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ORIGINAL RESEARCH

Evaluation of two Indian native chicken breeds for reproduction traits and heritability of juvenile growth traits

Santosh Haunshi · Murugesan Shanmugam · Mahendra Kumar Padhi · Matam Niranjan · Ullengala Rajkumar · Maddula Ramakoti Reddy · Arun Kumar Panda

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Abstract The present study was conducted to evaluate two Indian native chicken breeds, namely, Aseel and Kadaknath for fertility, hatchability, genetic parameters of juvenile growth traits, and semen quality traits at the onset of sexual maturity. The fertility was similar in Aseel (86.96%) and Kadaknath (85.15%); however, a relatively higher hatchability was observed in Kadaknath (77.94%) than Aseel (70.74%). Heritability estimates of body weights at 4 weeks of age were almost similar in Aseel (0.37) and Kadaknath (0.39), while the estimate of body weight at 6 weeks of age was higher in Aseel (0.42) than Kadaknath (0.31). The heritability estimate of shank length at 6 weeks of age was lower in Aseel (0.16) compared to Kadaknath (0.35). The age at first egg in the flock was comparable in Aseel (148 days) and Kadaknath (150 days). Aseel breed with significantly ($P \leq 0.001$) higher body weight, absolute and relative testes weights had significantly higher semen volume ($P \leq 0.05$) and sperm motility ($P \leq 0.01$) but had lower seminal plasma cholesterol level ($P \leq 0.05$) as compared to Kadaknath. It can be concluded that there is a scope for genetic improvement of these two native breeds for juvenile growth traits since heritability estimates of these traits were relatively high.

Keywords Aseel · Kadaknath · Juvenile traits · Heritability estimates · Reproduction traits

S. Haunshi (✉) · M. Shanmugam · M. K. Padhi · M. Niranjan · U. Rajkumar · M. R. Reddy · A. K. Panda
Project Directorate on Poultry,
Rajendranagar,
Hyderabad 500 030, Andhra Pradesh, India
e-mail: santoshi575@yahoo.com

Introduction

Aseel and Kadaknath are two important native chicken breeds of India. In spite of their desirable characters such as hardiness, adaptability to the tropical climatic conditions, disease tolerance, and flavor of meat and eggs, they were overlooked due to their poor growth and egg production potential. Aseel (Peela) is a meat type game bird with brown feathers and long shanks while Kadaknath is a dual purpose bird with fibromelanosis (Fm), non-inhibitor dermal melanin (id), and slow feathering (K) characters (Singh et al. 2010). The growth performance of these native breeds is considerably low, although Aseel breed is superior to Kadaknath breed in body weights (Chatterjee et al. 2007; Mohan et al. 2008a; b; Haunshi et al. 2011). Therefore, efforts are being made to genetically improve these two native breeds for growth performance under tropical and subtropical conditions of India. Further, these two breeds are being used to develop improved chicken varieties for backyard poultry farming. Although considerable amount of literature is available on genetic parameters of growth traits of commercial chicken lines, but same information may not be relevant in slow-growing native chickens (Dana et al. 2011). Further, comparative assessment of these two breeds for fertility and hatchability traits under similar management conditions is required to be carried out before taking up breeding program to improve native chickens. Therefore, a comparative study on fertility, hatchability, and genetic parameters of juvenile growth traits (body weights at 4 and 6 weeks of age and shank length at 6 weeks of age) was carried out in Aseel and Kadaknath breeds. Since absolute and relative testes weights of Aseel birds at 20 weeks of age were significantly higher than those of Kadaknath breed, it was decided to carry out the comparative assessment of semen quality and seminal plasma biochemical

parameters in Aseel and Kadaknath breeds at the onset of sexual maturity.

Materials and methods

This experiment was conducted during the months from January to July on the experimental poultry farm of the institute (Project Directorate on Poultry) located at Hyderabad (17°20′ N, 78°30′ E), India. A total of 973 chicks of Kadaknath (using 42 sires and 125 dams) in two hatches and 716 chicks of Aseel (using 28 sires and 83 dams) in three hatches were produced as pedigreed populations. Fertility and hatchability percent on total (TES) and fertile eggs set (FES) basis were calculated. Body weights at 1-day-old and 4 and 6 weeks of age were recorded, while shank length was measured at 6 weeks of age. Birds were provided with chick starter ration and water in ad lib quantity up to 8 weeks of age. All the birds were reared under intensive system of rearing on deep litter in open-sided house and similar management practices were followed for all the chicks throughout the experimental period. The birds were given grower ration from 9 weeks onwards till the onset of sexual maturity. At 20 weeks of age, 12 male birds from each breed were weighed and slaughtered and absolute and relative testes weights were recorded. Birds were housed in individual cages from twenty-first week onwards. The experiment was carried out following the guidelines of institute animal ethics committee.

Semen quality analysis

Semen was collected following standard practice of massage method (Lake et al. 1985) from cocks of each genetic group housed in individual cages. The collection and examination of the semen were done by single investigator during the study to avoid biasness. The semen collection from 30 cockerels of each breed was done at 20 and 22 weeks of age, and the percentage of birds which gave semen was calculated. A total of 20 birds from Kadaknath and 18 birds from Aseel were used to study the semen quality and seminal plasma biochemical parameters at 24 weeks of age. The semen was collected in sterile glass funnels, and the volume of semen ejaculate was assessed by drawing the collected sample into 1-ml syringe with an accuracy of 0.02 ml. The appearance of semen was scored on a scale of 1 to 5 by visual examination (McDaniel and Craig 1959). Subsequently, individual samples were diluted four times by using high temperature diluent (suitable for storing semen at 20°C or 40°C) having NaCl, glucose, and TES (Chaudhuri and Lake 1988) which were then used for the evaluation of semen quality traits. Individual motility of sperms was assessed as percentage of progressively motile sperms by following the light microscopy method (Haunshi et al. 2010).

The concentration of sperm was determined by computer-assisted semen analysis (Motic CASA Plus, Motic Instruments, Canada). The 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) dye reduction test was carried out in duplicate samples to assess the fertilizing ability of sperms since fertilizing ability and semen quality are considered to be correlated with the ability of sperms to reduce tetrazolium dye MTT (Hazary et al. 2001). Reduction of MTT dye resulted in increased absorbance that was measured with a colorimeter at 570 nm wavelength.

Proportions of live, dead, and abnormal sperms were estimated by differential staining technique using eosin–nigrosin stain (Campbell et al. 1953). In each slide, 200 sperms were examined under oil immersion (×100) microscope. Both fully and partially stained sperms were counted as dead. The same slides were used for estimating the percent abnormal sperm count on the basis of noticeable abnormalities of head, neck, mid-piece, and tail region.

Seminal plasma biochemical traits

For the separation of seminal plasma, semen samples of three to four birds were pooled together in each group and centrifuged twice at 3,000 rpm for 10 min and supernatant seminal plasma was collected. The total seminal plasma protein was estimated as per the method described by Lowry et al. (1951). Seminal plasma cholesterol level was determined using chemical (Zlatki's) method (Zak et al. 1954). Nitric oxide in seminal plasma was determined by the method described by Miranda et al. (2001). Total nitrite was determined by Griess assay after conversion of nitrate to nitrite by vanadium (III) chloride reduction and the color intensity was measured at 540 nm in an ELISA reader.

Statistical analysis

Means and standard errors of various parameters were calculated using standard statistical methods. Arcsine transformation was carried out for percentage values (<20 and >80) of various parameters prior to analysis. Significant difference between the two breeds for various traits was tested by Student's "*t*" test. The hatch-corrected data were utilized for the estimating heritability values by variance component analysis (King and Henderson 1954). Genetic and phenotypic correlations between body weight and shank length were estimated using variance component analysis (Becker 1992).

Results

Fertility in Aseel and Kadaknath breeds was very similar; however, a relatively higher hatchability was noticed both on FES and TES basis in Kadaknath (Table 1). Body weights (1-day-old and 4 and 6 weeks of age) and shank length (6 weeks of age) of Aseel (34.85±0.11, 160.87±1.36, and 270.13±2.46 g and 57.43±0.22 mm) were significantly ($P \leq 0.001$) higher than those of the Kadaknath (28.08±0.09, 120.82±0.87, and 204.67±1.56 g and 51.46±0.18 mm).

The heritability (sire component) estimates (Table 2) of body weight at 4 weeks of age were comparable in Aseel and Kadaknath, while that of body weight at 6 weeks of age was relatively higher in Aseel as compared to that of Kadaknath. On the other hand, heritability value (sire component) of body weight at 6 weeks of age was higher than that of the body weight at 4 weeks of age in Aseel, while heritability values (sire, dam, and sire + dam components) of body weight at 6 weeks of age were less than those of body weight at 4 weeks of age in Kadaknath. Heritability value of shank length was higher in Kadaknath than that of Aseel. In general, heritability values of body weights in both Aseel and Kadaknath breeds were relatively high and that of shank length was moderate (as per the classification of Dalton 1980) in Aseel and higher in Kadaknath. The genetic and phenotypic correlations between body weight and shank length at 6 weeks of age in Aseel (0.93±0.05, 0.82) and Kadaknath (0.94±0.03, 0.76) were similar, positive, and considerably high in magnitude.

The age at first egg in the flock was very similar in Aseel (148 days) and Kadaknath (150 days) breeds. Body weight, absolute, and relative testes weights at 20 weeks of age were significantly ($P \leq 0.001$) higher in Aseel than those of Kadaknath breed (Table 3). The percentage of birds which gave semen at 20 and 22 weeks of age was by and large similar in both breeds. No significant difference was noticed between these two breeds in the appearance of semen, concentration of sperms, fertilizing ability [MTT Formazan (nanomoles per minute per million sperms)] and live, dead, and abnormal sperm percentages. However, semen ejaculate volume ($P \leq 0.05$) and sperm motility percentage ($P \leq 0.01$) were significantly higher in Aseel as compared to Kadaknath (Table 3). Aseel and Kadaknath breeds did not differ in seminal plasma protein and nitric oxide levels but seminal plasma cholesterol level was significantly ($P \leq 0.05$) lower in Aseel.

Discussion

Reproduction traits such as fertility and hatchability are influenced by genotype, nutrition, management of birds, age, and hatching conditions. The reduced hatchability (on both FES and TES basis) in Aseel compared to Kadaknath breed might be due to delay in pipping of shells by chicks. In all three hatches, the eggs which were classified as dead in shells were opened to observe for dead embryos. However, most of the embryos inside the shells were alive; it appears that the eggs of Aseel breed may need to be kept for longer duration in a hatcher for better hatchability, although this needs to be validated. The difference in hatchability between these two breeds can be attributed to intrinsic breed difference since the birds of both breeds were reared under similar (housing, rearing, and feeding) management conditions and hatchability traits were measured at the same age. Even setting and hatching processes were carried out in same incubator on same days.

Fertility and hatchability on TES basis of Aseel breed were slightly higher than those reported by Mohan et al. (2008a) although the hatchability on FES basis was lower in the present study. In Kadaknath, the fertility and hatchability were much higher than those reported by Mohan et al. (2008b). The difference in fertility and hatchability could be attributed to the differences in age of birds and agro-climatic conditions since management practices followed in both studies were by and large similar.

Finding of significantly ($P \leq 0.001$) higher juvenile body weights in Aseel as compared to Kadaknath breed is in conformity with the observations of Chatterjee et al. (2007) and Haunshi et al. (2011). Overall, slightly higher body weights were recorded in the present study at respective age

Table 1 Fertility and hatchability traits of Aseel and Kadaknath breeds at 40 weeks of age

Hatch	Aseel			Kadaknath		
	Fertility (%)	Hatchability (%)		Fertility (%)	Hatchability (%)	
		Fertile egg set	Total egg set		Fertile egg set	Total egg set
Hatch I	91.89	84.19	77.37	89.60	93.01	83.45
Hatch II	82.57	75.97	62.73	82.70	87.59	72.43
Hatch III	86.41	83.46	72.12	–	–	–
Average	86.96	81.21	70.74	85.15	90.30	77.94

Table 2 Heritability estimates for body weights (4 and 6 weeks of age) and shank length (6 weeks of age) in Aseel and Kadaknath breeds

Traits	Aseel			Kadaknath		
	h_S^2	h_D^2	h_{S+D}^2	h_S^2	h_D^2	h_{S+D}^2
Body weights						
4 weeks	0.37±0.22	0.61±0.20	0.49±0.15	0.39±0.16	0.33±0.13	0.37±0.10
6 weeks	0.42±0.18	0.24±0.14	0.33±0.11	0.31±0.13	0.21±0.12	0.26±0.09
Shank length						
6 weeks	0.16±0.12	0.27±0.15	0.22±0.11	0.35±0.13	0.09±0.09	0.22±0.09

h^2_S sire component, h^2_D dam component, h^2_{S+D} sire and dam component

than those reported in earlier generations of respective breeds at similar agro-climatic location (Chatterjee et al. 2007; Haunshi et al. 2011).

The existence of higher estimates of heritability (Sire component) for juvenile growth traits in both breeds suggests the presence of additive genetic variance (King and Henderson 1954) and hence selection for growth traits at juvenile stage will lead to genetic improvement of these breeds. Higher heritability estimates for juvenile growth traits might be due to the fact that these native breeds were reared as random-breeding populations and were not subjected for intensive selection for any of the economic traits. The presence of strong and positive correlation between body weight and shank length will help in improving the shank length of native birds indirectly. High shank length that helps birds to escape from predators is a desirable trait in free range or semi-intensive system of rearing. Information on the genetic parameters of juvenile growth traits in native chickens of India in particular and Asia in general is sparse in literature to compare with the present findings. However, our observations were in agreement with the reported findings of moderate to high estimates of heritability of juvenile growth traits in African native chickens (Norris and Ngambi 2006; Dana et al. 2011).

The age at first egg in both breeds was comparable with the reported findings of (Mohan et al. 2008a; b) although it was much lesser than those observed in our earlier study (Haunshi et al. 2011). In this particular generation, the birds

Table 3 Body weight, testes weight, and semen quality traits of Aseel and Kadaknath breeds of chicken (mean ± s.e.)

Traits	Genotype		*P* value
	Aseel	Kadaknath	
Body weight and testes weights recorded at 20 weeks of age			
Live body weight (g)	1655.5±51.68a	1226.83±27.04b	<0.001
Absolute testes weight (g)	12.97±1.37a	4.13±1.34b	<0.001
Relative testes weight (%)	0.78±0.08a	0.34±0.10b	<0.001
Percentage of birds gave semen in first attempt (20th week)	52%	50%	–
Percentage of birds gave semen in second attempt (22nd week)	62.5%	61.0%	–
Semen quality traits at 24 weeks of age			
Ejaculate volume (ml)	0.20±0.02a	0.15±0.02b	<0.05
Appearance	3.56±0.18	3.95 ±0.20	NS
Progressive sperm motility (%)	79.41±2.42a	68.95±3.47b	<0.01
Sperm concentration (millions/μl)	5.06±0.17	5.09±0.34	NS
Fertilizing ability (MTT Formazan) (nmol/min/million sperms)	20.19±3.48	16.26±1.47	NS
Live sperms (%)	90.66±1.79	89.44±1.43	NS
Dead sperms (%)	9.34±1.79	10.56±1.43	NS
Abnormal sperms (%)	2.25±0.34	3.56±0.59	NS
Seminal plasma biochemical traits at 24 weeks of age			
Total protein level (g/dl)	1.30±0.13	1.15±0.07	NS
Cholesterol level (mg/dl)	37.95±5.13a	75.89±10.26b	<0.05
Nitric oxide level (μM)	379.50±104.14	343.45±71.03	NS

NS nonsignificant

were subjected to increasing day length (out of season birds) during their later part of growing period, hence there was significant reduction in age at first egg compared to those reported in our earlier study.

The significant difference in absolute and relative testes weights between Aseel and Kadaknath did not have an effect on the percentage of birds that gave semen at respective age and most of the semen quality traits. Ejaculate volume and live and abnormal sperm counts of Kadaknath in the present study were comparable to those reported for the Kadaknath breed at 27 weeks of age (Biswas et al. 2009); however, higher sperm concentration and lower motility in Kadaknath were observed in the present study. Seminal plasma protein values observed in the present study were relatively higher than those reported at 27 weeks of age (Biswas et al. 2009) in Kadaknath. The differences in semen quality traits of Kadaknath breed of the present study and those of Biswas et al. (2009) could be attributed to the difference in the age of birds, management, and agro-climatic conditions of the location. On the other hand, ejaculate volume, appearance, motility, and fertilizing ability of Aseel and Kadaknath were lesser than those reported at 42 weeks of age in same breeds at same agro-climatic location in previous generation (Haunshi et al. 2011) although live and dead sperm counts were comparable. The differences in semen quality traits between these two studies might be due to the difference in age of the birds.

Body weight is one of the important economic traits that need to be improved in native chickens for improved performance under backyard system of rearing. From the results of the study, it can be concluded that although Aseel had higher juvenile body weights and shank length than that of Kadaknath, both breeds need to be improved for juvenile body weight traits. The existence of high estimates of heritability (sire component) for juvenile growth traits in both breeds suggests the presence of additive genetic variance and that provides scope for improvement of these slow-growing breeds for juvenile growth traits by traditional quantitative genetic principles.

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