EFFECTS OF SOLAR DRIER SUPPLEMENTED WITH LANTERN OR ELECTRIC BULB HEAT ON JAPANESE QUAIL EGGS HATCHABILITY

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ABSTRACT

Artificial incubation in Japanese quails commercial production is unavoidable because the hens do not incubate their eggs. But artificial incubators require electricity, expertise and are not readily accessible hence alternative strategies that seem affordable and easy become indispensible. Two separate studies: electric incubator and solar drier supplemented with lantern heat; electric incubator and solar drier supplemented with electric bulb heat were carried out using two hundred Japanese quail eggs. Incubation period, number of hatchlings, chick weight, fertility rate, hatchability and chick yield were determined. Thermometer was used in monitoring the incubation temperature and relative humidity. Hatchability failure was recorded in both solar drier supplemented with lantern and electric bulb heat but 74.3%; 85.7% was recorded in control. All the incubated eggs in both solar drier supplemented with lantern and electric bulb appeared unfertile. These observations could be due largely to irregular incubation temperature of 30.3 to 58.8°C; 23.9 to 42.6°C during the day and 21.3 to 36.5°C; 27.1 to 38.7°C during the night in solar drier supplemented with either lantern or electric bulb heat. Therefore, solar drier supplemented with lantern or electric bulb heat, may not provide the required microclimatic conditions required to sustain Japanese quail embryos development.

Keywords: Embryo growth, incubator, Japanese quails, physiological status

INTRODUCTION

Initially, Japanese quails were known for singing, with time it was observed that the eggs and meat were nutritionally rich with medicinal attributes (Fah, 2009; Howes, 1964). More importantly, it is preferred in avian research to other poultry species (Reese and Reese, 1962). Unfortunately, the hens hardly incubate their eggs, so use of artificial incubators is inevitable for commercial production. Regrettably, artificial incubators are not manufactured locally, available, affordable and it is powered by electricity which may not be available always. Hence, the quest for alternative heat source to provide the required microclimatic conditions, required to sustain Japanese quail embryos development with improved hatchability. Consequently, this study was aimed at investigating the use of solar heat in poultry eggs incubation, in order to make good some elements of climate change.

MATERIALS AND METHODS

Study I

One hundred Japanese quail eggs obtained from National Veterinary Research Institute, Vom, were weighed and 50 each were randomly allotted to electric incubator: control (38°C) and solar drier. At night, hurricane lantern was placed inside the solar drier to supplement heat only at night (See plates 1 and 2).

Study II

Anotherclutch of 100 Japanese quail eggs from the same source as in study I, were weighed and randomly allocated (50 each) to control (38°C): electric incubator and solar drier. A 100W electric bulb was fixed inside the solar drier and switched on only at night to supplement heat (See plates 1 and 2).

DATA COLLECTION AND ANALYSIS

The studies were conducted separately and incubation temperature as well as relative humidity was recorded daily during the day: (midday and evening) and during the night: (midnight and morning) using a thermometer with a sensitive probe. At hatch, incubation period, number of hatchlings, chick weight, fertility rate, hatchability and chick yield were determined as described by Copper Akpinar *et al*. (2017). After the emergence of chicks, 5 days allowance was given for late hatching and on incubation day 22, the unhatched eggs were carefully windowed and the physiological status of the eggs vis-à-vis the developing embryos was recorded as proposed by Idahor *et al*. (2018), but was modified to include further categorisation as either "Unfertile: no evidence of embryo growth" or "Fertile: evidence of embryo growth".

Plate 1: Electric incubator: Control

Plate 2: Solar drier where lantern or electric bulb was used to supplement heat only at night

Those that were "infertile", "caked" and "not clear whether fertile or not" were categorised as **Unfertile**: **no evidence of embryo growth**. Whereas, those with "early dead embryos", "fully developed but dead embryos", "pipped and dead embryos", "pipped and alive but not able to emerge embryos" as well as "pipped and hatched alive" were considered as **Fertile**: **evidence of embryo growth**. Data were subjected to descriptive statistics and ANOVA at $\alpha_{0.05}$ using SPSS (2010).

RESULTS AND DISCUSSION

Temperature and relative humidity in electric incubator and solar drier supplemented with lantern heat is presented in Table 1. There were statistical differences (P<0.05) in all the parameters measured, except temperature during the day and night in electric incubator (control) and relative humidity during the day in solar drier supplemented with lantern heat.

Table 1: Temperature and relative humidity of electric incubator and solar drier supplemented with lantern heat

	Treatments (±STD)							
	Electric incubator (Control)				Solar drier (Supplemented with lantern heat)			
	During the day		During the night		During the day		During the night	
ID	Temp (^oC)	RH (%)	Temp (^oC)	RH (%)	Temp (^oC)	RH (%)	Temp (^oC)	RH (%)
0	38.15±0.13	35.50±6.25^{b}	38.78±0.21	37.25±6.08^{d}	48.00±9.13^{ab}	31.45±2.01	29.25±10.90^{bc}	43.15±6.12^{ab}
1	38.20±0.08	32.00±5.48^{b}	38.58±0.63	44.00±2.94^{bc}	45.75±6.65^{ab}	30.05±4.88	26.00±10.71^{c}	40.48±3.75^{ab}
2	38.25±0.06	40.75±1.89^{a}	38.18±0.47	46.50±2.38^{abc}	47.25±3.40^{ab}	31.55±2.53	26.00±7.35^{c}	41.80±5.19^{ab}
3	38.75±2.90	44.75±2.99^{a}	38.98±0.62	50.75±1.89^{a}	45.00±8.12^{ab}	31.55±2.06	25.75±8.50^{c}	42.15±6.15^{ab}
4	38.03±0.49	41.25±1.71^{a}	38.58±0.54	50.75±1.89^{a}	49.25±5.06^{ab}	31.30±1.72	25.25±8.06^{c}	43.10±5.34^{ab}
5	38.13±0.22	43.00±1.41^{a}	38.53±1.16	51.00±2.94^{a}	44.75±12.55^{ab}	32.30±3.50	27.75±8.54^{c}	41.23±3.92^{ab}
6	38.18±0.05	41.75±2.06^{a}	38.58±2.60	51.25±0.50^{a}	49.50±10.21^{ab}	29.48±2.83	24.50±15.38^{c}	40.60±4.25^{ab}
7	38.00±3.54	45.75±6.95^{a}	38.70±0.56	50.75±0.96^{a}	49.50±10.21^{ab}	31.93±5.56	25.75±2.22^{c}	41.80±5.72^{ab}
8	38.08±0.46	44.00±2.45^{a}	38.35±1.48	49.25±4.11^{ab}	49.50±10.21^{ab}	31.45±2.40	25.75±13.35^{c}	44.77±2.42^{ab}
9	38.30±0.00	46.75±1.26^{a}	38.80±0.81	48.00±1.63^{abc}	49.00±13.95^{ab}	30.33±1.80	32.33±19.63^{b}	41.40±3.28^{a}
10	38.30±0.00	44.25±2.06^{a}	38.75±1.08	47.50±0.58^{abc}	47.25±12.29^{ab}	31.18±1.42	34.75±16.70^{ab}	39.58±4.09^{ab}
11	38.30±0.00	45.25±0.50^{a}	38.90±1.44	49.00±1.41^{ab}	52.751±7.46^{ab}	30.38±1.52	35.25±19.57^{a}	39.90±7.39^{ab}
12	38.28±0.05	44.75±1.50^{a}	38.35±1.59	47.25±1.50^{abc}	41.00±6.63^{ab}	31.90±3.65	33.75±13.51^{ab}	39.03±5.84^{ab}
13	38.30±0.00	45.75±1.71^{a}	38.53±1.98	49.00±1.15^{ab}	42.00±5.72^{ab}	32.45±3.30	33.50±18.20^{ab}	38.00±3.26^{ab}
14	38.20±0.08	47.50±1.73^{a}	38.10±1.19	49.75±0.96^{a}	30.25±10.21^{b}	31.85±4.13	30.50±10.34^{b}	37.25±3.23^{ab}
15	38.00±0.54	47.75±2.22^{a}	38.85±2.08	49.75±1.26^{a}	53.25±12.47^{ab}	32.40±4.84	21.25±4.72^{c}	41.75±3.39^{ab}
16	38.20±0.20	46.50±1.29^{a}	38.88±2.17	51.50±2.65^{a}	51.25±24.62^{ab}	31.85±4.13	33.25±13.63^{ab}	44.15±5.74^{ab}
17	38.13±0.10	41.00±5.83^{a}	38.03±1.56	38.00±0.16^{d}	58.75±12.53^{a}	30.28±2.00	21.25±8.30^{c}	36.20±3.92^{ab}
18	38.18±0.10	31.00±5.35^{b}	38.18±0.96	43.25±4.99^{c}	47.25±14.38^{ab}	31.55±4.30	28.75±14.87^{c}	39.88±4.85^{b}
19	38.25±0.06	37.75±4.79^{b}	38.30±0.92	43.50±2.38^{c}	49.25±12.24^{ab}	32.40±4.84	36.50±21.44^{a}	42.45±4.85^{ab}
20	38.32±2.89	44.00±3.56^{a}	38.93±0.51	49.25±1.89^{ab}	56.00±4.85^{ab}	31.85±4.13	28.75±17.46^{c}	39.88±4.85^{b}
21	38.05±0.51	41.50±2.08^{a}	38.98±0.79	51.75±0.50^{a}	44.75±2.19^{ab}	29.10±0.61	23.25±15.62^{c}	39.88±4.85^{b}

^{a,b,c,d}: Mean values on the same column with different superscripts differ significantly at p<0.05; ID: Incubation day; Temp: Temperature; RH: Relative humidity; STD: Standard deviation.

While the temperature was constantly 38°C in control, it fluctuated from 30.3 to 58.8°C during the day and 21.3 to 36.5°C during the night in solar drier supplemented with lantern heat. This was evidently out of a range of 36 – 38°C recommended for poultry eggs incubation (Archer and Cartwright, 2018; Sartell, 2018). The relative humidity varied between 29 and 45% in solar drier supplemented with lantern heat and 31 – 52% in electric incubator (control). These were within a range of 32 – 75% reported by Archer and Cartwright (2018).

Table 2 shows the temperature and relative humidity in electric incubator and solar drier supplemented with electric bulb heat. There were statistical variations ($P<0.05$) in all the parameters monitored, except temperature in control that was seemingly constant at 38°C both day and night but, varied from 23.9 – 42.6°C during the day and 27.1 to 38.7°C during the night in solar drier supplemented with electric bulb heat.

Table 2: Temperature and relative humidity in electric incubator and solar drier supplemented with electric bulb heat

	Treatments (±SD)							
	Electric incubator (Control)				Solar drier (Supplemented with electric bulb)			
	During the day		During the night		During the day		During the night	
ID	Temp (°C)	RH (%)	Temp (°C)	RH (%)	Temp (°C)	RH (%)	Temp (°C)	RH (%)
0	38.06±0.29	45.10±2.15^{a}	38.33±1.66	44.29±4.22^{b}	41.08±1.73^{a}	49.25±0.50^{b}	32.80±5.60^{b}	28.25±13.77^{cd}
1	38.29±0.14	38.70±4.43^{c}	38.23±1.11	42.23±3.11^{b}	40.18±5.95^{a}	49.25±10.44^{b}	33.15±7.04^{b}	25.50±13.60^{d}
2	38.45±0.44	40.75±1.89^{b}	38.10±0.20	41.39±2.66^{b}	42.58±8.34^{a}	43.50±11.68^{c}	38.75±4.26^{a}	25.25±9.43^{d}
3	38.11±1.11	44.75±3.09^{a}	38.03±0.55	43.05±1.44^{a}	40.15±8.26^{a}	52.00±2.83^{ab}	34.35±6.65^{b}	26.75±9.71^{d}
4	38.54±0.13	40.22±1.04^{b}	38.41±0.54	50.12±1.55^{a}	40.33±5.91^{ab}	43.50±14.36^{c}	33.85±6.06^{b}	23.00±7.07^{d}
5	38.33±1.32	42.11±1.45^{b}	38.13±1.12	51.54±3.03^{a}	39.85±5.61^{ab}	40.00±17.42^{c}	33.33±6.88^{b}	24.75±8.46^{d}
6	38.14±0.45	41.75±2.06^{b}	38.44±1.63	49.66±2.58^{a}	41.25±4.96^{a}	51.50±13.40^{ab}	34.00±7.06^{b}	29.50±24.37^{c}
7	38.09±1.01	41.34±4.85^{b}	38.00±0.33	49.55±3.33^{a}	39.85±9.28^{a}	52.00±13.37^{ab}	31.70±6.21^{b}	31.25±16.26^{b}
8	38.11±0.51	44.09±2.66^{a}	38.09±2.11	51.00±6.32^{a}	39.03±8.77^{a}	50.00±10.86^{ab}	32.13±4.28^{b}	26.00±14.45^{d}
9	38.25±1.08	46.11±2.23^{a}	38.22±1.66	50.88±4.88^{a}	39.60±8.64^{a}	47.25±13.57^{b}	34.68±7.58^{b}	24.25±17.29^{d}
10	38.10±0.07	44.25±2.06^{a}	38.32±1.08	49.59±3.22^{a}	41.68±7.72^{a}	48.50±15.15^{a}	31.38±7.12^{b}	24.75±16.03^{d}
11	38.22±0.07	46.25±3.51^{a}	38.40±1.76	49.07±4.81^{a}	37.25±6.03^{b}	44.50±19.16^{c}	31.38±5.47^{b}	35.00±15.25^{c}
12	38.44±0.44	34.79±1.53^{c}	38.84±1.00	48.92±3.44^{a}	40.00±7.02^{a}	55.00±21.92^{ab}	29.10±7.78^{b}	29.75±21.62^{b}
13	38.32±0.43	45.33±2.76^{a}	38.13±1.90	49.40±2.35^{a}	40.53±5.56^{a}	59.50±18.52^{a}	27.10±7.58^{c}	35.75±14.38^{c}
14	38.33±1.03	47.50±2.55^{a}	38.18±1.22	49.86±0.44^{a}	37.80±4.38^{b}	57.75±14.24^{ab}	34.18±5.93^{b}	35.50±13.20^{c}
15	38.22±0.22	47.75±2.29^{a}	38.77±1.92	49.34±2.04^{a}	42.18±5.29^{a}	43.50±4.73^{c}	32.60±4.00^{b}	28.00±11.17^{cd}
16	38.20±0.20	44.54±1.66^{a}	38.63±2.77	50.03±1.33^{a}	38.28±3.54^{b}	47.50±12.48^{b}	27.58±5.99^{c}	38.25±12.82^{c}
17	38.13±0.10	44.08±5.21^{a}	38.60±1.52	48.77±1.66^{a}	31.43±6.01^{c}	56.50±16.62^{ab}	27.23±6.78^{c}	61.50±31.84^{a}
18	38.38±0.19	31.34±5.57^{c}	38.66±0.93	48.25±4.44^{a}	38.65±3.62^{b}	64.25±24.09^{a}	27.73±7.64^{c}	32.25±13.40^{c}
19	38.50±0.06	35.75±2.33^{c}	38.38±0.92	43.11±2.76^{b}	35.70±5.37^{bc}	52.50±13.63^{ab}	30.28±5.96^{b}	43.25±17.80^{bc}
20	38.42±0.04	44.80±3.99^{a}	38.43±0.51	46.24±1.55^{ab}	35.98±9.29^{bc}	61.25±17.91^{a}	31.88±8.78^{b}	33.75±15.37^{c}
21	38.00±0.23	41.37±2.48^{b}	38.66±1.33	51.33±2.33^{a}	23.95±8.77^{d}	57.75±29.74^{ab}	31.95±3.23^{b}	50.00±26.23^{b}

^{a,b,c,d}: Mean values on the same column with different superscripts differ significantly at $p<0.05$; ID: Incubation day; Temp: Temperature; RH: Relative humidity; STD: Standard deviation.

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Though these values seemed to be close to 38°C given as normal incubation temperature in poultry eggs, the fluctuation margin was wider than a range of 0.2 – 3.0°C reported to be a margin of safety (Poultry Hub (2018; French, 2000). Relative humidity was close to the values given as normal during poultry eggs incubation (Archer and Cartwright, 2018).

Table 3 provides the physiological status and hatchability of Japanese quail eggs incubated in electric incubator and solar drier supplemented with lantern or electric bulb heat. There was hatchability failure in both solar drier supplemented with either lantern or electric bulb heat whereas, as high as 74.3%; 85.7% was recorded in control during the studies. This observation lent more credence to the report of Idahor *et al.* (2016) that improvising solar drier as poultry eggs incubator may not be possible. But was at variance with the findings of Osanyinpeju *et al.* (2016) who recorded 44% hatchability in fowl eggs incubated in solar powered poultry egg incubator. All the incubated eggs in both solar drier supplemented with lantern and electric bulb heat appeared unfertile. This probably signified unsuitable microclimatic conditions for the blastoderm to develop into embryos resulting in hatchability failure.

Table 3: Physiological status and hatchability of Japanese quail eggs incubated in electric incubator and solar drier supplemented with either lantern or electric bulb heat

	Treatments			
Parameters	**Control**	**Solar drier supplemented with lantern heat**	**Control**	**Solar drier supplemented with electric bulb heat**
Total eggs set	50	50	50	50
Egg weight (g)	10.43	10.06	10.28	10.17
IP (days)	17	-	18	-
Unfertile eggs: No evidence of embryo growth				
Infertile	5	0	7	0
NCWFN	1	38	1	35
Caked	2	12	3	15
Fertile eggs: Evidence of embryo growth				
EDE	3	0	2	0
FDDE	1	0	3	0
PDE	2	0	5	0
PAE	0	0	0	0
Hatched chicks	36	0	29	0
Fertile eggs	42	0	39	0
Fertility rate (%)	84	0.00	78	0.00
Hatchability and chick quality				
Hatchability (%)	85.7	0.00	74.3	0.00
Chick weight (g)	6.47	0.00	6.35	0.00
Chick yield (%)	62.0	0.00	61.77	0.00

IP: Incubation period; NCWFN: Not clear whether fertile eggs or not; EDE: Early dead embryos; FDDE: Fully developed but dead embryos; PDE: Pipped and dead embryos; PAE: Pipped and alive but not able to emerge embryos.

CONCLUSION AND RECOMMENDATION

Since hatchability was recorded only in the control (electric incubator), solar drier supplemented with either lantern or electric bulb heat, may not be feasible in Japanese quail eggs incubation. Therefore, further investigations on how to harvest solar heat during the day, conserve and stabilize it during the night become imperative, in order to make good some elements of climate change.

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