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EFFECTS OF VARYING FEEDING TIMES ON FERTILITY AND HATCHABILITY OF BROILER CHICKEN BREEDERS IN A TROPICAL ENVIRONMENT

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Abstract

This study investigated the effects of feeding times on total egg production, fertility and hatchability of broiler chicken breeders in a tropical environment. The experiment was conducted using 240 Marshal Broiler breeder flocks for eight weeks between 40 to 48 weeks of age. The birds were randomly assigned to 3 treatment groups of feeding times (3, 5 and 7 am), with four replicates per treatments. Each feeding time consisted of 80 birds replicated in quadruplets of 20 birds each in a Completely Randomized Design. Prior to the eighth week data collection, the birds were allowed to get accustomed to the new feeding pattern for the first two weeks. The first four weeks (1 – 4 weeks) of the experiment was scheduled for the feeding time and eggs were collected and taken to the hatchery on regular basis. The second four weeks (5 – 8 weeks) was for monitoring of the eggs in the hatchery and the stages of embryonic development. Significant ($p<0.05$) differences were obtained only in the hen-day egg production, average number of chicks hatched and percentage hatchability. Broiler chicken breeders on 3 and 5 am feeding times recorded similar hen-day egg production. Survivability was best ($p<0.05$) at 3 am (85.16%) feeding time and poorest in broiler chicken breeders on 5 am feeding time. Feeding did not impact negatively on the embryonic development. It was then concluded that feeding broiler breeders at 3 am or 5 am in tropical environment enhanced better hen-day egg production, and hatchability.

Keywords: Broiler breeders, egg production, feeding time, embryonic development

EFFETS DES DIFFERENTS TEMPS D'ALIMENTATION SUR LA FERTILITE ET LE TAUX D'ECLOSION DES POULETS DE CHAIR REPRODUCTEURS DANS UN ENVIRONNEMENT TROPICAL

Resume

La présente étude a analysé les effets des temps d'alimentation sur la production totale d'œufs, la fertilité et le taux d'éclosion des poulets de chair reproducteurs dans un environnement tropical. L'expérience a été menée en utilisant 240 troupeaux de poulets de chair reproducteurs âgés de 40 - 48 semaines pendant huit semaines. Les oiseaux ont été répartis de manière aléatoire à 3 groupes de traitement de temps d'alimentation (3, 5 et 7 heures du matin), avec quatre répétitions par traitement. Chaque temps d'alimentation comportait 80 oiseaux répliqués en quadruplets de 20 oiseaux chacun dans un dispositif complètement randomisé. Avant la collecte des données de la huitième semaine, les oiseaux ont été autorisés à s'habituer au nouveau mode d'alimentation pendant les deux premières semaines. Les quatre premières semaines (1 à 4 semaines) de l'expérience ont été programmées pour la période d'alimentation et les œufs ont été régulièrement recueillis et amenés à l'écloserie. Les deux autres quatre semaines (5 à 8 semaines) visaient la surveillance des œufs dans l'écloserie et les stades de développement embryonnaire. Des différences significatives ($p <0,05$) n'ont été obtenues qu'au niveau de la production journalière d'œufs, du nombre moyen de poussins éclos et du pourcentage d'éclosion. Les poulets de chair reproducteurs dont les temps d'alimentation étaient fixés à 3 et 5 heures du matin ont enregistré une

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production journalière similaire d'œufs. Le taux de survie était meilleure (p <0,05) au temps d'alimentation de 3 h a.m. (85,16%) et le plus faible chez les poulets de chair reproducteurs soumis au temps d'alimentation de 5 heures du matin. L'alimentation n'a pas eu d'impact négatif sur le développement embryonnaire. On a alors conclu que l'alimentation des poulets de chair reproducteurs à 3 heures du matin ou à 5 heures du matin dans un environnement tropical améliorait la production d'œufs et le potentiel d'éclosion.

Mots-clés : poulets de chair reproducteurs, production d'œufs, temps d'alimentation, développement embryonnaire

Introduction

The efficiency of hatcheries is often measured in terms of hatchability which greatly influences the production and distribution of day-old chicks and eventually initiates the poultry production chain (King'ori, 2011). Although, genetic factors could influence fertility and hatchability of breeder birds, but with proper management and handling of these birds, some genetical traits can be suppressed. According to Zuidhof et al. (2014), there have also been unintended consequences, and a prime example is the challenge of allocating feed to parent stocks, which is faced daily by hatching egg producers. Overweight hens produce excess follicles in their ovaries and their reproductive output is seriously compromised in terms of settable egg numbers, fertility and chick quality.

Changing time of feeding (from morning to afternoon) was among many experimental alternatives used to improve egg shell quality of broiler breeder hens maintained under optimal environmental conditions (Bootwalla *et al.,* 1983; Wilson and Keeling, 1991). It was reported that afternoon feeding resulted in a higher rate of egg production (Balnave, 1977; Bootwalla *et al.,* 1983). However, a decline in egg production was observed by Harms (1991) when feeding time was changed from morning to afternoon. Wilson and Keeling (1991) also speculated that a change in time of lay or increased transit time of the egg through the oviduct, could be responsible for the delay in time of oviposition observed when broiler breeder hens were fed in the afternoon. A study by Spradley et al. (2008) reported that broiler breeders fed twice a day laid more and heavier eggs through 42 weeks of age and had better overall body weight uniformity than those fed once a day. Chen et al. (2006) reported that high glucose availability due to hyperphagia in broiler breeders could result in lipotoxicity and ovarian dysfunction. This thereby hinders fertility and hatchability which are major parameters of reproductive performance and are most sensitive to environmental and genetic influence.

Several feeding regimes systems are applied to improve the performance of fertile egg production in poultry. The usual procedure is to feed broiler breeder hens once a day particularly in the morning. Cave (1981) evaluated different feeding schemes for female broiler breeders from 24 to 63 weeks of age, and reported no difference in egg production. The lowest body weight gain, together with the heaviest egg mass, indicated that more frequent feeding allowed better partition of nutrients for egg formation instead of body tissue.

Feeding time seems to have the potential to influence the performance of adult broiler breeder flocks and it is thus of great importance (Backhouse and Gous, 2006). Formerly, feeding breeders in the late afternoon was a standard procedure, but latter study (Leeson and Summers, 2000) showed that choice of feeding time for adult breeders could influence the production of settable eggs, egg shell quality, fertility and hatchability. The authors further stated that feeding in the late afternoon resulted in probable reduction of mating activities and the increase of the amount of broken eggs because the hens are more interested in feeding than in mating activity and there are more aggression between males. Additionally, the later the hens are fed the higher the chances for the production of eggs with abnormal shells resulting in a reduction in hatchability (Clunies et al., 1993). Hence, choosing an adequate feeding system as

well as the best time in the day for providing the feed could be considered among the most important practices, which help small poultry producers to achieve the best possible production performance especially under hot and humid climatic conditions in tropical countries. The adequate time in the day for poultry feeding, especially in hot regions, could be considered as one of the most important factors that play an important role in the body thermo-regulation of birds (De Avila *et al.,* 2003; Ashour *et al.,* 2004). This study therefore aimed at determining the effects of changing the time of poultry feeding in the dry season and at cooler hours in a tropical environment in a broiler breeder farms on the productive and reproductive performance of the birds.

Materials and methods

Experimental site

The research was conducted at Obasanjo Farms Nigeria Ltd., Igbo-Ora breeder's Farm, Oyo State, Nigeria. The site is situated in the rain forest zone of Nigeria, on latitude 7026'1.79" N and longitude 3017'16.37" E with an elevation of 140m above sea level (Google earth, 2016).

Experimental birds and management

The experiment was conducted using 240 Marshal Broiler breeder flocks for eight weeks between 40 to 48 weeks of age. These birds were randomly assigned to 3 treatment groups, with four replicates per treatments. The birds were housed in a fenced hall, with cages equipped with nipple drinker system. Room's cleaning and disinfection programs were carried out in accordance with standards employed by the Farm. Prior to the eighth week data collection, the birds were allowed to get accustomed to the new feeding pattern for the first two weeks. The first four weeks of the experiment was scheduled for the feeding time and eggs were collected from the birds and taken to the hatchery on regular basis (not more than 5 days storage period). The second four weeks was then used for the monitoring of the eggs in the hatchery and the stages of the embryonic development.

Feeding Times

Three feeding times were used, 3.00 am (as control; the practice on the farm), 5.00 am and 7.00 am i.e. 3:00 hours, 5:00 hours and 7:00 hours. All birds were fed once a day at the chosen varying feeding times on 135 g of feed per bird per day. All the treatments were replicated four times to contain 20 birds per replicate. The lighting schedules for the birds were for 12 hours of day light, 4 hours of artificial lighting and 8 hours of darkness.

Data Collection

Laying performance of breeders

Daily records of feeds consumed, mortality from the start of the experiment till the end of the experiment was recorded and used for this study.

1. Feed Conversion Ratio (FCR): This was calculated as the ratio of feed consumed (g) to weight of hen-day egg laid (g):
   FCR = {Total feed intake (g)/Total egg produced (g)}
2. Hen-day production (HDP): This was measured by the ratio of the egg laid in a day divided by the number of birds alive multiplied by 100.
   HDP = (Egg laid per day/☐ of birds alive) *100 %
3. Breeder house mortality: This was a measure of birds that are alive, which gave an indication of the survivability of the breeder stocked. It was calculated by the formula:
   Breeder house survivability = (☐ of broiler breeders that are alive/ Total ☐ of broiler breeders in stocked) *100 %

Percentage Egg production

This was calculated by the ratio of the total number of eggs produced to the total number of birds stocked per pen multiplied by 100. That is:

Percentage egg production = (Total ☐ of eggs produced/Total ☐ of birds stocked per pen) *100

Fertility Test

This was determined on the 5th day of incubation. A total of 390 eggs set were moved into the candling room and candling was done to check for fertility. Clear eggs (eggs with no living shrimp-like structure) were separated.

Percentage Fertility

This was calculated as the number of fertile eggs divided by the number of eggs set and multiplied by 100% Fertility = (☐ of fertile eggs/☐ of eggs set) *100

The percentage infertile (% infertile) eggs was determined by subtracting the percentage fertile eggs from 100.

Percentage Hatchability

This was determined by the ratio of number of chicks hatched to the number of fertile eggs multiplied by 100% Hatchability = (☐ of chicks hatched/☐ of fertile eggs) *100

Determination of Embryonic Development

A total number of three hundred and thirty-six (336) hatching eggs (4 eggs from each replicate of 3 treatments) at days 1, 3, 5, 7, 10, 15 and 18 of incubation were broken into petri dishes for the determination of embryonic development. Also, 4 eggs (an egg per replicate) from each treatment were gently broken to determine the weight of the growing embryo, the amount of remaining yolk, albumen and moisture loss. Pictures of the more pronounced development of the embryo were taken.

Chick Quality Assessments

Ten chicks were picked at random from each treatment to assess chick quality using PASGAR® score for parameters observed (Meijerhof, 2009). For each chick, the average score was calculated. The parameters evaluated include the following:

1. **Chick Vitality:** if when the chick is made to lie on its back and it sits up immediately (score=0) but if it takes more than 3 seconds to sit up (score=1).
2. **Navel:** the navel is normal when it is completely closed and all yolk is absorbed (score=0). If navel is open and/or a dried cord can still be seen (score=1).
3. **Hock Joint:** if the hock joint is not enflamed and have a normal colour (score=0). But if the hock joint is enflamed and/or red (score=1).
4. **Beak:** if the beak is clean and the nostrils are closed (score=0), but if the beak is dirty and/or has a red dot (score=1).
5. **Abdomen:** the size of the abdomen depends on the size of the yolk sac and is essentially linked to temperature and humidity in during incubation. If the chick has a soft abdomen (score=0), but if the abdomen is hard and the skin is stretched (score=1).

Statistical Analysis

Data obtained were subjected to completely randomized design. Significantly ($p<0.05$) different means among variables were separated using Duncan's multiple range test as contained in SAS (2004).

Results

Effects of feeding times on egg production of broiler chicken breeders

Table 1 shows the effects of feeding time on the total egg production of broiler chicken breeders. Significant ($p<0.05$) difference was obtained only in the hen-day egg production among the treatments. Comparable values of 69.19% and 69.83% were observed in broiler chicken breeders on 3 and 5 am feeding times, respectively and these were significantly ($p<0.05$) higher than 60.55% recorded in birds on 7 am feeding time.

Effects of feeding times on egg fertility and hatchability of broiler chicken breeders

The effects of feeding time on egg fertility and hatchability of broiler chicken breeders in tropical environment are shown in Table 2. Feeding times significantly ($P<0.05$) affected the average number of chicks hatched and the percentage hatchability. Broiler chicken breeders on feeding times 3 am and 5 am recorded similar values in the average number of chicks hatched and percentage hatchability. Birds on 7 am feeding time recorded the least (25.34) average number of chicks hatched and

the poorest percentage hatchability (90.53 %). The other parameters measured were not significantly (p>0.05) affected by the feeding times. Broiler chicken breeders on 3 am and 5 am feeding times recorded numerically higher values (90.31 and 84.84 eggs, respectively) in egg laid compared to the birds on 7 am (79.69 eggs) feeding time. The same observation was made for the egg set across the treatments. However, birds on 5 am feeding time recorded numerically highest percentage fertile eggs (91.27 %) and percentage infertile eggs (9.57 %) than birds on 3 am and 7 am feeding times.

Effects of Feeding Time on survivability of Broiler Chicken Breeders

Table 3 shows the effects of feeding time on the survivability of broiler chicken breeders in a tropical environment. The best (P<0.05) survivability was obtained in broiler chicken breeders on 3 am feeding time (85.16 %) followed by birds fed at 7 am (74.69 %) while the poorest survivability was observed in broiler chicken breeders on 5 am feeding time. The other parameters measured were not significantly (P>0.05) influenced by the feeding times.

Effects of Feeding Time on the quality of chicks of Broiler Chicken Breeders

Table 4 shows the effects of feeding time on the quality of chicks of broiler chicken breeders in a tropical environment. Feeding times did not significantly (p>0.05) influence the average chick weight, vitality of the chicks, navel, hock joint, beak and abdomen.

Effects of feeding time on embryonic development of broiler chicken breeder eggs

Plates 1 to 7 show the embryonic development of broiler chicken breeder eggs as affected by the feeding times. It was observed that feeding did not impact negatively on the embryonic development hence at every stage of measurement, a plate describes the development irrespective of the feeding times.

Table 1: Effect of feeding time on total egg production of broiler chicken breeder birds

	Feeding time		
Parameter	**3 am**	**5 am**	**7 am**
Feed intake (g/bird/day)	126.02±5.59	117.64±1.20	126.23±1.09
Average egg mass (g)	45.27±3.20	47.81±4.49	38.60±1.31
Average egg laid	90.31±3.89	84.84±4.78	76.69±2.71
Feed conversion ratio	1.95±0.15	1.73±0.05	1.98±0.01
Hen-day egg production (%)	69.19±1.10[a]	69.83±4.05[a]	60.55±1.65[b]

[a,b]: Means on the same row having different superscripts are significantly (p<0.05) different

Table 2: Effects of feeding time on egg fertility and hatchability of Broiler chicken breeders

	Feeding time		
Parameter	**3 am**	**5 am**	**7 am**
Average number of eggs laid	90.31± 3.89	84.84± 4.76	79.69± 2.71
Average number of eggs set	32.75±2.68	31.50±2.56	30.75±2.56
Average number of fertile egg	29.75±2.72	28.75±1.38	28.00±1.47
% Fertile eggs	90.84±2.91	91.27±2.90	91.06±3.53
Average number of infertile eggs	3.00±0.41	2.75±0.48	2.75±0.25
% Infertile eggs	9.16±1.43	9.57±1.33	8.94±1.36
Average number of chicks hatched	28.67±2.72[a]	27.69±1.75[a]	25.34±0.75[b]
% Hatchability	96.39±0.37[a]	96.32±1.57[a]	90.53±2.52[b]

[a,b]: Means on the same row having different superscripts are significantly (p<0.05) different

Table 3: Effects of feeding time on survivability of broiler chicken breeders

	Feeding time		
Parameter	**3 am**	**5 am**	**7 am**
Feed intake (g/bird/day)	126.02± 5.59	117.64± 1.20	126.23± 1.09
Average number of eggs laid	90.31±3.89	84.84±4.76	79.69±2.71
Feed conversion ratio	1.95±0.15	1.74±0.05	1.98±0.01
Breeder house survivability (%)	85.16±9.82[a]	63.72±3.96[b]	74.69±2.02[b]

[a,b]: Means on the same row having different superscripts are significantly (p<0.05) different

Table 4: Effects of Feeding Time on the Quality of chicks of Broiler Chicken Breeders

	Feeding time		
Parameter	**3 am**	**5 am**	**7 am**
Average chick weight (g)	41.73±0.91	42.08±0.71	39.93±1.35
Vitality	2.00±0.41	2.50±0.50	1.75±1.18
Navel	0.75±0.48	0.25±0.25	0.75±0.25
Hock joint	0.00±0.00	0.00±0.00	0.00±0.00
Beak	0.00±0.00	0.00±0.00	0.00±0.00
Abdomen	0.00±0.00	0.00±0.00	0.00±0.00

[a,b]: Means on the same row having different superscripts are significantly (p<0.05) different

Plate 1 shows the picture of the first day of incubation. No development of embryo could be observed at this stage. The development of blood vessel and formation of appendages could be seen in Plate 2 which depicts the pictorial representation of an incubated chicken egg at day 3. Plate 3 shows the development of a growing chicken embryo on day 5 of incubation. The blood vessels were more obvious at this stage and formation of eyes could be observed. Day 7 of the embryonic development is shown in Plate 4; the eyes are

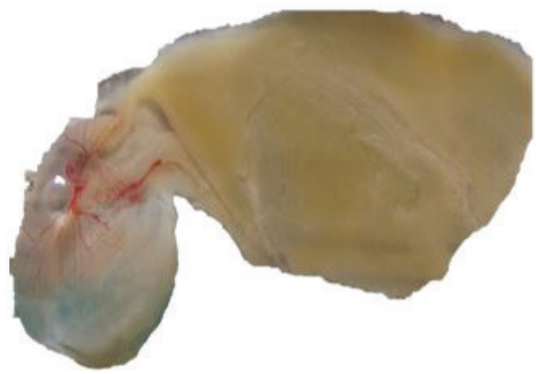

Plate 2. Embryonic development at day 3 (x 10)

Plate 1: Embryonic Development at day 1 (x10)

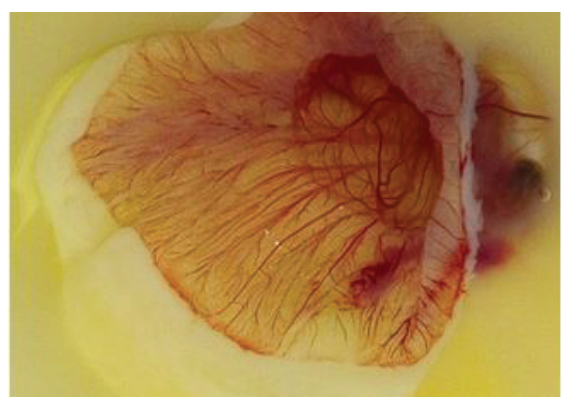

Plate 3. Embryonic development at day 5 (x 10)

Plate 4: Embryonic development day 7 (x 10)

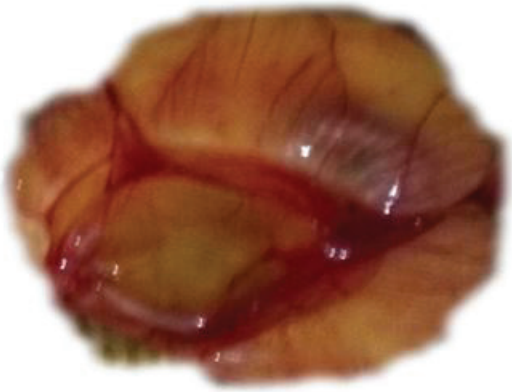

Plate 5. Embryonic development at day 10 (x 10)

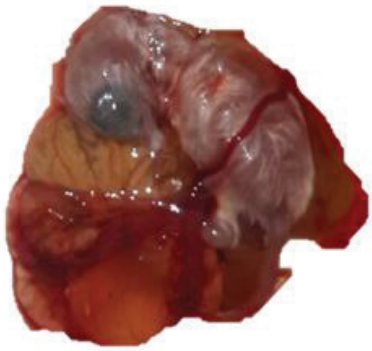

Plate 6: Embryonic development day 15 (x 10)

Plate 7: Embryonic development at day18 (x 10)

more conspicuous at this stage of incubation, also feather development could be observed. Plate 5 shows the embryonic development at day 10 of incubation; the head of the embryo is formed and the feathers are more obvious. The chick is well-developed, the eyes are more visible, beak, legs and feathers are well-developed on day 15 of incubation which is depicted in Plate 6. Plate 7 shows the stage of incubation of chicken egg at day 18. All parts of the chick are well-formed and conspicuously well-developed at this stage.

Discussion

In this study, significant differences were observed in the total hen-day egg production, birds fed at 3 and 5 am recorded higher hen-day egg production than flocks fed at 7 am. This result contrasted the findings of Londero et al. (2016) who reported that egg production of broiler breeders was not affected by the time of feeding. The result obtained by Londero et al. (2016) could be attributed to the difference in the time of feeding of the experiment which was on single feeding of 8 am, twice feeing times of 8 am and 3 pm, and single feeding of 3 pm.

Eggs laid across the treatments were not significantly affected by the varying times of feeding. This is however in agreement with the findings of Samara et al. (1996); De Avila et al. (2003); Backhouse and Gous (2006) who found out that the number of eggs produced per hen were not affected by feeding time. This study shows that average egg mass was not significantly influenced by different feeding times contrary to the findings of Backhouse and Gous (2006), who observed that feeding times and frequency affected egg mass. This could be due to difference in strains of breeders used in the experiments.

Feeding time has no effect on the feed intake of broiler breeders. This is in contrast with the findings of Ukachukwu and Akpan (2007) who reported a significant difference in the feeding regime of laying birds on restricted feeding. The difference between the present study and the findings by Ukachukwu

and Akpan (2007) could be as a result of the different management systems practiced.

In poultry reproductive flocks, it is essential to achieve a large number of eggs with normal structure, optimal morphological composition and interior quality (Majid *et al.,* 2013). Egg laid were not affected by time of feed allocation. This confirmed the findings of Samara et al. (1996), that different feeding schedules had no effect on the egg production. Fertility among the treatments were not affected by feeding time as reported by Bootwella et al. (1983) who found out that feeding time had no effect on breeders' fertility. Gibson (2006) also reported that different feeding schedules had no significant effect on fertility of broiler chicken breeders. However, the observed insignificance in the treatments could be as a result of timing and artificial insemination done for the breeders thereby confirming the reports by Penfold et al. (2000) in the endangered Northern Pintail duck.

Significant differences were observed in the breeder house mortality; birds fed at 5 am and 7 am recorded a higher mortality rate than those fed at 3 am. This could be as a result of increase in temperature as the sun rises compared to when the birds were fed earlier at 3 am thereby causing heat stress for the birds. This result however is in agreement with Wilson et al. (1989), who observed that the time of feeding is a factor that may result in heat stress, due to the heat increment from exothermic reactions that occur during feed metabolism. The authors observed that there is an increased interior temperature 5 hours after feeding time which causes a remarkable increase in body temperature of the birds.

Results from this study showed significant differences in the percentage hatchability at different times of feeding. This result corroborates the finding of Petek (2006) who reported that birds fed during the late hours of the morning and afternoon records a higher hatchability performance. Feeding time has no effect on the embryonic development of broiler eggs. The development followed the normal embryonic development similar to the finding of Tona et al. (2005). Moreover, feeding time has no effect on the chick weight of the broiler chicks across the treatments. This could be as a result of similarity in egg weight during incubation. Chick vitality, navel, hock, beak and abdomen were also not affected by the feeding time of the broiler breeders. The chicks observed recorded a healed navel, clean beak and of no deformities thereby confirming the findings of Tona et al. (2005).

Conclusion

From the results of the experiment it could be concluded that:

1. Feeding broiler chicken breeders at 3 am and 5 am had better hen-day egg production and hatchability
2. Survivability of broiler chicken breeders fed at 3 am was better than those fed at 5 am and 7 am.
3. Embryonic development was not influenced by time of feeding.

Impact

Based on this study, 3 am and 5 am feeding time could be recommended for a better productive performance of broiler chicken breeders in terms of hen-day egg production and higher percentage hatchability. However, for the best chicks' survivability, feeding time of 3 am could be retained by the Broiler Breeder Farm.

Ethical approval:

All applicable international, national and/or institutional guideline for the care and use of animals were followed.

Informed Consent:

Consent of every individual included in this study was obtained.

Conflict of interest:

The authors hereby declare that they have no conflict of interest.

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