

ASSOCIATION OF BREEDER AGE AND BODY WEIGHT WITH FERTILITY AND HATCHABILITY IN NATIVE CHICKEN

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ABSTRACT

The study was conducted to study the effect of age and body weight of parents on hatchability from 27 weeks to 52 weeks of age in native chicken breeders. The breeders were fed with diet as per BIS specifications and managed under standard conditions. The hatching eggs were collected and cleaned, fumigated and stored in the cold storage room. After 7 days, they were set in incubator. On 21st day, the chicks were pulled out. The hatchability on fertile eggs set was calculated based on the good quality chicks produced. The collected data on fertility and hatchability were analysed by general linear regression model by age, body weight of male and female parents using SPSS statistical package (Version 23.0). The results of this study indicated a significant difference ($p < 0.01$) in fertility, hatchability parameters and middle mortality with respect to age and body weight of parent.

Keywords: Native chicken, age, body weight, fertility and hatchability

Received : 11.05.2026

Revised : 21.09.2026

Accepted : 29.09.2026

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INTRODUCTION

Poultry industry in India has become incredible progress from a small-scale backyard venture to commercial, full-fledged, self-sufficient and agrobased industry (Verma *et al.*, 2018). Indigenous chickens are quite hardy as it is resistance to heat, disease, possesses meat with good flavor, higher fertility and hatchability along with good dressing percentage owing to their low productivity. Native chicken production has developed as important and resourceful point to resolve the problems related to

malnutrition, food safety, low income and poverty as a whole (Ekka *et al.*, 2016) and it alleviates protein deficiency and ropes economic empowerment in rural people by providing egg and meat for consumption (MLD, 2006). Thus chicken production reduces the gap between supply and source of animal protein which is accessible for consumption. Indigenous chickens are good foragers and require minimal attention to require for their growth and development (Alabbad, 2014).

The body weight has strong negative relationship with reproduction in domestic poultry (Siegel and Dunnington, 1985). The factors which affect the hatchability are strain, health, number and age of the flock, egg size, weight and quality, egg storage duration and condition in broiler breeders (Tona *et al.*, 2005). The efficiency of the breeder negatively associated with age and quality of hatching egg is influenced by its internal egg composition or ratio, egg weight, shell quality which leads to increased early and late embryo mortality (Tona *et al.*, 2004).

The composition of egg and ratio of albumen to yolk and quality of eggshell highly affected by age of breeder. The yolk values of both absolute and relative values are larger for older breeder flocks than younger flock (Nangsuay *et al.*, 2013). Padhi *et al.* (2013) found that the egg weight have negative correlation with its yolk to albumen ratio with regard to parent age and associated with early embryonic mortality. The effect on nutrient availability leads to defects in embryonic development

(Machado *et al.*, 2020) and differences in embryonic metabolism resulted by oxygen availability during incubation (Nangsuay *et al.*, 2017) also affected by the age of the breeder

Egg size is the economically important reproductive trait in layers as it is influenced by age and it is manipulated by fat, protein and enzymes in the diet. The young breeder produces eggs with strong shells and dense albumin, which hampers the transfer of moisture and gas exchange ultimately, leads to reduced hatchability. The weight loss during incubation in egg is related with egg weight between large egg from post peak broiler breeders and small eggs from young broiler breeder. Hatchability is elite quantitative trait that influenced by genetic make-up, nutrition and environmental condition. The increased genetic potential of indigenous chicken is achieved by planned breeding program with specific traits for improve productivity and efficiency (Wilson *et al.*, 2018). Some non-genetic factors like genotype, age of the breeder hen (Patra *et al.*, 2016) and season also affect the heritability in chicken ranges from 0.06 - 0.13 (Sapp *et al.*, 2004).

The possible loss of hatchability in older age breeders is due to larger egg size (Leeson and Summers, 2000), higher incidence of early and late embryo mortality (Elibol and Braket, 2003; Joseph and Moran, 2005), This study is carried out to study the effect of age and body weight of parents on fertility and hatchability on fertile egg set and total egg set under intensive system of management.

MATERIALS AND METHODS

Ethics statement

This experiment is approved by Institutional Animal Ethical Committee (Approval Number: IAEC / 6/VCRI/ NKL /2019).

Management of birds

The study was conducted at Poultry Farm Complex, Namakkal, Tamil Nadu between October 2020 and May 2021 starting from 27th week to 52nd weeks in Aseel native chicken breeders. Native chickens were reared in intensive system with standard practices for a period of 52 weeks. The breeders were fed diets with BIS standard as 16% crude protein, 2600 kcal ME / Kg, 3.0% calcium and 0.45% available phosphorus *ad libitum*. A total of 480 females were reared in 6 pens, each pen having 80 females with 10 males at the ratio of 1:8 in flock mating system. The number of eggs collected was 25,551 numbers and 24,529 eggs were selected for hatching purpose in 26 hatch intervals. The sample body weight (10% of the birds) was taken at random on weekly basis. A Photoperiod of 17 hours was provided up to 52 weeks. At 40th week, Ranikhet Disease Vaccine (killed) was given subcutaneously to maintain the immunity.

The selected hatching eggs were cleaned, fumigated and stored in the cold storage room at around 16-18°C with 70% relative humidity for 7 days. After that eggs are allowed to prewarm to reach the

room temperature and set in setter with temperature range of 99.5°F to 99.8°F for 18 days and 99°F in hatcher for last 3 days in multistage incubator. The chicks were pulled out on 21st day and remaining hatchery debris consist of infertile eggs, early embryonic mortality and middle mortality and late mortality were identified during break open analysis. The mortality of embryo was categorized into early (3 - 5 days) during first week of incubation, mid (second week of incubation) and late (third week of incubation). The day in which the embryo died can be assessed based on embryo development. The eggs with blood ring are considered as early embryonic death. The dead chick with adhered to shell is considered as dead in shell after intact shell. The chick piped out the shell by its beak but failed to hatch is considered as piped one. The hatched-out chicks were collected, graded and dispatched. Fertility percentage was calculated by number of fertile eggs divided by total number of eggs set while hatchability percentage on total egg set was calculated by the number of chicks hatched divided by total number of eggs set and multiplied by 100. Hatchability was calculated based on total egg set and fertile egg on the basis of saleable chicks only. The hatchability of eggs is expressed as the function of both hen and roosters on fertility and embryonic survival.

Data collection

Data on fertility, hatchability and break open analysis on the day of hatch are collected and recorded. Fertility was

calculated on the basis of total eggs set, whereas hatchability was calculated on the basis of total eggs and fertile eggs set. The fertility and hatchability were calculated by using the following formulae

$$\text{Fertility} = \frac{\text{Number of fertile eggs}}{\text{Total number of eggs incubated}} \times 100$$

$$\text{Hatchability on total eggs \%} = \frac{\text{Number of chicks hatched out}}{\text{Total number of eggs set}} \times 100$$

$$\text{Hatchability on fertile eggs \%} = \frac{\text{Number of chicks hatched out}}{\text{Total number of fertile eggs set}} \times 100$$

Statistical Analysis

Independent variables included hatchability (%), hatch-FES, chicks per parent, infertile eggs, early embryonic mortality (EEM: 3-7 days), middle embryonic mortality, late embryonic mortality (18-21days), live chicks / weak chicks dead-in-shell percentage and fertility. Dependent variables comprised parent age, body weight of male parent and body weight of female parent. The relationships between the independent and dependent variables were evaluated using second-order polynomial (quadratic) regression analysis, incorporating both linear (X) and quadratic (X²) terms to assess potential nonlinear relationships.

RESULTS AND DISCUSSION

This experiment was conducted with native chicken breeders to find out its

production performance from 27th week to 52nd week. The effect of age of the parents and its body weight on reproductive performances like fertility and hatchability were studied. The results were interpreted in the form of regression coefficients, coefficient of determination and level of significance of regression model for hatchability parameters with age and body weight of breeders.

Effects of age of the breeders on hatchability

The results presented in Table 1 revealed that breeder age was highly significantly associated with most hatchability parameters, including fertility, hatchability and hatch day break open analysis, except for embryonic mortality during 3 -7 days and the middle period of incubation which were not significantly associated with breeder age. Hatchability was highly dependent on age of the breeders as it is influenced by fertility and decreased with age as it is related with egg composition, egg weight, shell quality and increased embryo mortality (Tona *et al.*, 2004). They confirmed that the fertility is also related to hen's age, ability to mate successfully, storage of sperm, ovulation and embryo formation and its development (Brillard, 2003). Apart from this, poor hatchability may also result from unbalanced feed, improper collection and cleaning of eggs. Fertility of an egg and embryonic mortality during the hatching process is different for different strains or breeds.

The age of breeder would influence the subsequent embryogenesis and hatchability by utilizing the nutrients available in the egg (Yang *et al.*, 2020) in older breeders. The lower hatchability at aged breeders is consistently adhered with the findings of Aarujo *et al.* (2016) at 62 weeks old breeders (82.80%) than of 34 weeks old breeders (86.60%) and this differences in hatchability is because of decline in shell quality resulted in higher embryo mortality.

The results confirmed that the drop in hatchability as hen age advances are due to shortening of the clutch length in Hubbard breed at 60 weeks of age (Iqbal *et al.*, 2016), higher mortality and embryo mortality at 45 weeks of age (Ei-Safty, 2012), shell quality change and frequent mating activity leads to fertilization by old sperm. This is in contrast with the findings of Bouba *et al.* (2021) who observed lower hatchability in young breeders which are not associated with infertility with age and the size of the egg and its shell quality (porosity) would impair transfer of nutrients during late incubation influence the hatchability.

The significant differences ($p < 0.01$) in hatch day break open analysis was observed as a function of breeder age (Aarujo *et al.*, 2016). The breeder age did not affect ($p < 0.05$) the embryo mortality from 3-7 days and middle mortality (8-17 days) which is supported by Nangsuay and Van Beek, (1993) and Fassenko *et al.* (1995) who stated that fertility is inversely proportional to breeder age.

Effect of body weight of parents on hatchability

The regression coefficients, coefficients of determination and level of significance of regression model for hatchability parameters as influenced by body weights of male and female parents are presented in Table 2 and Table 3, respectively.

The body weight of male and female parents has significant ($p < 0.01$) effect on hatchability parameters except embryonic mortality at 3-7 days and in middle age of incubation. The reproductive efficiency of female breeders is affected by increased age at sexual maturity, rate of lay and ovarian regression. As breeder age increased, body weight of both male and female parents also increased, which was associated with a decline in hatchability and its related parameters during the experimental period.

CONCLUSION

The body weight and age of the parent may have significant correlation among fertility, hatchability and embryonic mortality traits. As the age of the hen advances, the shell quality become deteriorated and leads to higher moisture loss thorough the egg shell will affect the hatchability traits. The body weight will have direct correlation with the egg weight and increase in egg weight will have less eggshell thickness and less hatchability. Early embryonic mortality is resulted from

failure of the embryo to resume development after having stored and placed in the setter whereas middle mortality is related to nutritional deficiencies in the breeder diet or embryonic metabolism. Egg handling procedure and method of collection and storage condition of hatching egg is also affecting the hatchability. The hatchery loss occurred during 3 -5 day and mid mortality is not affected by age and body weight of parent breeders as it implied that this could be corrected by précised nutrient

recommendation.

ACKNOWLEDGMENTS

The author is thankful to the Department of Poultry Science, Veterinary College and Research Institute, Namakkal for giving permission to conduct this experiment. Author is thankful to the post-graduate students and undergraduate students of this college who assisted in the study.

Table.1. Regression coefficients, coefficients of determination and level of significance of regression model for hatchability parameters of parents

Independent variables	R Square	Standard Error of the Estimate	F statistic for the regression model	P-Value	Regression Equation (x: Age in weeks)
Hatchability %	0.766	0.97782	165.619	<0.001	$33.420 - 3.50E-02 x^2 + 2.746 x$
Hatch - FES	0.651	1.18453	94.303	<0.001	$42.944 - 2.90E-02 x^2 + 2.369 x$
Chicks per parent	0.988	1.59500	4235.480	<0.001	$-50.028 + 2.00E-03 x^2 + 1.754 x$
Infertile	0.556	0.73622	63.260	<0.001	$22.547 + 1.30E-02 x^2 - 0.973x$
EEM	0.587	0.46720	71.914	<0.001	$17.002 + 9.00E-4 x^2 - 0.741x$
3-7 days	0.016	0.34857	0.844	0.433	$0.304 - 1.00E-03 x^2 + 0.046 x$
Middle	0.019	0.32277	0.961	0.386	$-0.260 - 1.00E-03 x^2 + 0.069 x$
18 - 21 days	0.486	0.72932	47.697	<0.001	$25.826 + 1.40E-02 x^2 - 1.103x$
Live chicks / Weak chicks	0.452	0.41282	41.627	<0.001	$9.442 + 5.00E-03 x^2 - 0.419x$
Dead in shell	0.231	1.07710	15.207	<0.001	$24.243 + 1.20E-02 x^2 - 0.916x$
Fertility	0.556	0.73622	63.260	<0.001	$77.453 - 1.30E-02 x^2 + 0.973x$

- FES - Fertile Egg Set
- EEM - Early Embryonic Mortality

P < 0.01 indicates significant at 1% level

Table.2. Regression coefficients, coefficients of determination and level of significance of regression model for hatchability parameters of male parent

Independent variables	R Square	Standard Error of the Estimate	F statistic for the regression model	P-Value	Regression Equation (x: Age in weeks)
Hatchability %	0.766	0.97782	165.619	<0.001	$33.420 - 3.50E-02 x^2 + 2.746 x$
Hatch - FES	0.651	1.18453	94.303	<0.001	$42.944 - 2.90E-02 x^2 + 2.369 x$
Chicks per parent	0.988	1.59500	4235.480	<0.001	$-50.028 + 2.00E-03 x^2 + 1.754 x$
Infertile	0.556	0.73622	63.260	<0.001	$22.547 + 1.30E-02 x^2 - 0.973x$
EEM	0.587	0.46720	71.914	<0.001	$17.002 + 9.00E-4 x^2 - 0.741x$
3-7 days	0.016	0.34857	0.844	0.433	$0.304 - 1.00E-03 x^2 + 0.046 x$
Middle	0.019	0.32277	0.961	0.386	$-0.260 - 1.00E-03 x^2 + 0.069 x$
18 - 21 days	0.486	0.72932	47.697	<0.001	$25.826 + 1.40E-02 x^2 - 1.103x$
Live chicks / Weak chicks	0.452	0.41282	41.627	<0.001	$9.442 + 5.00E-03 x^2 - 0.419x$
Dead in shell	0.231	1.07710	15.207	<0.001	$24.243 + 1.20E-02 x^2 - 0.916x$
Fertility	0.556	0.73622	63.260	<0.001	$77.453 - 1.30E-02 x^2 + 0.973x$

- FES - Fertile Egg Set
 - EEM - Early Embryonic Mortality
- P < 0.01 indicates significant at 1% level**

Table.3. Regression coefficients, coefficients of determination and level of significance of regression model for hatchability parameters of female parent

Independent variables	R Square	Standard Error of the Estimate	F statistic for the regression model	P-Value	Regression Equation (x: Age in weeks)
Hatchability %	0.532	1.37185	57.458	<0.001	$-435.448 - 1.687E-04x^2 - 0.596x$
Hatch - FES	0.836	5.95639	256.831	<0.001	$-131.669 + 4.369E-05x^2 - 0.012x$
Chicks per parent	0.371	0.87615	29.825	<0.001	$193.762 + 6.531E-05x^2 - 0.222x$
Infertile	0.411	0.55827	35.233	<0.001	$149.120 + 4.645E-05x^2 - 0.166x$
EEM	0.008	0.35014	0.385	0.681	$5.222 + 1.157E-06x^2 - 0.004x$
3-7 days	0.006	0.32481	0.315	0.730	$9.905 + 2.820E-06x^2 + 0.010x$
Middle	0.370	0.80704	29.693	<0.001	$246.728 + 7.936E-05x^2 - 0.277x$
18 - 21 days	0.309	0.46341	22.610	<0.001	$75.544 + 2.359E-05x^2 - 0.085x$
Live chicks / Weak chicks	0.242	1.06938	16.160	<0.001	$243.826 + 7.796E-05x^2 - 0.272x$
Dead in shell	0.371	0.87615	29.825	<0.001	$-93.762 - 6.531E-05x^2 + 0.222x$
Fertility	0.556	0.73622	63.260	<0.001	$77.453 - 1.30E-02x^2 + 0.973x$

- FES - Fertile Egg Set
 - EEM - Early Embryonic Mortality
- P < 0.01 indicates significant at 1% level**

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