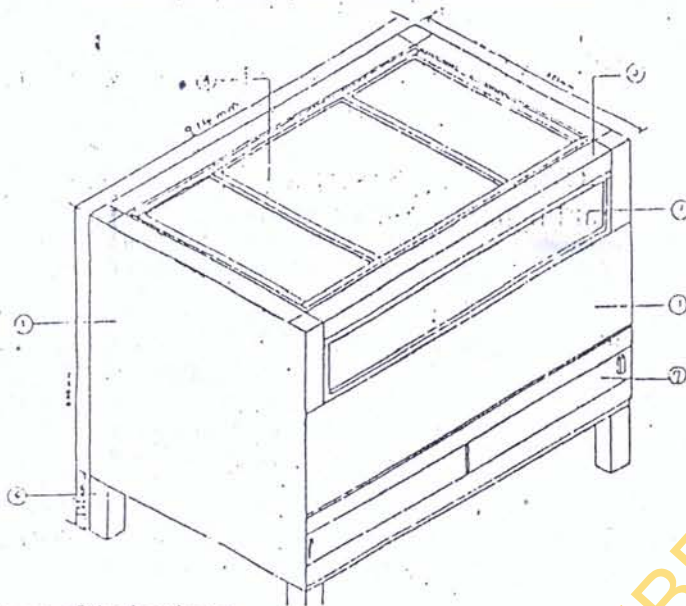


Fig. 1. External features of the incubator

Legend: 1 = front cover; 2 = glass inspection panel; 3 = beam; 4 = lid; 5 = side cover; 6 = stand; 7 = adjustable vent.

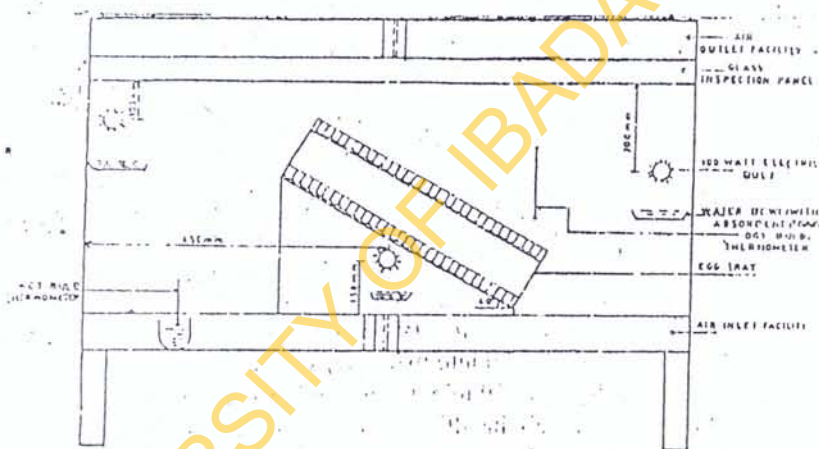


Fig. 2. Sectional view of the incubator showing spatial arrangement of facilities within.

### The Design Features of Incubator

The external features of the incubator area shown in Fig. 1 while Fig. 2 shows the spatial arrangement of facilities provided within. A brief description of the functional component parts of the incubator are presented below:

#### The cabinet

The cabinet was produced using 6.4 mm thick interior-grade plywood for the floor, side walls and the lid, and the sawn wood of *Terminalia superba* for the beams and columns. The choice of these materials were based on local availability, relative low cost and effectiveness in performing the desired functions of insulation and structural stability.



*Inspection panel*

A 2 mm thick 800 mm x 160 mm transparent glass was used for constructing the glass inspection panel provided for egg inspection and environmental condition monitoring during incubation.

*Heat sources*

To raise the ambient temperature of the incubator to the desired level (37° C - 39° C), three units of 40 W white electric bulbs were fixed on three sides of the incubator. Two commonly used domestic kerosene-lanterns were also provided as supplementary heat sources during electricity outages.

*Humidifiers*

To achieve the optimum ambient relative humidity (58%) in the incubator, three improvised humidifiers were provided in form of three 0.5 l capacity plastic bowls filled with water in which absorbent plastic foams were dipped to increase the rate of evaporation. These were placed directly below the electric bulbs.

*Vents*

Since adequate ventilation is necessary to facilitate the entrance of oxygen into and the removal of excess carbon dioxide from within the incubator; two sliding doors, each having 0.05 m<sup>2</sup> surface area were provided at the top (at the back) and at the bottom (in front) of the incubator.

*Egg trays*

Two egg trays were provided. Each tray consisted of a 30-egg capacity plastic crate attached to a 4.5 m x 3.2 m plywood sheet. Both trays were joined together at each end by a set of four 25 mm x 150 mm wooden pegs to form a 2-layer rack having a clearance of 150 mm in-between. The rack was then attached to two wooden supports which provided the required tilt angle of 40° to the horizontal as in cabinet-type incubators.

*Instrumentation*

A laboratory-type mercury-bulb thermometer was provided above the egg-trays unit for temperature measurement. In the absence of an hygrometer, two similar mercury-bulb thermometers, one dry bulb and wet bulb (i.e. having its bulb covered with a wick before being inserted in a container of water) were provided to monitor the dry bulb and wet-bulb temperatures respectively from which relative humidity values can be obtained using the psychrometric chart.

All the structural component parts of the cabinet i.e. the beams, columns and the side walls were designed and constructed using standard wood engineering design procedure obtained from Barrie and Sammet (1966), NSO (1973), and Breyer (1980). This was to ensure structural stability and integrity.

## Experimental Methods

*Egg selection and storage prior to incubation*

The incubator was tested with 30 chicken eggs procured from an hatchery in Ibadan, Nigeria. The parent stock breed was a broiler, "Anak 2000" which originated in Israel and is reputable for table meat and early maturity. The average age of the laying birds was 30 weeks. The eggs were of normal shape (i.e. irregular ovoid), of good texture and were free from cracks, blood and meat spots.

*Management of eggs in the incubator*

The incubator was placed in a 12.6 m<sup>2</sup> room with adequate ventilation provided by two windows that has a total surface area of 4.1 m<sup>2</sup> and two 2 m x 1.3 m doors aligned face to face on either side of the room. The air inlet vent of the incubator was aligned parallel to the general direction of air flow.

The various hatchery practices observed were: (i) Egg setting: The eggs were set with the larger ends up at 8pm on October 3, 1997 with the ambient temperature and relative humidity of 38° C and 70% respectively.

(ii) Environmental control involving the monitoring and control of temperature and relative humidity. The ambient temperature was monitored three times daily throughout the incubation period at 7a.m, 3 p.m and 10 p.m. Observing temperature higher than 39° C necessitated putting off one of the electric bulbs while the temperature lower than 36.5° C necessitated closing the vents. The two kerosene lanterns were-put on during electricity outage covering a period of 89 hours. Also, a relative

humidity exceeding 70% necessitated the removal of one of the humidifiers. The relative humidity never fell below the recommended value of 58% throughout the test duration.

(iii) Egg turning was done manually three times daily at 7a.m, 3 p.m and 10 p.m. The incubator was opened and the eggs were turned in opposite directions on each occasion. Turning was discontinued after the 18th day of incubation as recommended by Oluyemi and Roberts (1988).

(iv) Candling was done on the 7th and the 18th day respectively, by passing a bright beam of light through each egg to determine fertility as recommended by Oluyemi and Roberts (1988). The infertile eggs found on each occasion were removed.

*Data Analysis*

The percentage fertility and hatchability of the eggs were calculated at the end of incubation using the following formulae provided by Rice and Bosford (1956):

Percentage fertility = Number of fertile eggs / Total number of egg set x 100% .....(1)

Percentage hatchability = Number of hatched chicks / Total number of fertile eggs x 100% .....(2)

**Results**

Table 1 shows the results obtained from the operational test of the incubator while Figure 3 shows the ambient temperature and relative humidity variation during incubation.

Table 1. Incubator performance parameters

Performance measure	Value
Fertility of eggs	86.21%
Hatchability of chicks	76.0%
Mortality rate	18.5%
Incubation period	20 days

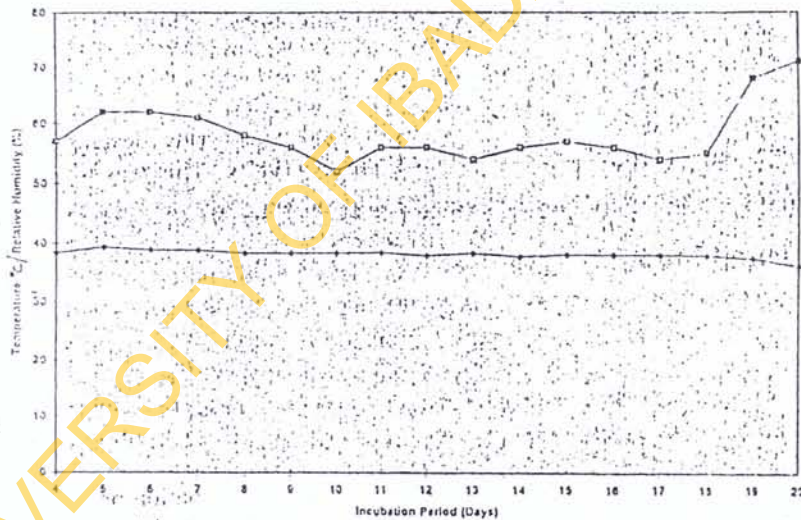


Fig. 3. Ambient incubator temperature and relative humidity variation during the 20 days incubation period.

**Discussion**

*Incubation Period*

The hatching of fertilized eggs began on the night of the 19th day and ended on the night of the 20th day without the incidence of malformed chicks. This is in conformity with the observations of Oluyemi and Roberts (1988) who reported a range of 20-21 days for the hatching of chickens under similar conditions.. This result was achieved with the maintenance of the ambient temperature and



relative humidity within the recommended value range of 36° C to 39° C and 52% to 62% respectively, (the average values being 38.07° C and 58.4%), up till the 18th day followed by a reduction in ambient temperature from 37.8° C to 36° C and an increase in relative humidity (from 55% to 71%) on the 19th day as recommended by Komolafe *et al.* (1981) and Oluyemi and Roberts (1988).

#### *Percentage fertility*

The high percentage fertility of 86.2% recorded indicates that the eggs were obtained from a reasonably sound parent stock and that the pre-incubation storage temperature and relative humidity conditions were largely appropriate for the type of eggs used.

#### *Percentage hatchability*

The percentage hatchability of 76% recorded is considered an "excellent" result even in a cabinet or forced draught incubator. The smoke production from the lanterns used was minimal and the duration of usage was low, representing only 19% of the total 480 hours of incubation. Hence, there was no problem of embryo suffocation.

#### *Mortality rate*

Five out of the seven unhatched eggs were "dead-in-shell" embryos while the rest two were infertile eggs not discovered during candling. This mortality rate of 18.5% is considered acceptable in artificial incubation (Anonymous, 1982). However, a thorough examination of the "dead-in-shell" embryos revealed that the cause of death was malpositioning. This condition, according to Morley (1981), results in death within 6 to 10 days of the commencement of incubation. Contrary to Morley's description of the normal position of the embryo at hatching, i.e. the head being positioned towards the larger end of the egg and the right side of the body, while the beak points towards the air cell, the "dead-in-shell" embryos were found with their heads lying between their thighs. Other possible embryo malpositions noted by the same author are: (i) head in small end of egg; (ii) head to the left side of the body; (iii) head rotated so that beak is not pointing towards the air cell; (iv) feet over wing; and (v) head over wing. The reasons for the occurrence of such deviations from the normal position are, however, not clear. They may not be unconnected with the position of the egg during incubation since, according to Oluyemi and Roberts (1988), altering this parameter has a definite influence on embryo mortality rate.

### **Conclusion**

A wooden, flat-type incubator has been designed, constructed and tested, with fowl eggs. The novel approach of using plywood as the construction material and improvising the humidifiers and supplementary heat sources within the incubator paid off with a relatively high percentage hatchability and a correspondingly low mortality rate obtained by hatching with the incubator.

### **References**

- Akinsanmi, O. 1977. Certificate Agricultural Science Longman Group Ltd; London.
- Anonymous, 1982. Incubation and Hatchery Practice Reference Book 148, Ministry of Agriculture, Fisheries and Food, United Kingdom, Great Britain.
- Barrie, H.J. and Sammet, L.L. 1966. Farm Structure John Wiley and Sons Inc. New York. U.S.A.
- Breyer, E.D. 1980. Design of Wood Structures McGraw-Hill Book Company Inc. New York.
- Buhr, J.J. 1995. Incubation Relative Humidity Effects on Allantoic Fluid Volume and Hatchability? Poultry Science 74, 874-884.
- Komolafe, M.F.; Adegbola, A.A.; Are, L.A. and Ashaye, T.I. 1981. Agricultural Science for West African Schools and Colleges, University Press Limited, Ibadan.
- Morley, A.J. 1981. Poultry Husbandry McGraw-Hill Book Company Incorporation, New York.
- Norwood, J. 1982. Chicken Incubators for the Humid Tropics. Appropriate Technology 9, 21-23.
- NSO, 1973. Nigerian Standard Code of Practice. NCPI. Part 3. Published by Ministry of Industries, Lagos, Nigeria.

- oyemi, J.A. and Roberts, F.A. 1988. Poultry Production in Warm Wet Climates macmillan Publishers Limited London.
- ice, J.E. and Bosiford, H.E. 1956. Practical poltry Management John Wiley and Sons Inc. New York, U.S.A.
- Walsh, T.J., Rizk, R.E. and Brake, J. 1995. Effects of Temperature and Carbon-dioxide on Albumen Characteristics, Weight Loss and Early Embryonic Mortality of Long Stored Hatching Eggs. Poultry Science 74, 1403-1410.

UNIVERSITY OF IBADAN LIBRARY