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Comparative study of growth and layer economic traits in Aseel and Kadaknath chicken breeds under intensive rearing system

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Abstract
Aseel and Kadaknath are two of the most important native chicken breeds of India. Aseel having an aggressive behavior and fighting ability is well known for its meat qualities and Kadaknath is popular for its black meat and eggs having proven medicinal and added nutritional values. The present study was designed to evaluate the effect of genetic and non genetic factors on growth and layer economic traits and compare the estimated phenotypic and genetic parameters in the two indigenous breeds. Single generation data was collected from Aseel and Kadaknath birds reared under intensive system in Desi Fowl Unit of ICAR- Central Avian Research Institute, Izatnagar, Uttar Pradesh, India. The least square means of growth traits revealed a higher body weight gain at 20 (BW20) and 40 (BW40) weeks in Aseel i.e. 1036.02 ± 13.64 g and 1561.32 ± 19.67 g respectively compared to Kadaknath measuring 602.53 ± 19.73 g and 1158.79 ± 23.44 g respectively. Both the breeds took almost same time to reach sexual maturity. Least square means of egg weight at 28 (EW28) and 40 (EW40) weeks, egg production up to 40 weeks (EP40) were 38.22 ± 0.72 g, 43.68 ± 0.49 g, 40.88 ± 2.70, respectively in Aseel and 33.68 ± 0.79 g, 40.06 ± 0.73 g and 35.82 ± 2.13, respectively in Kadaknath. All the concerned traits were found to have medium to high heritability suggesting scope for further improvement in growth and production traits in both the breeds via proper selection and mating program.

Keywords: Genetic factors, non-genetic factors, heritability, correlation, Aseel, Kadaknath

Introduction

Poultry industry is one amongst the fastest growing industries in India. India is the second largest poultry market in the world. It produces about 122.09 billion eggs (with an average growth rate of 6.70%, BAHFS, 2021-22) and 4.34 million tonnes of poultry meat (growing @ 8-10%, BAHFS, 2020). Total meat production (including poultry) in the country is 8.80 million tonnes in 2021-22.

Globally, India ranks third in egg production and fifth in broiler production. The egg and broiler production has been rising @ 8-10% per annum. Total poultry population in India is 851.81million (20th livestock census) and is at seventh rank across the globe.

The demand of poultry products in the market is increasing day-by-day with the increase in human population. In developed countries, the per capita consumption of eggs is 240 and chicken meat is 20 kg per annum. As per National Institute of Nutrition, India, the recommended per capita consumption of poultry eggs is 182 eggs and that of meat is 11.5 kg but the actual consumption is 89 eggs and 6.52 kg meat only. This wide margin between the two signifies that still the poultry industry is far from saturation and also there is a long way to bridge the gap between the developed and developing countries. Poultry sector contributes about Rs. 125 lakh Crores accounting for about 1% of the national GDP and about 14% of the Livestock GDP.

The local/ indigenous breeds contribute maximum poultry genetic resources playing an important role in developing countries like India. Indigenous chickens comprise a greater part of the national flocks in India. Even though their growth rates and egg production are low, they are generally better in disease resistance and comparatively have higher levels of performance even under poor nutrition and high environmental temperatures than the commercial strains under village systems. It has been reported that Aseel and Kadaknath native chicken breeds had higher immuno-competence than White Leghorn chicken (Kokate *et al.*, 2017) [10].

The original home tract of Aseel is Andhra Pradesh. It is a source of income for the tribals. Aseel is known for its delicious and flavored meat. Eggs are generally kept for hatching and are not eaten or sold. Aseel is popularly a game bird and is well known for its hostility, high stamina, majestic gait and fighting qualities. The home tract of Kadaknath is Jhabua and Dhar districts of Madhya Pradesh and adjoining districts of Rajasthan and Gujarat. Its flesh is a black delicacy with medicinal values. The tribals treat chronic diseases in human beings by the blood of Kadaknath and use its meat as an aphrodisiac. The meat and eggs of Kadaknath are a rich source of protein and iron. The annual egg production is around 80 eggs.

The low productivity of the indigenous chicken breeds has attracted the interest of researchers. Nowadays, the indigenous chicken breeds are being genetically improved for their productivity so as to make them economically viable. Further, these improved indigenous breeds are being used for developing crosses for backyard poultry farming. However, not many studies have been conducted on Aseel and Kadaknath regarding their growth and egg production performance. Hence, genetic evaluation and comparative studies of Aseel and Kadaknath is much needed. Moreover, the knowledge of genetic and non genetic factors affecting the growth, production and reproduction of birds along with estimation of genetic and phenotypic parameters helps in pure line selection and cross bred production which is mainly used in poultry breeding.

Material and Methods

Data

The required data were recorded on 180 pedigreed birds of Aseel and 120 pedigreed birds of Kadaknath native chickens, maintained at the ICAR- Central Avian Research Institute's Desi Farm unit, for the proposed study. The data generated was from a single generation. Traits were recorded from individual birds which were kept in separate cages and were identified by wing and leg band numbers. Standard feeding and management was practiced along with proper vaccination schedule being followed in the farm.

Traits recorded

The growth and layer economic traits such as age at sexual maturity (ASM) for individual pullet calculated as the number of days from hatching to the laying of the first egg, body weights (g) of all the pullets at 20 (BW20) and 40 (BW40) weeks of age, average of egg weights of three consecutive days for each pullet at 28^{th} (EW28) and 40^{th} (EW40) weeks of age, individual daily egg production of each pullet up to 40 weeks of age (EP 40) were recorded.

Statistical analysis

Data recorded on growth and egg production traits were analyzed using mixed model least squares analysis of variance and maximum likelihood program (Harvey, 1990). Sire was taken as random effect and hatch as fixed effect wherever applicable in the model. Following statistical model was used:

$$Y_{ijk} = \mu + S_i + H_j + e_{ijk}$$

Where

Y_{ijk} = Value of a trait measured on k^{th} individual belonging to i^{th} sire and j^{th} hatch.

μ = Population mean

S_i = Random effect of i^{th} sire

H_j = fixed effect of hatch (j= 1 in case of Aseel, j=2 in case of Kadaknath)

e_{ijk} = Random error associated with mean zero and variance σ^2e.

The chicks were also evaluated for the inheritance pattern of all the recorded traits. Genetic and phenotypic parameters of body weights and layer economic traits were estimated using paternal half-sib correlation method (Becker, 1975).

Results

In Aseel females, the least squares means of growth traits *viz*., BW20, BW40 and production traits *viz*., ASM, EW28, EW40 and EP40 were 1036.02 ± 13.64g, 1561.32 ± 19.67g, 214.39 ± 2.22 days, 38.22 ± 0.72g, 43.68 ± 0.49g and 40.88 ± 2.70 eggs, respectively. Least squares analysis of variance of all the growth and production traits of Aseel native chicken are presented in table 1. The overall least squares means and standard errors of all the considered traits are presented in table 2. Sire was found to have a significant ($P \le 0.05$) effect on BW20 and EP40 but not on other traits. The hatch effect was not taken into account as all the experimental birds belong to same hatch.

In Kadaknath females, the estimated least square means of growth traits *viz*., BW20, BW40 and production traits *viz*., ASM, EW28, EW40 and EP40 were 602.53 ± 19.73 g, 1158.79 ± 23.44 g, 213.04 ± 2.80 days, 33.68 ± 0.79 g, 40.06 ± 0.73 g and 35.82 ± 2.13 eggs respectively. The least squares analysis of variance of all the considered traits are represented in table 3. The least squares means along with their standard errors are depicted in table 4. Hatch and sire were found to have non-significant effects on all the growth as well as layer economic traits. In the present study, Aseel native chicken breed showed higher body weight at twenty and forty weeks of age compared to that of Kadaknath native chicken breed.

The heritability estimates for both BW20 and BW40 were found to be higher in magnitude in both the breeds *viz*., 0.81 ± 0.31 and 0.75 ± 0.23, respectively in Aseel and 0.81 ± 0.39 and 0.79 ± 0.34, respectively in Kadaknath. ASM was found to have higher heritability in Aseel (0.42 ± 0.25) as compared to Kadaknath (0.24 ± 0.11). Egg weights showed higher heritabilities whereas egg production up to forty weeks showed medium heritability in both Aseel as well as Kadaknath birds. For Aseel birds, heritabilities ± standard errors along with phenotypic and genetic correlations among the concerned traits are shown in table 5. The same parameters are represented in table 6 for Kadaknath birds under study. In present investigation, the genetic correlation among the various traits lies within the range of -0.97 ± 0.16 to 0.83 ± 0.66 in Aseel birds and -0.83 ± 0.25 to 0.87 ± 0.11 in Kadaknath birds, although no definite pattern of genetic correlation was observed amongst the traits. The phenotypic correlation ranges from -0.60 (among ASM and EP40) to 0.57 (among BW20 and BW40) and from -0.58 (among ASM and BW20) to 0.50 (among BW20 and BW40) in Aseel and Kadaknath birds respectively.

Table 1: Least squares analysis of variance of various layer economic traits in Aseel native chicken breed

Source of variation	Mean sum of squares											
	df	ASM	df	BW20	df	BW40	df	EW28	df	EW40	df	EP40
Sire	**27**	640.84	30	27416.41*	25	42172.65	6	8.77	12	8.71	15	484.66*
Error/ Remainder	107	485.36	125	16569.79	95	46804.72	10	8.94	45	13.94	55	217.18

df = Degrees of freedom;*$P \leq 0.05$.

Table 2: Least squares mean ± standard error of various layer economic traits in Aseel native chicken breed

Factors	Least squares means± standard errors					
	ASM (days)	BW20(g)	BW40(g)	EW28(g)	EW40(g)	EP40 (No.)
Overall	214.39 ± 2.22 (135)	1036.02 ± 13.64 (156)	1561.32 ± 19.67 (121)	38.22 ± 0.72 (17)	43.68 ± 0.49 (58)	40.88 ± 2.70 (71)

Figures within parentheses denote number of observations.

Table 3: Least squares analysis of variance of various layer economic traits in Kadaknath native chicken breed

Source of variation	Mean sum of squares											
	df	ASM	df	BW20	df	BW40	df	EW28	df	EW40	df	EP40
Sire	24	355.64	21	34338.86	22	35274.56	10	11.13	6	8.62	21	185.18
Hatch	1	396.02	1	35389.84	1	44660.79	1	2.21	1	10.86	1	11.52
Error/ Remainder	61	680.31	77	22274.25	42	36116.67	22	21.02	13	11.28	19	178.44

df = Degrees of freedom

Table 4: Least squares mean ± standard error of various layer economic traits in Kadaknath native chicken breed

Factors		Least squares means± standard errors						
		N	ASM (days)	BW20(g)	BW40(g)	EW28(g)	EW40(g)	EP40 (No.)
Overall		87	213.04 ± 2.80	602.53 ± 19.73 (100)	1158.79 ± 23.44 (66)	33.68 ± 0.79 (34)	40.06 ± 0.73 (21)	35.82 ± 2.13 (42)
Hatch	1	40	215.63 ± 4.55	625.26 ± 27.89(43)	1192.01 ± 38.84 (31)	33.39 ± 1.27 (15)	40.94 ± 1.14 (11)	34.98 ± 3.81 (23)
	2	47	210.44 ± 4.26	579.79 ± 25.52 (57)	1125.56 ± 37.08 (35)	33.98 ± 1.15 (19)	39.18 ± 1.18 (10)	36.65 ± 4.02 (19)

N= Number of observations; Figures within parentheses denote number of observations.

Table 5: Heritability (at diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations of various layer economic traits in Aseel native chicken breed

Traits	ASM	BW20	BW40	EW28	EW40	EP40
ASM	0.42 ± 0.25 (104)	-0.66 ± 0.08 (104)	0.52 ± 0.26 (104)	NE	0.20 ± 0.09 (80)	-0.97 ± 0.16 (104)
BW20	-0.44 (104)	0.81 ± 0.31 (104)	0.68 ± 0.26 (104)	NE	-0.44 ± 0.11 (80)	0.83 ± 0.66 (104)
BW40	-0.09 (104)	0.57 (104)	0.75 ± 0.23 (104)	NE	NE	0.51 ± 0.31 (104)
EW28	-0.16 (33)	0.16 (33)	0.17 (33)	0.41 ± 0.28 (33)	NE	NE
EW40	0.12 (80)	0.04 (80)	0.26 (80)	0.004 (33)	0.73 ± 0.39 (80)	-0.34 ± 0.11 (80)
EP40	-0.60 (104)	0.29 (104)	-0.03 (104)	-0.03 (33)	0.04 (80)	0.28 ± 0.06 (104)

Figures within parentheses denote number of observations; NE = the estimate is not estimable

Table 6: Heritability (at diagonal), genetic (above diagonal) and phenotypic (below diagonal) correlations of various layer economic traits in Kadaknath native chicken breed

Traits	ASM	BW20	BW40	EW28	EW40	EP40
ASM	0.24 ± 0.11 (89)	-0.54 ± 0.22 (89)	-0.53 ± 0.26 (58)	-0.83 ± 0.25 (24)	NE	-0.49 ± 0.010 (30)
BW20	-0.58 (89)	0.81 ± 0.39 (89)	0.72 ± 0.29 (58)	0.74 ± 0.39 (24)	NE	0.37 ± 0.07 (30)
BW40	-0.25 (58)	0.50 (58)	0.79 ± 0.34 (58)	NE	NE	0.87 ± 0.11 (30)
EW28	-0.23 (24)	0.39 (24)	0.27 (24)	0.66 ± 0.24 (24)	NE	-0.06 ± 0.05 (24)
EW40	-0.22 (16)	0.36 (16)	-0.04 (16)	0.27 (16)	NE	NE
EP40	-0.34 (30)	0.34 (30)	-0.05 (30)	-0.05 (24)	0.23 (16)	0.31 ± 0.12 (30)

Figures within parentheses denote number of observations; NE= the estimate is not estimable

Discussion

Growth and layer production traits

Comparatively higher estimates of BW20 and BW40 i.e. 1381.4 ± 18.2 g and 1704.4 ± 23.2 g respectively were reported in Aseel by Rajkumar *et al*. (2017) [14]. Thangadurai *et al*. (2020) [16] reported BW20 and BW40 as 820 g and 1400 g respectively in TANUVAS Aseel which were lower than the present estimates in Aseel native chicken. Haunshi *et al.* (2011) [6] reported the BW20 and BW 40 as 769.11 ± 12.41 g and 1,321.6 ± 18.4 g respectively in Kadaknath, the estimates being higher than the one estimated in the present study. Similar results were obtained by Bhagora *et al.* (2022) [1] where they reported the higher estimates of BW20 and BW40 week as 1247.07 ± 30.31 g and 1520.44 b ± 39.85 g respectively in Kadaknath chicken breed. The differences found in the estimates of various body weights as reported in different reports might be due to the different genetic background of the stocks used during the studies and also due to differences in the various environmental factors like feed, heat and cold stress management, disease condition, vaccination schedule etc followed during the experiment.

Haunshi *et al*. (2012) [7] reported a comparatively lower ASM i.e. 174 ± 0.9 days in Aseel birds. Rajkumar *et al*. (2017) [14], in their study found ASM of Aseel birds as 214.0 ± 6.0 days.

The estimate is close to the estimate obtained in present study. Yet another study by Dalal *et al*. (2019) [4], reported ASM as 182.66 ± 1.98 days in Aseel which is lower than that of the present estimate. Miazi *et al.* (2020) [11] reported ASM as 210 days in Aseel birds. Lower ASM estimate than the present estimate in Kadaknath Breed were reported by Dalal *et al.* (2019) [4] and Bhagora *et al.* (2022) [1] as 210 days, 169.83 ± 0.95 days and 195.22 ± 3.62 respectively. The different genetic groups reared and selected in different environments might be the reason for differences in the estimates of age at sexual maturity as reported in different reports.

Haunshi *et al*. (2012) [7] reported egg weight at 28 weeks and 40 weeks as 42.57±0.30 g and 47.57±0.34 g respectively in Aseel which are higher than the estimates of present study. Rajkumar *et al.* (2017) [14] reported a lower egg weight at 40 weeks i.e. 38.8 ± 0.6 g as obtained in their study on Aseel birds. Comparatively higher estimates of EW28 and EW40 were reported by Haunshi *et al.* (2019) [8] i.e. 43.4±0.23 g, 48.9±0.28g respectively in PD-4 Aseel. In Kadaknath higher estimates of EW 28 and EW40 compared to the one obtained in present study were reported by Haunshi *et al.* (2012) [7] as 36.02±0.33 g and 46.68± 0.71 g respectively. Almost similar i.e. 41.99 ± 0.29 g EW40 was reported by Dalal *et al.* (2019) [4]. Bhagora *et al.* (2022) [1] reported higher EW28 and EW40 as 41.56±0.19 g and 41.06 ± 1.83 g. Variations in the weights of egg at different ages might be attributed to genetically variable stocks used in the study along with the differences in the observed age at sexual maturity of these stocks in the experiments.

Haunshi *et al.* (2011) [6] and Rajkumar *et al*. (2017) [14] reported EP40 in Aseel as 36.23 eggs and 18.0 ± 1 eggs respectively, lower than the estimate of present study. Comparatively higher estimate of EP40 in Aseel was reported by Dalal *et al*. (2019) [4] *viz*. 64.89 ± 2.10 eggs. Similar result as that of present study was reported by Chitra (2021) in TANUVAS Aseel as 42.5±0.32 eggs. Chatterjee *et al*. (2010), Haunshi *et al*. (2011) [6], Haunshi *et al*. (2012) [7] and Dalal *et al*. (2019) [4] reported EP40 in Kadaknath chicken as 44.68 eggs, 49.40 eggs, 62.39 eggs and 55.48 ± 1.22 eggs respectively which are higher than the present estimates of EP40 in Kadaknath. The variations reported by different studies can be due to the genetic backgrounds of the stocks that varied in every single study.

Effect of genetic and non- genetic factors

Dalal *et al*. (2019) [4] reported that sire effect was highly significant on BW20 but was non-significant on EP40 in Aseel birds. They also reported non-significant effect of sire on all the traits under study in case of Kadaknath birds. For a successful execution of breeding program aimed at improvement of population performance, the main pre requisite is the proper and efficient selection of sire as sire is considered as half of the flock. Contrary to the present finding, Dalal *et al.* (2019) [4] reported highly significant effect of hatch on BW20, BW40 and ASM.

Heritability (h^2)

Kabir *et al.* (2006) estimated the heritability for BW20 and BW40 of Aseel as 0.70 ± 0.35 and 0.42 ± 0.21 in the female line. Dalal *et al.* (2019) [4] reported that the growth traits showed moderate to high heritability (0.35–0.70) in Aseel and low to medium (0.12–0.37) in Kadaknath.

Dalal *et al*. (2019) [4] found EP40 as medium heritable trait *viz*. 0.35 in Aseel. The extreme variations in the heritability estimates as per different reports might be attributed to the differences in genetic background and variation in environmental conditions.

Lower heritability estimate for ASM (0.19), EW40 (0.22) and EP40 (0.14) in Kadaknath were reported by Dalal *et al*. (2019) [4].

Genetic and phenotypic correlations

Contrary to present study, Dalal *et al.* (2019) [4] found that the genetic correlation between BW40 and AFE was positive in Kadaknath and negative in Aseel chicken. Negative genetic correlation among AFE and EP40 was also reported. This indicated that earlier the birds achieve sexual maturity, more will be the number of eggs produced. Negative genetic correlation between EP40 and EW40 are similar to the reports of Sreenivas *et al*. (2012) [15] in white leghorn chicken and Rahim *et al*. (2016) in Rhode Island Red chicken. Greater the number of eggs, lesser will be the per egg weight. The positive phenotypic correlation between BW20 and BW40 obtained in present study are in agreement with the findings of Qadri *et al*. (2013) and Dalal *et al.* (2019) [4]. The genetic and phenotypic correlations obtained in present study did not reveal any specific trend in Aseel as well as in Kadaknath native chicken birds which might be due to the fact that males were not considered and the study was conducted only on female birds. Also, not many reports are available to compare the present estimates of heritabilities and genetic correlation in Aseel and Kadaknath native chicken breeds.

Conclusion

Kadaknath and Aseel are the two most important native chicken breeds of India. The present study concluded that Aseel birds, being selected for fighting abilities showed greater body weight gain compared to that of Kadaknath birds. Both the breeds were observed to start egg laying almost at similar age. However, Aseel breed was found to lay more number of eggs up to forty weeks with higher egg weight compared to that of Kadaknath. The study also revealed that birds with lower body weight at twenty weeks attain age at first egg late. Moderate to high heritability estimates of various traits in Aseel and Kadaknath provide scope for improvement in the flock using different means of selection in future. High and positive genetic correlations found among body weights and layer economic traits can be exploited in developing models for genetic improvement in production performance of native chicken breeds.

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