



Genetic characterization of Binjharपुरi cattle in Odisha, India: Implications for breeding stock selection

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ABSTRACT

The present study on 938 Binjharपुरi cattle, owned by 230 farmers across 20 villages in four blocks of Jajpur district, the native tract, varying in age, sex and location were assessed. Data were collected through personal interactions with farmers to assess the production and reproduction performance. In 375 cattle (24 male and 351 females) of different age groups. Observations indicated that males exhibited numerically higher body weight than female counterparts without significant difference between sex till maturity, but significantly higher body weight of 252.51 was recorded in males against 206.76 in female counterparts at adulthood. Locality did not have significant effect on any of the biometric traits and body weight at all stages of growth. Binjharपुरi cows matured at the age of around 29 months (872.46 days) and dropped their first calf at the age of around 40 months (1184.22 days). The calving interval was around 15 months. Overall lactation length was observed as 293.59 days with average daily milk yield of 4.37 kg in these cows. Moderate but higher heritability estimates were observed at 12 months of age than those at adult stage for body weight and all the conformation traits. Positive and moderate to high genetic and phenotypic correlations were observed between body weight and body measurements. Heritability estimates for reproduction parameters viz. age at sexual maturity, age at first calving, calving interval and production trait like lactation length ranged from 0.29 ± 0.10 to 0.41 ± 0.14 .

Key words: Breeding, critical, genetic, potential, selection

INTRODUCTION

Individuals having differential ability not only survive but also reproduce successfully in subsequent generations ensuring continued survival of the said population along with natural selection over many generations under evolution have brought sustained improvement in the population and trigger breeds within species. The Binjharपुरi cattle breed, registered with the accession number INDIA_CATTLE_1500_BINJHARPURI_03033, derives its name from its significant presence in the Binjharपुर block of Jajpur district, Odisha. Evaluation of characteristics, diversity, distribution, differential performance along with present status

of animal genetic resources is highly essential for their sustainable utilization, genetic development and conservation (Panigrahi and Dash, 2018). Hence, the present study was conducted to estimate performance and different genetic parameters on economical traits.

MATERIALS AND METHODS

The native tract includes Jajpur and neighboring regions in Kendrapada, Bhadrak, Keonjhar and Dhenkanal districts (Fig.1 & 2). Under hot and humid climatic profile with summer temperature up to 46°C , winter with an average of 13°C and annual rainfall of 1500 mm, these animals are adapted and are contributing to the livelihood,

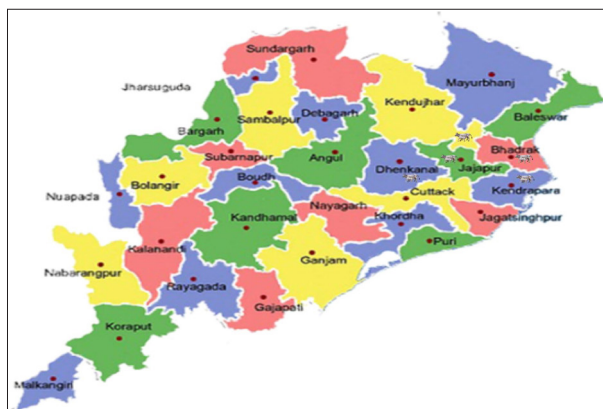


Fig. 1. Native tract of Binjarpuri cattle

family nutrition, agricultural operations (Fig. 3) and transportation even with promotions for mechanization by Government.

Data were collected through personal interactions with farmers to assess the production and reproduction performance and biometric traits were measured physically for both sexes at various stages of growth.

The body weight at different ages was calculated using Schaeffer's formula i.e.,

$$\text{Body weight in kg} = (L \times G^2)/660$$

Where L = Body length in inches

G = Chest girth in inches.

Length and girth, measured in cm, were transformed to inches for application in Schaeffer's formula (Fig. 18, 19, 20 & 21). A least squares analysis (2-way classification without interaction) was used to examine the effects of sex.

The heritability and genetic correlations were calculated by using the sire component of variance as below:

Estimation of heritability

$$\text{Heritability: } h^2_s = \frac{4\sigma^2_s}{\sigma^2_s + \sigma^2_w} \text{ (Becker, 1975)}$$

$$\text{Standard error for heritability } (h^2) = \sqrt{\frac{2(1-t)^2[1+(k-1)]^2}{k(k-1)(s-1)}}$$

$$\text{Where, } t = \frac{\sigma^2_s}{\sigma^2_s + \sigma^2_w}$$

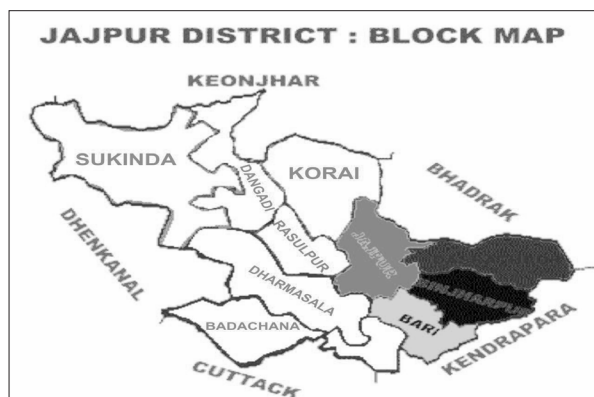


Fig. 2. Block of Jajpur district coloured marks showing high concentration of Binjarpuri cattle

K = Average number of progeny per sire

Estimation of genetic correlation

Genetic correlation (r_g) between the traits was calculated from sire component of variance in the following formula.

$$r_g = \frac{COV_{s(XY)}}{\sqrt{\sigma^2_{s(X)} \cdot \sigma^2_{s(Y)}}}$$

The genetic interpretation is

$$r_g = \frac{COV_A + \frac{1}{4}COV_{AA}}{\sqrt{(V_{A(X)} + \frac{1}{4}V_{AA(X)}) (V_{A(Y)} + \frac{1}{4}V_{AA(Y)})}} \quad \text{(Becker, 1975)}$$

Standard Error for genetic correlation r_g :

$$\text{S.E. for } r_g = \frac{1-r_g^2(XY)}{\sqrt{2}} \sqrt{\frac{S.E.(h^2_X) \cdot S.E.(h^2_Y)}{h^2_X \cdot h^2_Y}}$$

(Falconer and Mackay, 2009)

Estimation of phenotypic correlation

Phenotypic correlations among different traits were obtained by using the following formula.

$$r_p = \frac{COV_{s(XY)} + COV_{w(XY)}}{\sqrt{(\sigma^2_{s(X)} + \sigma^2_{w(X)}) (\sigma^2_{s(Y)} + \sigma^2_{w(Y)})}} \quad \text{(Becker, 1975)}$$

Error for phenotypic correlation (r_p):

$$\text{S.E. } r_p = \sqrt{\frac{1-r_p^2 P(XY)}{n-2}} \quad \text{(Goulden, 1962)}$$

Native tract, managerial practices, utility and milk products of Binjarpuri cattle along with the process of measurements are presented in Fig. 3 to 21.



Fig. 3. A pair of Binjharpuri bullocks in a ploughing state



Fig. 4. A Binjharpuri bull



Fig. 5. A Binjharpuri cow



Fig. 6. The Binjharpuri cow dung cake



Fig. 7. A typical shed built for Binjharpuri cattle



Fig. 8a. A Binjharpuri herd



Fig. 8b. Binjharpuri cattle herd at farmer's place



Fig. 8c. Binjharpuri cattle herd under shed after grazing



Fig. 9. A herd of cattle assembled before grazing



Fig. 10. Binjharpuri cattle provided with groundnut stover



Fig. 11. Cattle provided with Bengal gram chuff



Fig. 12. Binjharpuri cattle provided with rice gruel



Fig. 13. Binjharpuri cattle provided with straw



Fig. 14. Cattle store house for crop residue



Fig. 15. A lady milking Binjharpuri cow



Fig. 16a. Ghee prepared from Binjharpuri cow's milk



Fig. 16b. Curd prepared from Binjharpuri cow's milk



Fig. 16c. Cottage cheese prepared from the cow's curd



Fig. 17a. A black coloured Binjharpuri cow

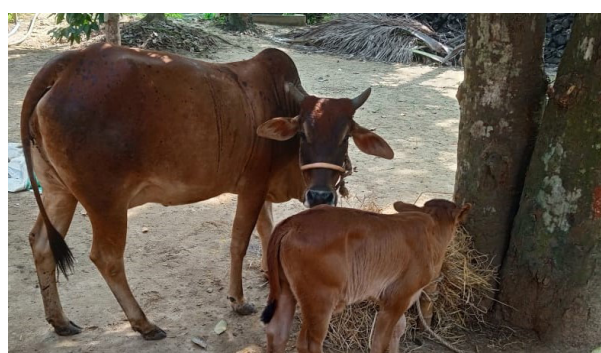


Fig. 17b. A red coloured Binjharpuri cow with calf



Fig. 18. Measurement of body length



Fig. 19. Measurement of height at withers



Fig. 20. Measurement of heart girth



Fig. 21. Measurement of punch girth

RESULTS AND DISCUSSION

Body weight and biometric traits

The body weight and biometric traits of both sexes as presented in Table 1 depict that the least squares overall mean for body weight was 249.58 ± 2.86 kg. The average body weight was estimated as 252.51 ± 5.87 kg in males and 206.76 ± 2.84 kg in females and the height at withers were 117.04 ± 0.87 cm for males and 106.18 ± 0.86 cm for females with significant difference between them making males heavier and taller than their

female counterparts. Besides, the average body length, heart girth, and punch girth of males were 122.78 ± 0.88 , 141.84 ± 1.08 and 147.44 ± 0.78 cm and corresponding estimates in females were 107.28 ± 0.80 , 132.25 ± 0.78 and 138.65 ± 1.07 cm with significant difference between sexes. Other biometric traits like head, horn, tail, switch, and ear lengths did not show significant difference between male and female Binjharपुरi cattle; however, males had numerically higher estimates than female counterparts with respect to ear and switch.

Table 1. Means and standard error for biometric traits of adult Binjharपुरi cattle (sex wise)

Traits	Sex		Overall (375)
	Male (24)	Female (351)	
Body weight (kg)	$252.51^a \pm 5.87$	$206.76^b \pm 2.84$	249.58 ± 2.86
Height at withers (cm)	$117.04^a \pm 0.87$	$106.18^b \pm 0.86$	116.35 ± 0.72
Body length (cm)	$122.78^a \pm 0.88$	$107.28^b \pm 0.80$	121.79 ± 0.76
Heart girth (cm)	$141.84^a \pm 1.08$	$132.25^b \pm 0.78$	141.23 ± 0.65
Punch girth (cm)	$147.44^a \pm 0.78$	$138.65^b \pm 1.07$	146.88 ± 0.75
Head length (cm)	43.22 ± 0.25	43.86 ± 0.37	43.68 ± 0.22
Horn length (cm)	12.11 ± 0.18	12.24 ± 0.25	12.21 ± 0.11
Length of tail (cm)	99.12 ± 0.58	97.65 ± 0.68	98.74 ± 0.48
Length of switch (cm)	26.34 ± 0.14	27.32 ± 0.16	27.18 ± 0.10
Length of ear (cm)	22.68 ± 0.18	22.27 ± 0.31	22.32 ± 0.16

*Means with different superscripts in a row for a trait under sex differ significantly ($p \leq 0.05$)

Lower body weight, height at withers, and heart girth were reported in Binjharपुरi cattle by Mahakur et al. (2017); in Kathani cattle by Yadav et al. (2022) and in Badri cattle by Dar et al. (2022) and higher estimates were recorded in Alambadi cattle by Parameswari et al. (2021) and almost similar results were recorded in Binjharपुरi cattle by Dash et al. (2013).

Reproduction and production traits

Binjharपुरi cows attain sexual maturity

at 872.46 ± 1.86 days, give birth to their first calf at an average of 1184.22 ± 1.72 days, and continue to deliver 10 to 11 calves at an average interval of 453.33 ± 1.02 days during their lifespan (Table 2). A lower age at first calving was recorded in Alambadi cattle by Parameswari et al. (2021) and in Kathani cattle by Bhagat et al. (2022). A longer calving interval was observed in Alambadi cattle by Parameswari et al. (2021) and in Kathani cattle by Bhagat et al. (2022).

Table 2. Least square means and standard error for reproduction and production traits Binjharपुरi cattle (locality wise)

Sl. No.	Traits	Locality				Overall (423)
		Dasrathpur (112)	Jajpur (98)	Bari (105)	Binjharपुर (108)	
1	Age at sexual maturity (days)	868.45±10.24	872.68±8.86	884.45±8.55	864.77±9.26	872.46±1.86
2	Age at first calving (days)	1178.56±12.34	1186.25±9.12	1204.18±9.86	1168.83±11.66	1184.22±1.72
3	Calving interval (days)	452.48±6.86	460.36±7.38	455.54±7.47	445.67±7.55	453.33±1.02
4	Service period (days)	177.24±8.78	184.06±7.22	179.43±7.65	172.54±8.12	178.16±1.15
5	Lactation length (days)	284.66±12.44	290.25±11.37	296.87±12.14	302.68±12.53	293.59±2.24
6	Average daily milk yield (lt)	3.88±0.56	4.22±0.48	4.53±0.45	4.86±0.52	4.37±0.14
7	Lactation yield (lt)	1104.48±86.24	1224.86±78.65	1344.82±82.75	1471.03±78.47	1285.62±10.24
8	Dry period (days)	168.53±10.27	170.19±11.14	159.62±10.27	143.04±9.65	160.19±2.12

The overall least squares mean of lactation length in Binjharपुरi cows was recorded at 293.59±2.24 days (Table 2). A shorter lactation length was observed in Belahi cattle by Vohra et al. (2016), in Jhari cattle by Pundir et al. (2020), in Alambadi cattle by Parameswari et al. (2021), in Binjharपुरi cattle by Nayak et al. (2022) & Lohith et al. (2022), and in Kathani cattle by Bhagat et al. (2022).

The average daily milk yield among Binjharपुरi cows was found to be 4.37±0.14 liter. A lower daily milk yield was reported in Binjharपुरi cattle by Nayak et al. (2022) and a higher yield was reported in Belahi cattle by Vohra et al. (2016), in Jhari cattle by Pundir et al. (2020), in Alambadi

cattle by Parameswari et al. (2021) and in Kathani cattle by Bhagat et al. (2022).

Genetic parameters

Conformation traits

The heritability estimate for body weight (BW) in adult Binjharपुरi cattle was 0.28±0.12. The corresponding heritability estimates for height at withers (HW), body length (BL), heart girth (HG), and pelvic girth (PG) were 0.25±0.11, 0.30±0.17, 0.24±0.11 and 0.26±0.12, respectively (Table 3). Higher heritability estimates for height at withers and body length were reported in Sahiwal cattle by Khan et al. (2018).

Table 3. Heritability, genetic and phenotypic correlations among the biometric traits for adult Binjharपुरi cattle

Traits	Body weight	Height at withers	Body length	Heart girth	Punch girth
Body weight	0.28±0.12	0.46±0.23	0.30±0.23	0.22±0.17	0.41±0.23
Height at withers	0.51±0.13	0.25±0.11	0.41±0.22	0.42±0.24	0.38±0.26
Body length	0.38±0.12	0.46±0.09	0.30±0.17	0.34±0.26	0.41±0.24
Heart girth	0.45±0.13	0.36±0.08	0.51±0.06	0.24±0.11	0.25±0.16
Punch girth	0.40±0.09	0.38±0.11	0.33±0.07	0.43±0.09	0.26±0.12

*Diagonal estimates are heritability; above diagonal are genetic correlations and below the diagonal are phenotypic correlations

Reproduction and production traits

The heritability estimate for age at sexual maturity in Binjharपुरi cattle was 0.34 ± 0.13 . The

estimates for age at first calving, calving interval, and lactation length were 0.41 ± 0.14 , 0.28 ± 0.11 and 0.29 ± 0.10 , respectively (Table 4).

Table 4. Heritability, genetic and phenotypic correlations among different production and reproduction traits of Binjharपुरi cattle

Traits	Age at sexual maturity	Age at first calving	Calving interval	Lactation length
Age at sexual maturity	0.34 ± 0.13	0.43 ± 0.05	0.42 ± 0.04	0.35 ± 0.05
Age at first calving	0.78 ± 0.12	0.41 ± 0.14	0.43 ± 0.06	0.24 ± 0.04
Calving interval	0.61 ± 0.07	0.83 ± 0.13	0.28 ± 0.11	0.25 ± 0.05
Lactation length	0.31 ± 0.08	0.32 ± 0.17	0.56 ± 0.19	0.29 ± 0.10

*Diagonal estimates are heritability; above diagonal are genetic correlations and below the diagonal are phenotypic correlations

Higher heritability estimates for age at first calving were reported by Chand (2011) in Tharparkar cows, and Kumar et al. (2016) for Ongole cows. However, Ratan (2018) recorded a lower heritability estimate for age at first calving in Sahiwal cows.

Lower heritability estimates for calving interval were observed by Chand (2011) in Tharparkar cows, Ekka (2012) in Kankraj cows, and Ratan (2018) in Sahiwal cattle. On the other hand, Patro et al. (2005) reported a higher heritability estimate for calving interval in Motu cows of Odisha, than that observed in the present study.

CONCLUSION

The Binjharपुरi cows of Odisha are being reared for a small amount of milk. Bullocks are very popular for agricultural operations and carting and for obtaining manure on a low-input basis. The animals were medium in size with an average adult body weight of 260 kg and a height of around 116 cm at withers. The cow attained sexual maturity around the age of 29 months and dropped the first calf around the age of 40 months. The calving interval was approximately 15 months. The cows recorded an average daily milk yield of 4.37 litres with slightly less than a 10-month lactation length. The characteristics of these unique cattle fits to consideration of Binjharपुरi as a dual-purpose cattle breed. Recording of moderate heritability of economic traits and moderate to high genetic correlations in the present study. Obtaining dataset on production performance of Binjharपुरi cows in

the native tract and exploring the results in this study along with individual variations for selection of elite animals under strategic breeding programmes triggering conservation and genetic improvement of this unique cattle breed.

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