Nigerian J. Anim, Sci. 2024, 26 (1): 51-57

Egg incubation temperature and hatchability of two mutual brooding hens at different locations in Nasarawa State, Nigeria.

[1]Idahor, K.O., [2]Fatai, R.B., and [3]Dogara, M.U.

[1]Department of Animal Science, Nasarawa State University, Keffi, Shabu-Lafia Campus, P.M.B. 135, Lafia, 950101, Nigeria
[2]Animal Science Department, University of Ibadan, Ibadan
[3]Department of Animal Science, Faculty of Agriculture, Federal University of Lafia, P.M.B. 146, Lafia

Correspondence email: *koidahor@nsuk.edu.ng*

Target audience: *Hatchery operators, poultry farmers and the scientific community*

Abstract

Single-hen incubation is often the common practice but, in rare cases, two hens may mutually lay eggs in the same nest and incubate them together. This phenomenon may boost hatchability in natural incubation. Unfortunately, there is a dearth of knowledge on the incubation temperature and hatchability hence, this study was conducted. Mutual brooding hens were sought within Lafia and Karu Local Government Areas of Nasarawa State. Within a spate of 4 months, six sets of two hens' incubating eggs in the same nest were found. Data on incubation temperature, number of eggs incubated, incubation period and chicks hatched were recorded. It was shown that minimum incubation temperature varied from 34.9 – 36.6oC while maximum incubation temperature ranged from 37.3 – 38.8oC. In a total of 8, 9, 12, 14, 15 and 15 eggs incubated by two hens in Uke (Karu), Gitata (Karu), Ombi II (Lafia), COAST staff quarters (Lafia), Angwan Chindo (Karu), and COAST students' village (Lafia), respectively, the hatched chicks were 1 (12.5%), 7 (77.8%), 10 (83.3%), 7 (50.0%), 6 (40.0%) and 7 (46.7%) in that arrangement. These observations seemingly proved that two hens could mutually lay eggs together and incubate them thus, where possible, double-hen incubation may be simulated to increase chicken production.

Keywords: Broody hen, egg clutch, local chicken, two-hen incubation

Description of problem

Egg incubation is the process whereby eggs of oviparous or egg-laying animals, develop an embryo within the egg, after the egg's formation and ovipositional release. Egg incubation is done under favourable environmental conditions, possibly by setting and hatching the eggs. The act of sitting on eggs to incubate them is also known as brooding whereas, the action or behavioural tendency to sit on a clutch of eggs is called broodiness (1). Incubation is the process of providing optimum temperature, air circulation and relative humidity suitable for embryo development, growth and emergence as chick. This process

could be natural, where the broody hen sits on the eggs and covers them with the feathers to provide suitable environmental conditions for hatching. The other type of incubation is artificial, where incubators are used to simulate environmental conditions required to stimulate embryonic development and growth until the emergence of chicks (2).

According to FAO (3), broody hen chosen for natural incubation should be large enough to cover and keep the eggs warm, healthy and preferably vaccinated, with a good brooding and mothering record. Signs of broodiness are that the hen stops laying, remains sitting on the eggs, ruffles the feathers, spreads the wings and makes a distinctive clucking sound. It was emphasised that eggs usually become fertile about four days after the rooster has been introduced to the hens. Essentially, a maximum of 14 to 16 eggs may be brooded in one nest, but hatchability often declines with more than ten eggs, depending on the size of the hen. Feed and water provided near the hen, will enhance better condition and reduce embryo damage due to the cooling of the eggs if the hen has to leave the nest to scavenge for feed. The hen keeps the eggs at the correct humidity by splashing water on them from her beak. This is a further reason for providing easy access to water. In very dry regions, slightly damp soil can be placed under the nesting material to assist the hen in maintaining the correct humidity i.e. between 60 and 80 percent. Fertile eggs from other birds are best added under the brooding hen between one and four days after the start of brooding.

It was reported that local broody hens in Bangladesh, will sit on and hatch a second clutch of eggs, but often loses considerable weight in the process especially if insufficient attention is paid to the provision of feed and water (4). As given (5), the incubation period for chicken eggs is 20 to 21 days but may be up to 42 to 50 days in ostrich and emu, respectively. It was expressed that after sitting for some days, a broody hen can be given some newly hatched chicks and, if they are accepted, the original eggs can be removed and replaced with more chicks thus, hens with a better record of mothering can be better utilized for their abilities. FAO (3) stated that eggs initially need a very controlled heat input to maintain the optimum temperature of 38°C, because the embryo is microscopic. As the embryo grows in size especially on day 18, it produces more heat than it requires and may even need cooling hence, moisture levels of 60 to 80 percent are important to stop excess moisture loss from the egg contents through the porous eggshell and membranes.

After 20 – 21 days of incubation, the chicks emerge through a process described as piping and the final exit of the chick from the eggshell is called hatching. As reported by FAO (3), a hatchability of 80 percent of the eggs set in natural incubation is normal, but a range of 75 to 80 percent is considered satisfactory. The setting of hatchings is best timed so that the chicks to be hatched are two months of age at the onset of major weather changes, such as either the rainy or dry season or winter or summer. An abundant natural feed supply over the growing period of the chicks will ensure a better chance for their survival. Successful poultry species instinctively lay and incubate their eggs at a time of the year when newly hatched chicks will have a better supply of high protein and energy feed provided by the environment. For example, guinea fowl will only lay eggs in the rainy season. However, seasonal

changes in weather patterns are also times of greater disease risk.

In seldom cases, two hens may mutually lay eggs, brood them and raise the chicks together harmoniously yet, there are little or no information on egg incubation temperature and hatchability of two hens mutual brooding phenomenon. Hence, this study becomes timely and imperative, in a quest to understand better wild animal lifestyle.

Materials and methods

Mutual brooding hens were sought within Lafia and Karu Local Government Areas, Nasarawa State between June and September, 2023. During this period, only six sets of two hens' incubating eggs, that is two hens sitting on clutches of eggs, were found in the study areas. In every nest of the mutual brooding hens, a digital thermometer was placed on the eggs (as shown in plate 1) and was read daily in the morning (6:00am), afternoon (12:00 noon) and evening (6:00pm) but the mean values were recorded as the incubation temperature. Incubation temperature data collection was extended to incubation day 23 as suggested (2) to capture chicks that may hatch later than incubation day 20 – 21. The time the hens ceased laying and sat on the eggs was considered as the incubation start date. The period between incubation start day and 18 first day of chick emergence from the incubated eggs was recorded as the incubation period. The number of chicks hatched divided by the number of eggs incubated multiplied by 100 as described (2) was considered as the egg hatchability. The values obtained were analysed using simple descriptive statistics prescribed by (6).

Plate 1: Use of digital thermometer to obtain incubation temperature

Results

Given in table 1 is egg incubation temperature of two mutual brooding hens at different locations in Nasarawa State. There were no statistical differences ($p>0.05$) in the daily mean incubation temperature recorded in all the locations. However, the minimum incubation temperature ranged from 34.9^{o}C on incubation day 11 to 36.6^{o}C on incubation day 19 whereas, the maximum incubation temperature varied between 37.3^{o}C on incubation day 4 and 38.8^{o}C on incubation day 8.

Egg hatchability of two mutual brooding hens at different locations in Nasarawa State is provided in table 2. A total number of 8, 9, 12, 14, 15 and 15 eggs were incubated in Uke (Karu), Gitata (Karu), Ombi II (Lafia), COAST staff quarters (Lafia), Angwan Chindo (Karu), and COAST students' village (Lafia), respectively. In all these, chicks hatched were 1, 7, 10, 7, 6 and 7 representing hatchability of 12.5%, 77.8%, 83.3%, 50.0%, 40.0% and 46.7% in Uke (Karu), Gitata (Karu), Ombi II (Lafia), COAST staff quarters (Lafia), Angwan Chindo (Karu), and COAST students' village (Lafia), in that order.

Table 1: Egg incubation daily temperature of two mutual brooding hens at different locations in Nasarawa State (°C)

Incubation days	Two mutual hens' incubation locations						Statistics		
	Uke, Karu	Gitata, Karu	Angwan Chindo, Karu	COAST Stud. Villa., Lafia	COAST Qtrs., Lafia	Ombi II, Lafia	Min.	Max.	STD
1	37.2	38.1	36.9	36.1	37.6	36.6	35.8	38.4	0.86
2	38.1	37.1	36.9	36.2	36.2	37.7	36.1	38.5	1.00
3	36.2	37.3	37.2	36.9	37.3	36.7	36.5	37.9	0.89
4	35.5	36.8	37.4	36.9	37.3	37.0	36.4	37.3	0.89
5	36.5	36.7	38.4	37.5	37.6	37.4	36.2	38.5	0.89
6	36.7	37.1	37.9	37.5	37.1	37.7	36.5	38.0	1.00
7	36.7	36.4	36.6	37.1	37.3	37.1	36.2	37.6	0.86
8	36.1	37.3	37.4	38.4	36.6	37.2	35.8	38.8	0.85
9	36.8	37.2	36.6	37.7	37.3	38.1	36.4	38.4	0.86
10	37.1	36.6	37.7	37.7	36.6	36.2	36.2	38.1	0.89
11	37.4	37.5	36.7	37.6	36.4	35.5	34.9	37.9	0.89
12	36.3	37.5	37.0	37.5	37.6	36.5	36.1	37.9	1.00
13	36.4	37.3	37.4	37.4	37.7	36.7	36.1	37.9	1.00
14	36.0	36.8	37.7	36.6	37.2	36.7	35.7	38.0	0.86
15	36.5	37.1	37.1	36.8	37.2	36.8	36.2	37.4	1.00
16	36.2	37.1	37.8	36.9	37.0	37.6	36.0	37.8	0.89
17	36.7	36.8	37.0	36.8	37.5	36.8	36.3	37.8	0.89
18	36.9	37.6	37.4	37.0	37.6	37.2	36.5	37.8	0.89
19	36.7	36.8	37.3	37.3	37.5	37.5	36.6	37.8	1.00
20	36.1	37.2	37.5	37.2	37.6	36.9	35.9	38.0	0.86
21	36.8	37.4	37.5	37.3	37.5	36.8	36.3	37.9	0.89
22	36.6	37.1	37.3	37.4	36.9	36.1	36.0	37.7	0.89
23	37.7	37.4	36.6	38.4	36.8	36.2	36.4	38.6	1.00

Table 2: Hatchability of two mutual brooding hens at different locations in Nasarawa state

Parameters	Uke	Gitata	Angwan Chindo	Coast Student village	Coast Qtrs.	Ombi II, Lafia
No. of eggs incubated	8	9	15	15	14	12
Incubation start date	July 2, '23	July 15, '23	July 20, '23	Aug 2, '23	Aug 9, '23	Aug 20, '23
First hatched chick	July 23, '23	Aug 5, '23	Aug 9, '23	Aug 22, '23	Aug 30, '23	Sep 9, '23
Incubation days	21	21	20	20	21	20
No. of chicks hatched	1	7	6	7	7	10
Hatchability (%)	12.5	77.8	40.0	46.7	50.0	83.3

COAST Qtrs.: College of Agriculture, Science and Technology Staff Quarters; Aug.: August; Sep.: September

Plate 2: Two mutual brooding hens at Uke, Karu

Plate 3: Two mutual brooding hens at Gitata, Karu

Plate 4: Two mutual brooding hens at Angwan Chindo, Karu

Plate 5: Two mutual brooding hens at COAST students' village, Lafia

Plate 6: Two mutual brooding hens at COAST staff quarters, Lafia.

Plate 7: Two mutual brooding hens at Ombi II, Lafia

Plates 2 – 7 show two mutual brooding hens that were found at Uke, Karu, Gitata, Karu, Angwan Chindo, Karu, COAST students' village, Lafia, COAST staff quarters, Lafia and Ombi II, Lafia.

Discussion

The incubation temperature recorded in this study, is somewhat higher than a range of 34.59 – 35.05°C reported (7) when one-hen and two-hen brooding strategies were compared. But similar to a range of 36.1 – 40.1°C reported (2), when optimum incubation temperature was being determined in Japanese quail. The incubation temperature recorded in all the locations were within 33 – 40°C reported to be the lower limit of optimal embryo development in avian species (8, 9, 10). Meanwhile, a range of 37 – 38°C have been reported as the optimum operating temperature (5, 11) for avian species and it was stated that deviations from this optimum value, could have a major impact on hatching success (12). Also, it was reported that temperature outside the optimum range could affect post-hatch performance in avian species (2, 13, 14). Meanwhile, it has been suggested (16) that it would be more convenient to describe optimum incubation temperature in a range of values, rather than using a single value as an optimum incubation temperature in hatchery operations.

It was observed that the incubation temperature recorded in two-hen incubation was comparable to what was reported in single-hen incubation. Therefore, mutual hen incubation may be simulated because, as a hen goes to bout, the other remains on the nest. This strategy may ensure constant warmth for the growing embryos thus, boost the overall hatchability in natural hatchery process. The number of eggs incubated were close to 12 eggs incubated by two broody hens reported (6) and were within a maximum of 14 to 16 eggs that was

suggested (3) may be brooded in one nest. Going by this, it is expected that the two hens would have laid and brooded at least 20 - 30 eggs per nest. The explanation for the incommensurable number of eggs laid and incubated by the two hens, may be due to the hen's instinct that will stop egg laying but influence the behavioural tendency to sit on eggs laid so far (1, 3).

The incubation period was within 20 – 21 days as given in fowl (5) therefore, two-hen incubation may not necessarily influence incubation duration, even when the warmth required by the embryo is provided constantly as the hens' bout alternately. The egg hatchability in Gitata, Karu and Ombi II, Lafia was somewhat close to a range of 75 to 80 percent considered to be satisfactory in fowl (3, 1). However, the depressed values recorded in Uke, Angwan Chindo, COAST students' village and COAST staff quarters, may be coincidental or probably due to the season, environmental forces and human disturbances emanating from the experimenter during the incubation process. This is in consonance with the suspicion in year 2015, when reasons could not be adduced to the cause of embryonal deaths, among naturally incubated eggs in some households in COAL staff quarters now COAST, Lafia (7).

Conclusions and applications

This study demonstrated that two hens could mutually lay eggs together and incubate them. There were hatched chicks in all the two-hen incubations across the locations covered in the study. Where possible therefore, double-hen incubation may be simulated to increase chicken production. The adoption of natural incubation with two broody hens may increase chicken production particularly, in remote villages where artificial incubation is not feasible.

References

1. Wikipedia, (2023). Egg incubation. Accessed in December, 2023 from: https://en.wikipedia.org/w/index.php?title=Egg_incubation&oldid=1188170432
2. Idahor, K.O. (2021). Optimum incubation temperature determination and alteration to enhance sex reversal, hatchability and post-hatch performance of Japanese quails (*Coturnix japonica*). A PhD Thesis in the Department of Animal Science, submitted to the Faculty of Agriculture and Forestry, University of Ibadan, Ibadan, Nigeria. Pp 284.
3. FAO, (2004). Manual small-scale poultry production technical guide, FAO Animal Production and Health 1, Food and Agriculture Organization of The United Nations, Rome. Chapter 5: Incubation and Hatching, SBN 92-5-105082-1; ISSN 1810-1119.
4. Huque, Q.M.E. (1999). Poultry research in Bangladesh: present status and its implication for future research. In F. Dolberg, and P.H. Petersen, eds. Poultry as a Tool in Poverty Eradication and Promotion of Gender Equality, pp.151-164. Proceedings workshop, March 22-26, 1999, Tune Landboskole, Denmark (also available at http://www.husdyr.kvl.dk/htm/php/tune99/15-Haque.htm).

5. Archer G.S. and Cartwright A.L. (2018). Incubating and hatching eggs. Texas A&M AgriLife Extension Service, AgriLifeBookstore.org. EPS-001 7/13.
6. Adesoye P. O. 2006. Practical Guide to statistical analysis for scientists (A Primer Edn.). Debo Prints, Ibadan, Pp. 189.
7. Idahor, K.O., Sati, N.M., Emennaa, P.E., Fatai, R.B., Yakubu, A. and Abari, M.A. (2022). Comparison of one-hen and two-hen brooding strategies among Nigerian indigenous hens in natural incubation. In: Proceedings of 11th ASAN-NIAS Joint Annual Meeting & 27th ASAN Ann. Conf. Bauchi 2022, Pp 96 – 98.
8. Göth, A. and Booth, D.T. (2005). Temperature-dependent sex ratio in a bird. Biology Letters, 1: 31-33.
9. Mani, A.U., Garndawa, I.I. and Usman, B.A. (2008). Effects of pre-incubation storage on the hatchability of quail (*Coturnix japonica*) eggs in the Sahel region of Nigeria. International Journal of Poultry Science, 7(4): 350-354. ISSN 1682-8356.
10. Pam, T. (2015). Hatching eggs: A step by step guide. Pp. 3. Accessed in December, 2015 at: www.canteach.ca.
11. Archer, G.S. and Cartwright, A.L. (2018). Incubating and hatching eggs. Texas A&M AgriLife Extension Service, AgriLifeBookstore.org. EPS-001 7/13.
12. Sartell, J. (2018). Incubation station: a reference guide to incubation terms, temperatures, times and humidity levels. Community Chickens Newsletter. Accessed in July 2018 at: https://www.communitychickens.com/category/coops/https://www.beautyofbirds.com/egg incubationtemperature.html.
13. Wilson, W.O., Abbott, U.K. and Abplanalp, H. (1961). Evaluation of coturnix (Japanese quail) as pilot animal for poultry. Poultry Science, 40 (3):651-657. 22
14. Hulet, R.M., Gladys, G., Hill, D. and Meijerhof, R. (2000). Embryonic temperature effects on post-hatch performance in broilers. Avian Poultry Biology Review, 11:298-299.
15. Lourens, S. and Middelkoop, J.H. (2000). Embryo temperature affects hatchability and row-out performance of broilers. Avian Poultry Biology Review, 11:299-301.
16. French, N.A. (2009). Incubation and hatching. In: Biology of Breeding Poultry, (Hocking, P. M., Ed), Pp. 206-223. CAB International, Wallingford, Oxfordshire, UK.