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Genetic parameters in IWK layer line

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Abstract
A total of 4479 progenies covering three generations (S_{12} to S_{14}) at ICAR-DPR, Hyderabad were utilized for the study. Overall least squares means of body weight at 0 day, 4, 8, 16, 20 and 40 weeks of age were 36.07±0.05g, 204.94±0.71g, 474.53±5.54g, 951.72±3.10g, 1162.24±4.19g 1426.26±5.71 g, respectively. The heritability estimates for body weights at different ages were studied. Heritability estimates for body weight at 0 day, 4, 8, 16, 20 and 40 weeks of age were 0.13±0.05, 0.09±0.03, 0.22±0.05, 0.19±0.06, 0.24±0.06 and 0.54±0.08. Hatch effect was significant ($p \leq 0.01$) on the body weights at 0 day, 4, 8, 16, 20 and 40 weeks of age. Generation was significantly affected all body weight traits.

Keywords: Heritability, IWK, white leghorn, animal model

1. Introduction

Poultry production is one of the fastest-growing sub-sector of Indian agriculture with a major change in structure and operations in the poultry sector. The present population of poultry in India is about 851.81 million with 534.74 million commercial birds and 317.07 million backyard poultry [3]. Poultry breeding programs based on sound genetic principles aid in-rapid improvement in poultry meat and egg production. The knowledge of the performance of economic traits in chicken is important in formulating the breeding plans. For further improvement in production traits. In the breeding programmes of chicken genetically diverse stocks are exploited for improving economic traits, such as body weights and annual egg production.

Evaluation of implemented breeding programs through estimation of genetic progress and inbreeding coefficient is useful to develop better breeding programs for the future. Selection for one trait may bring about changes in the other associated traits referred to as correlated responses. Hence it is essential to study the genetic correlation between the traits in order to implement suitable selection programmes effectively to obtain overall improvement in the economic value of the bird. Therefore, the present study on the genetic evaluation of juvenile and production traits of IWK layer line was carried out to evaluate growth and production performance and to estimate the genetic parameters of growth and production traits in IWK line.

2. Materials and Methods

The current study was conducted at ICAR-Directorate of Poultry Research, Hyderabad, Telangana, India. Hyderabad is located in Deccan plateau in southern part of India positioned between 17°23’ N and 78° 28’ E at height of 500 m from mean sea level. The location experiences usually hot and humid tropical climate with temperature ranging from 20 °C in winter to 45 °C in summer seasons. IWK, an Indian White Leghorn layer which has been improved for egg weight and egg numbers was selected to study the genetic and non-genetic determinants affecting economic traits of egg production. The current population was generated using 200 dams and 40 sires in a pedigree mating. The selection of the sires and dams were done based on the egg weight at 28 weeks and egg production up to 64 weeks using (Egg weight) x 1.4 + EP64 index. A total of 4479 day old chicks of IWK produced wing banded at the time of pedigree hatch. The four hatches were taken at the interval of ten days. Since the data were collected from birds produced in different hatches in each generation, the data was adjusted for significant hatch effects as per [7] and the hatch corrected data were utilized for further statistical analysis. Heritability, genetic, phenotypic and environmental correlations were estimated by full sib correlation method using mixed model least squares and maximum likelihood (LSMLMW) computer program [7].

The statistical model for the estimation of heritability of various traits studied was as follows.

$$Y_{ijk} = \mu + s_i + d_{ij} + e_{ijk}$$

where,
Y_{ijk} = Measurement of a trait on k^{th} progeny belonging to j^{th} dam mated to i^{th} sire.
μ = Overall mean
s_i = effect of i^{th} sire
d_{ij} = effect of j^{th} dam mated to the i^{th} sire
e_{ijk} = uncontrolled environmental and genetic deviations attributable to the Individuals.

3. Results & Discussion

3.1 Mean values of body weights

The least square means of body weight at 0 day, 4, 8, 16, 20 and 40 weeks along with standard error are presented in Table.1

Table 1: Least squares means of body weight traits of IWK line chicken

Particulars	Body weight, g at					
	0 day	**4wks**	**8wks**	**16wks**	**20wks**	**40wks**
Overall LSM	36.07±0.05 (4479)	204.94±0.71 (3572)	474.53±5.54 (3294)	951.72±3.10 (1915)	1162.24±4.19 (1860)	1426.26±5.71 (1370)
Generation	**	**	**	**	**	**
S-12	36.22±0.08^b (1768)	265.89±0.98^c (1667)	533.14±2.40^c (1587)	1018.92±5.07^c (662)	1181.10±6.63^b (647)	1425.72±7.01^b (622)
S-13	35.03±0.09^a (1492)	132.59±1.22^a (1250)	411.31±3.00^a (1167)	843.81±5.21^a (597)	1080.42±6.92^a (582)	1321.72±9.18^a (332)
S-14	36.83±0.10^c (1219)	155.37±1.68^b (655)	420.54±21.41^b (540)	925.23±4.88^b (656)	1206.35±7.55^c (631)	1479.59±13.47^c (416)
Hatch	**	**	**	**	NS	**
1	35.73±0.08^a (2233)	173.57±1.04^a (1680)	472.76±2.47^a (1677)	925.48±4.34^a (912)	1156.13±5.54 (1016)	1380.71±6.04^a (871)
2	35.65±0.09^a (1335)	180.29±1.32^b (1013)	448.43±14.39^a (763)	952.75±4.79^b (698)	1148.51±7.03 (546)	1454.39±14.28^b (213)
3	36.87±0.15^b (485)	307.66±1.87^d (455)	538.90±4.53^c (442)	972.29±8.49^c (213)	1190.27±11.44 (201)	1446.73±11.95^b (196)
4	37.59±0.16^c (453)	270.24±1.94^c (424)	493.78±4.69^b (412)	1006.80±12.93^d (92)	1193.72±16.47 (97)	1486.17±17.63^c (90)
Gen x Hatch	**	**	**	**	**	*

Values in the parentheses are number of observations; Means with same superscripts do not differ significantly, * (P<0.05), ** (P<0.01).

In the present study, the overall LSM of body weight at 0 day was 36.07±0.05 grams which was in accordance with the earlier studies conducted in IWK line [1]. Body weight at 4 weeks of age in the present study was found to be 204.94±0.71 grams, but series of authors [15, 20, 27, 28, 32] in different chicken breeds reported lower values and few authors [12, 22, 26] recorded higher values than the present findings in different chicken breeds. It might be due to natural biological variation exists for growth traits among various breeds.
In the present study the mean body weight at 16 weeks of age was found to be 951.72±3.10, contrary to these findings lower values were reported by several authors [1, 8, 15, 23, 21] in different chicken breeds.
Body weight at 20 weeks of age in the present study was 1162.24±4.19 grams which was less compared to the findings of [1, 5, 12, 13, 15, 18, 24, 28, 29, 30] whereas higher values were reported by [2, 4, 10] in various chicken breeds.
The mean body weight at 40 weeks of age in the present study was 1426.26±5.71 grams. But various authors [5, 9,11, 12, 18, 25, 29, 30] reported higher values for the trait in various layers. However some authors [1, 10, 14, 31] reported lower values than the present findings.
Significant differences in LSMs for body weights were observed in different generations and hatches in the population under study. The underlying reason could be the variability in environmental and managerial conditions at different times.

3.2 Heritability estimates of body weights

The heritability estimates of body weight at 0 day, 4, 8, 16, 20 and 40 weeks along with standard error are presented in Table.2

Table 2: Heritability estimates for various traits in IWK layer line

Gen No.	Traits					
	BW0	**BW4**	**BW8**	**BW16**	**BW20**	**BW40**
S12-S14	0.13±0.05	0.09±0.03	0.22±0.05	0.19±0.06	0.24±0.06	0.54±0.08

In the present study, in the case of body weight on the day of hatch (BW0) it was found that out of the total heritability, maternal heritability holds a major share compared to the direct heritability. Egg quality traits like egg weight, size and shell quality, which were determined by the maternal inheritance influence the chick weight at hatch which was also true in the present study as the BW0 had significant maternal genetic effects. This explains that, though maternal genetic effects were essential for early body weight (hatch weight), the contribution of maternal permanent environmental effects was more than the direct and maternal genetic effects.
For the other body weight traits i.e., body weight at 4, 8, 16, 20 and 40 weeks of age the maternal genetic and maternal

permanent environmental heritability were significantly lower than the additive heritability indicating that the contribution of maternal effects to the phenotypic variation of body weight decreased significantly with age and was consistent with the report of [16].

The possible reason for the variation in heritability of body weights of the current study to the earlier literature might be due to the methods used to estimate the heritability of the traits. The traditional animal models ignore the maternal and permanent environmental effects in chicken leading to overestimation of additive genetic variance resulting in high heritability estimates. The maternal effect is defined as the condition in which the phenotype of the offspring is determined not only by the environment and its genotype but also by the genotype and environment of their mother. A maternal effect is a condition where the traits get influenced by the genotype and environment of the mother. Maternal effects are important for the development and expression of economic traits due to genetic or environmental differences between dams or by the combination of genetic or environmental differences [6, 19].

3.3 Correlations

The correlations of body weight at 0 day, 4, 8, 16, 20 and 40 weeks with each other are presented in Table.3

Table 3: Correlations among different body weight traits in IWK layer line

Trait combinations	Direct additive genetic correlation (r_a)	Maternal genetic correlation (r_m)	Maternal permanent environmental correlation (r_c)	Phenotypic correlation (r_p)	Number of observations
BW0 and BW4	0.36±0.26	0.23±0.06	0.41±0.18	0.10±0.02	3534
BW0 and BW8	0.20±0.21	-	0.40±0.19	0.14±0.02	3259
BW0 and BW16	0.01±0.25	0.76±0.27	0.15±0.05	0.09±0.03	1897
BW0 and BW20	0.27±0.22	-	-	0.08±0.03	1840
BW0 and BW40	0.19±0.18	-	-	0.16±0.03	1357
BW4 and BW8	0.84±0.08	0.90±0.14	-	0.54±0.01	2997
BW4 and BW16	0.67±0.12	-	0.03±0.02	0.29±0.02	1583
BW4 and BW20	0.61±0.16	-	-	0.33±0.03	1515
BW8 and BW16	0.83±0.08	-	0.03±0.01	0.53±0.02	1473
BW8 and BW20	0.81±0.09	-	-	0.53±0.02	1518
BW8 and BW40	0.69±0.09	-	-	0.37±0.03	1166
BW16 and BW20	0.90±0.03	-	-	0.66±0.02	1687
BW16 and BW40	0.80±0.08	-	-	0.45±0.02	1280
BW20 and BW40	0.98±0.03	-	-	0.63±0.02	1291

A low to moderate genetic and a low phenotypic correlation in a positive direction was observed between 0 day body weight and body weight at 4, 8, 16 and 20 weeks of age. The correlation coefficients of maternal permanent environmental effects were low to high between BW0 and other juvenile body weights with each other, which clearly showed that the maternal component had a significant effect on BW0. It indicated that the non-genetic factors such as mothering ability and uterus size have a significant effect on early body weight, which decreases or becomes negligible later on. Hence, selection based on early body weight might not be a good criterion while selecting individuals for higher body weight.

The genetic and phenotypic correlations among body weights at different ages (BW4, BW8, BW16 and BW20) were found to be positive in direction and high in magnitude. These findings are in accordance with the reports of [1, 14] who studied correlations among body weights at 16, 20 and 40 weeks of age.

The genetic and phenotypic association between BW20 and BW40 were positive in direction and high in magnitude and this was well in accordance with the reports of [2, 14] in different strains of White Leghorn.

4. Conclusions

In conclusion, the effect of maternal effect was significant on juvenile body weights rather than adult body weight and it indicated that the non-genetic factors such as mothering ability and uterus size have a significant effect on early body weight, which decreases or becomes negligible later on. Hence, selection based on early body weight might not be a good criterion while selecting individuals for higher body weight.

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