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Genetic and phenotypic characterization of Kuzi ducks of Odisha and evaluation of carcass quality

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ABSTRACT

In the present investigation, the Kuzi ducks of Odisha were studied with respect to different phenotypic traits and genetic parameters measured for Juvenile traits from 1,718 ducklings hatched in three hatches using 40 sires and 160 dams reared under standard management conditions. Fertility, hatchability, juvenile traits, body weight gains and plumage characteristics were recorded. Carcass characteristics of the drakes were also measured at 20 weeks of age. The average fertility was 75.42% and hatchability on total egg set and fertile egg set basis were 61.79 and 82.10%, respectively. The body weight between male and female showed sexual dimorphisms with respect to body weight and conformation traits from 4th week onwards in Kuzi ducks. The least square body weight recorded at 8 weeks of age in male, female and pooled over sexes were 1,388, 1,231 and 1,282 g, respectively. Heritability estimates for different juvenile traits were moderate to high in magnitude for the traits studied. Body weight recorded at 20 weeks of age was 1,818 g in male and 1,628 g in female. Total edible carcass yield was 76.48% at 20 weeks of age in male. Multi-colour is found to be dominant plumage colour. The study revealed that Kuzi ducks of Odisha have very good potential for duck farming in the country and the body weight of the duck may be improved by selection of the birds and the drake (male) may be used for meat purpose. The growth of the ducklings was very fast from 2 to 8 weeks of age.

Keywords: Body weight, Carcass quality, Conformation traits, Correlation, Duck, Heritability, Kuzi, Plumage colour

Duck is second most important poultry species after chicken in India. Duck farming is popular in many coastal states and other states having large water bodies. As per the 20th Livestock Census (2019), total duck population in the country is 33.51 million out of which, 32.5 million are being reared in backyard, which is about 97% of the total duck population of the country. It is also known that most of the Indian duck populations are of indigenous origin (Padhi 2014). Different aspects in respect to growth, production and reproductive performance of indigenous duck breeds in the country have been reported (Zaman *et al.* 2007, Padhi *et al.* 2009a, Padhi 2010, Veeramani *et al.* 2014, Padhi *et al.* 2019, Kamal *et al.* 2020). However, there are limited number of reports on genetic and phenotypic characteristics of the ducks native to Odisha. In Odisha, there are about 36 lakh ducks out of which, ~ 98% are being reared under backyard system. The indigenous ducks are mostly reared by the marginal and landless farmers. The reports on indigenous duck in Odisha are available in literature on various aspects like growth (Padhi *et al.* 2009a, 2019), production (Padhi *et al.* 2009b, Padhi 2010), phenotypic and morphometric characterization (Kamal *et al.* 2019), carcass characteristics (Padhi *et al*. 2007, 2010). Kuzi ducks are one of the indigenous non-descript breeds of Odisha popular in farming community and different traits of these birds are less studied (Annonymous 2019). Though indigenous ducks in India are important for improving duck production in the country, extensive research in selection and breeding has not been carried out so far. Cyriac *et al.* (2020) reported genetic parameters and response to selection for eight week body weight in Kutttanad ducks of Kerala. However, the genetic parameters in respect to different traits in other indigenous duck like Kuzi are not available. Keeping this in view, we aimed to study the genetic and phenotypic characteristics of Kuzi ducks of Odisha with respect to body weight, conformation traits, plumage colour and carcass quality.

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MATERIALS AND METHODS

Kuzi duck were collected from different parts of Odisha. Small population of Kuzi ducks available in the Regional Station of ICAR-Central Avian Research Institute, Bhubaneswar which is presently under ICAR-Directorate

of Poultry Research farm were also used for the current study. In the present study, the ducklings that survived up to 8 weeks (1,814 number) were used for phenotypic characteristics like plumage colour, bill colour, and 1,718 birds were used for the genetic study. These ducklings were produced in three hatches using 40 sires and 160 dams during 2019. After 8 weeks of age, 193 males and 467 females were selected for higher body weight and kept for growing upto 20 weeks of age. At 20 weeks of age, 20 drakes were sacrificed to evaluate the carcass quality traits according to Padhi *et al.* (2010). The experiment was carried out during 2019 to 2020 in hot and humid climate of Bhubaneswar in Odisha. The ducklings were brooded for 8 weeks under standard brooding practices in an open sided house on deep litter. During brooding, wheat based starter mash having 20% crude protein and ME of 2,900 Kcal/kg was provided. Sexing was done at 8 weeks of age and after selection on the basis of 8th week body weight, the selected male and female were kept for growing with standard grower management with duck grower ration containing 16% crude protein and 2,600 kcal/kg ME. Standard feeding and health care facility during brooding and growing period were followed. The birds were provided *ad lib.* water in tub having water depth of ~6 inches sufficient to immerse their head.

Fertility and hatchability data of each hatch were recorded. The per cent fertility and hatchability on total egg set and fertile egg set were calculated. During brooding period, body weight were measured at 0 day, two, four, six and eight weeks of age using a sensitive weighing scale balance with a precision up to 1 g. Conformation traits (shank length, keel length and bill length) were recorded at eight weeks of age in both male and female. Plumage colour, skin colour, bill, shank and eye colour were observed visually for each bird at 8 weeks of age and recorded in the population. When the bird had more than two colours, it was taken as multicolour plumage. The phenotypic features were observed, identified and documented properly. The ducks and drake selected at 8 weeks of age; the growing period body weight were recorded at 12, 16 and 20 weeks of age. Carcass quality traits were recorded as described previously. The weight of testis was also measured and expressed as % of live weight. Meat, bone and skin yield of two prime cuts (breast and leg) were recorded. Mortality if any were recorded every day.

Statistical analysis: Juvenile body weight and conformation data were analysed using least square technique (Harvey 1990) with a computer package and the hatch corrected data were utilized for estimating the heritability estimates by variance component analysis (King and Henderson 1954). Genetic and phenotypic correlations were estimated from variance-covariance component analysis (Becker 1975). All other body weight data, reproductive data as well as carcass quality data were analysed as per Snedecor and Cochran (1989). Per cent of population in respect to phenotypic characteristics were expressed as per cent of total number of birds used to collect the data for the traits.

RESULTS AND DISCUSSION

The average fertility obtained in Kuzi ducks was 75.42±2.34%. The hatchability expressed on total egg set basis and fertile egg set basis were 61.79±3.01 and 82.10±2.13% respectively. The fertility % obtained in this study was better than that reported by Kalita *et al.* (1992) in different strains of Khaki Campbell. The hatchability % on total eggs set basis and fertile egg set basis obtained in this study is better than that reported by Kalita *et al.* (1992) in Khaki Campbell ducks. This may be due to the breed/ population differences and use of open population of the duck as well. Cheng *et al.* (2003) reported better fertility in Brown Tasiya ducks through artificial insemination. The juvenile body weights and some conformation traits of male, female and pooled over sexes are presented in Table 1. Sexual dimorphism was evident with respect to body weight recorded from 4 week onwards. Further, the calculated value of weight gain at 0 to 2, 2 to 4, 4 to 6 and 6 to 8 weeks of age in male and female were 198.43, 445.23, 343.17, 363.89 and 197.74, 431.71, 312.95, 250.97 g, respectively. The corresponding values for pooled over sexes were 196.22, 439.80, 329.43, and 278.35 g. The maximum gain in body weight was observed from 2 to 4 weeks of age followed by 4 to 6, 6 to 8 and day old to 2 weeks of age irrespective of the sex. The body weight observed at day old and onwards up to 8th weeks of age are better than that reported by Padhi *et al.* (2009a), Padhi and Sahoo (2011) and Padhi *et al.* (2019) in indigenous duck. This may be due to natural selection or effect of selection in these birds. The weight at different weeks is also better than the weight reported by other indigenous duck of India (Senani *et al.* 2005, Gajendran and Karthickeyan 2009) and Nageswari duck of Bangladesh (Bhuiyan *et al.* 2017) and Jinding and Desi ducks of Bangladesh (Islam *et al.* 2012). Padhi and Sahoo (2012) reported lower weight gain between 2 to 4 and 4 to 6 weeks of age in pooled sexes but better weight gain from 6 to 8 weeks of age in indigenous ducks of Odisha. This may be due to better growth rate of ducklings during early period compared to later part of the age at 8th weeks of age. The higher early weight gain in the ducklings indicates the maximum gain may be achieved if birds are selected at an early age. The significant sexual dimorphism for body weight as evident from 4 weeks onwards in Kuzi ducks is similar to the other varieties of ducks (Senani *et al.* 2005). Padhi *et al.* (2009c) also reported significant dimorphism in Moti ducks of Odisha from 9th weeks onwards. The difference between body weights in male and female may be due to difference in breed and genetic makeup of the birds.

The least square estimates of shank length, keel length and bill length measured at 8th week of age are presented in Table 1. Kamal *et al.* (2020) reported lower shank length in male and female adult Maithili duck of Bihar. Significant differences were observed in male and female with respect to keel length and bill length. The keel length obtained in

Table 1. Sex wise least squares means for juvenile body weights and confirmation traits of Kuzi ducks

Trait	Male (819)	Female (899)	Pooled over sexes (1718)
Day old (g)	37.32^{a}±0.002	37.29^{a}±0.016	37.31^{a}±0.005
2wk BW (g)	235.75^{a}±0.05	235.03^{a}±0.07	233.53^{a}±0.08
4wk BW (g)	680.98^{a}±0.15	666.74^{b}±0.21	673.33^{ab}±0.10
6wk BW (g)	1024.15^{a}±1.91	979.69^{c}±1.01	1002.76^{b}±1.01
8wk BW (g)	1388.04^{a}±3.10	1230.66^{c}±2.75	1281.11^{b}±1.21
8wk SL (mm)	65.84^{a}±0.004	63.13^{c}±0.005	64.44^{b}±0.009
8wk KL (mm)	121.61^{a}±0.04	115.13^{c}±0.05	117.98^{b}±0.01
8wk BL (mm)	63.01^{a}±0.008	60.12^{c}±0.007	61.51^{b}±0.006

Means having different superscript in a row differ significantly ($p<0.05$). wk, week; BW, body weight; SL, shank length; KL, keel length; BL, bill length.

the present study was higher than that reported by Padhi *et al.* (2009b) in male and female indigenous ducks of Odisha. The higher conformation traits obtained in the present study may be due to higher body weight of the duck at similar age. The body weight data recorded at 12, 16 and 20 week of age (growing period) in drakes and ducks are presented in Table 2. Significant differences ($p<0.05$) were recorded between ducks and drake for growing period body weight irrespective of age of measurements. The body weight during growing period was better than the previous reports of Padhi (2010) and Kamal *et al.* (2019) in indigenous ducks of Odisha. Further, higher body weight during growing period may be due to selection of the drakes on basis of higher body weight at 8 of weeks of age.

The heritability (h^2) of different juvenile body weight and conformation traits as well as the genetic and phenotypic correlation between different juvenile traits is presented in Table 3. The h^2 estimates for juvenile body weights were high in magnitude indicating the presence of additive genetic variance for these traits and thus there is a scope for improvement. It is to mention here that heritability of a trait gives an indication about the proportion of variation due to the additive effects of the genes that can be transmitted to the next generation. Moderate heritability from sire plus dam component for 8th week body weight was reported by Cyriac *et al.* (2020) in Kuttanad ducks.

Table 2. Growing period body weight in duck and drake

Trait	Drake (193)	Duck (467)
12 wk BW (g)	1666^{a}±15	1492^{b}±10
14 wk BW (g)	1760^{a}±17	1566^{b}±8
16 wk BW (g)	1818^{a}±18	1628^{b}±9

Means having different superscript in a row differ significantly ($p<0.05$). wk, week; BW, body weight.

Though reports on heritability in indigenous ducks were scanty, however higher heritability estimates for juvenile body weight were reported in White Pekin ducks (Li *et al.* 2020, Deng *et al.* 2019) and Shan Ma laying ducks at 110 days of age (Lin *et al.* 2016). Our findings are in agreement with these studies. Heritability estimates for shank length and keel length were moderate in magnitude and for bill length, the h^2 were high in magnitude indicating the importance of additive genetic variance for these traits. The research reports on h^2 for conformation traits in indigenous ducks of India are scanty.

Genetic and phenotypic correlation between juvenile body weights and conformation traits is given in Table 3. The genetic correlation between different juvenile traits were positive and moderate to high in magnitude indicating that same sets of gene were controlling the juvenile traits and have positive pleotropic effects on the expression of these traits. This indicates that increase in body weights is directly proportional to increased conformation traits therefore, if desired, the selection may be carried out at 6 weeks of age. Similar findings of high genetic correlation between body weights in Kuttanad ducks was reported by Cyriac *et al.* (2020). The phenotypic correlations between different juvenile body weights were positive and moderate to high in magnitude. However, the phenotypic correlation between body weight and conformation traits were low to moderate in magnitude and between conformation traits values were positive moderate in magnitude. High phenotypic correlation between body weights in ducks was reported by Cyriac *et al.* (2020) which is in agreement with the present findings.

The phenotypic features like plumage colour, bill colour, shank colour, etc. with their percentage in straight run duck

Table 3. Heritability and correlation coefficients in Kuzi duck

	BW0	BW2	BW4	BW6	BW8	SL8	KL8	BL8
BW0	0.81±0.16	0.40	0.50	0.46	0.44	0.15	0.30	0.52
BW2	0.25	0.34±0.08	0.81	0.69	0.64	0.62	0.59	0.58
BW4	0.24	0.48	0.42±0.10	0.88	0.74	0.38	0.46	0.53
BW6	0.20	0.28	0.50	0.68±0.14	0.98	0.59	0.86	0.85
BW8	0.16	0.21	0.38	0.66	0.55±0.13	0.64	0.92	0.91
SL8	0.03	0.11	0.10	0.19	0.24	0.14±0.05	0.62	0.67
KL8	0.07	0.11	0.18	0.28	0.41	0.26	0.27±0.07	0.85
BL8	0.15	0.16	0.21	0.32	0.40	0.41	0.47	0.41±0.10

*Values in the diagonal sire: component heritability, values above diagonal: genetic correlation and below diagonal: phenotypic correlation. BW0, Body weight at day old; BW2, Body weight at 2 week; BW4, Body weight at 4 week; BW6, Body weight at 6 week; BW8, Body weight at 8 week; SL8, Shank length at 8 week; KL8, Keel length at 8 week; BL8, Bill length at 8 week.

measured at 8 weeks of age is given in Table 4. Most of the birds were having multicolour plumage. Similar observation in Desi duck of Odisha were reported by Kamal *et al.* 2019 but in different body parts having feather coverings of different colour. Predominantly multicolour plumage was reported in local duck of Andaman by Senani *et al.* (2005), Nageswari duck of Bangladesh by Morduzzman *et al.* (2015) and Maithili breed of duck by Kamal *et al.* (2020). The birds with single colour like white, black, and fawn were very less in number and percentage in our flock. This indicates that there is every chance to develop Kuzi varieties having unique plumage colour through selection and breeding in future. Eye colour of the duck were mostly dark and few yellow colour eyes were also present. Variation in eye colour was reported by Kamal *et al.* (2019) in desi duck of Odisha. Dominant black colour in Nageswari duck of Bangladesh was reported by Morduzzaman *et al.* (2015). There is a variation in the bill colour of Kuzi duck and brown was predominant followed by light pink to whitish, black and spotted. The present findings are not in agreement with the report on desi duck of Odisha by Kamal *et al.* (2019) and Maithili duck by Kamal *et al*. (2020). Morduzzaman *et al.* (2015) reported that Nageswari ducks have maximum black colouration for the bill. This may be due to difference in the breed characteristics of the ducks or may be due to mixing of different duck varieties and breeds in the field. The shank colour was also different among the individual Kuzi ducks and light pink was the maximum, followed by brown. Yellow and orange shank was reported in Maithili and desi duck of Odisha (Kamal *et al.* 2019, 2020) and dull yellow to pink yellow was reported by Senani *et al.* (2005) in Andaman duck and predominant black shank colour in Nageswari duck (Morduzzaman *et al.* 2015). Skin colour observed in the present study was light pink to white. White skin colour in different indigenous duck varieties was also reported (Kamal *et al.* 2019, 2020; Morduzzaman *et al.* 2015).

Table 4. Phenotypic features and their percentage in Kuzi duck (N=1804)

Phenotype	Characteristic	Frequencies	Percentage
Plumage colour	Multicolour	1465	80.76
	Black and white	125	6.89
	Fawn	87	4.80
	Khaki	56	3.09
	White	40	2.21
	Black	31	1.71
	Ash	10	0.55
Eye colour	Dark	1704	93.94
	Dark-yellow	110	6.06
Bill colour	Brown	767	42.28
	Light pink to whitish	683	37.65
	Black	187	10.31
	Spotted	138	7.61
	Slate grey	14	0.77
	Black and brown	10	0.55
	Blue	9	0.50
	Black and pink	6	0.33
Shank colour	Light pink	1245	68.63
	Brown	386	21.28
	Black	104	5.73
	Orange	25	1.38
	Yellow	20	1.10
	Black and pink	13	0.72
	Slate grey	13	0.72
	Spotted	8	0.44
Skin colour	Light pink to white	1814	100.00

The mortality % calculated by taking the average of three hatches revealed that the mortality during juvenile period from 0–8 weeks of age was 7.07±0.92% and 1.56±1.26% from 8 to 20 weeks of age. The mortality during 8–20 weeks period was lower compared to the juvenile periods. This indicates that one must be careful during brooding period to reduce the brooding period mortality. Higher mortality during brooding periods are also reported by Islam *et al.* (2012) and Kamal *et al.* (2020).

Carcass quality traits measured at 20 weeks of age in male are presented in Table 5. The results revealed that the blood and feather loss expressed as % of live weight in drake found in the present study is comparable to the report by Padhi *et al.* (2008) in Moti ducks. The head and shank + feet % obtained in the present study are in agreement with the report of Padhi *et al.* (2007). The eviscerated carcass % obtained in the present study was higher than the earlier report by Padhi *et al.* (2007) and Padhi *et al.* (2010) in indigenous duck of Odisha and it may be due to higher age of slaughter of the drake. Padhi *et al.* (2008) also reported lower carcass yield in Moti duck. Higher dressing % in Pekin ducks than the present study was reported by Padhi *et al.* (2010). The results indicate that the eviscerated yield was better at 20 weeks of age in male of Kuzi ducks. The edible offal like heart, liver testis and Gizzard expressed as % of live weight revealed that the Gizzard yield % is higher followed by testis, liver and heart. Total edible part obtained in the present study was higher than the report of Padhi *et al.* (2007) and it is due to higher eviscerated carcass yield. Different cut up parts weight expressed as % of eviscerated weight revealed that back cut yield higher % followed by breast, leg wing and neck. However the results did not agree with report of Padhi *et al.* (2010) in which leg cut showed higher yield than breast. It may be due to higher age of slaughter and the yield is better in breast than leg in the present study compared to the above reports. Breast meat as per cent of eviscerated weight observed in the present study was higher than the report of Padhi *et al.* (2008) and lower in case of leg meat yield %. This may be due to higher age of slaughter in the present study and the earlier reports suggest the meat deposition in the breast increases as the age advances. The breast skin and breast bone as % of eviscerated weight is higher than the legs. The meat to bone ratio for breast and leg cut were 3.479:1 and 2.6432:1, respectively. The meat bone ratio in both the cut were lower than the earlier report in indigenous duck of Odisha (Padhi

Table 5. Carcass quality at 20 weeks of age in male (N=20)

Parameter	Weight (g)	As % of live weight	% of eviscerated carcass wt
Prefasting, BW	1591±37		
Slaughter wt	1540±31		
Blood loss	82.05±7.15	5.36±0.49	
Feather loss	94.20±8.57	6.19±0.58	
Head	84.90±1.83	5.53±0.01	
Shank+feet	41.40±1.22	2.68±0.05	
Eviscerated carcass	1070.40±27.69	69.36±0.57	
Heart	11.60±0.34	0.75±0.02	
Liver	25.20±0.97	1.63±0.05	
Gizzard	42.30±1.65	2.74±0.09	
Testis	30.55±2.74	1.99±0.18	
Total edible part	1180±29.75	76.48±0.60	
Cut-up part			
Leg	186.1±5.54		17.45±0.44
Breast	266.05±9.92		24.78±0.44
Wing	143.25±5.35		13.39±0.37
Neck	127.5±4.03		11.95±0.32
Back	348.05±12.97		32.40±0.54
Meat bone and skin yield of prime cut			
Breast meat	162.10±4.52		15.19±0.32
Breast bone	48.6±2.73		4.55±0.22
Breast skin	48.3±3.33		4.44±0.21
Leg meat	106.0±3.96		9.98±0.39
Leg bone	40.6±1.22		3.82±0.12
Leg skin	37.7±2.45		3.49±0.19

et al. 2008). The results indicate that the drake meat:bone ratio in breast was better than leg cut at slaughter age of 20 weeks.

The study revealed that the Kuzi ducks of Odisha have multicolour plumage and variation exists with respect to bill and shank colour. The juvenile body weight and conformation traits showed sexual dimorphism from 4 weeks onwards and the body weight at 8 weeks of age. Maximum weight gain was obtained between 2 to 4 weeks of age. The weight gain thereafter reduced gradually as the age advanced and the birds reached at 20 weeks of age. Heritability estimates for juvenile body weight was high in magnitude indicating the body weight of the Kuzi ducks can be improved through selection. The genetic correlation between different juvenile traits were moderate to high in magnitude indicating that the increase in one trait may increase the other correlated traits. The carcass quality traits revealed the extra male of the breeds may be sold for better carcass yield at 20 weeks of age.

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