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Comparative production performance and egg quality of Kuzi Ducks (*Anas platyrhynchos*) and its crosses with Khaki Campbell

M K PADHI[1✉], S C GIRI[1] and S K SAHOO[1]

Regional Station, ICAR-Directorate of Poultry Research, Bhubaneswar, Odisha 751 003 India

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ABSTRACT

Comparative performance of Kuzi ducks and its two crossbreds with Khaki Campbell, viz. Kuzi × Khaki Campbell (DK) and Khaki Campbell × Kuzi (KD) were carried out in respect to various production, egg weight, age at different production level and egg quality traits. The laying period body weight showed significant difference between the three genetic groups, irrespective the age of measurement and Kuzi duck recorded significantly higher body weight than the two crosses. The crossbreds attained 50% duck day production significantly earlier as compared to Kuzi. Egg production per bird and average duck day production % during different periods differed significantly and the crosses recorded higher egg production than the Kuzi. DK laid more than 300 eggs up to 72 weeks of age. The average duck day production % from 72 to 80 weeks of age in both the crosses were 80% or more, indicating that the crosses may be used for second cycle for egg production. Egg weight recorded at different weeks of age showed significant difference between genetic groups and the egg weight were higher in Kuzi than the crosses. As the age advanced, the egg weight increased. Egg quality traits measured at different weeks of age showed significant difference between genetic groups and within genetic groups at different ages for some traits. The egg quality decreased as the age advanced. The study indicated that the crosses of Kuzi and Khaki Campbell may be used for higher egg production with good quality eggs.

Keywords: Crosses, Duck, Egg production, Egg quality, Egg weight, Khaki Campbell, Kuzi duck

Duck is the second most important species in poultry after chicken. Ducks are important food source in rural areas in Asia particularly South-east Asia. In India, like in many Asian countries in the world, amongst poultry birds, duck is preferred species after chicken in respect to egg and meat production and consumption. This is mostly due to many advantages of duck farming like they are preferred by the farmers under rural traditional backyard system due to their high adaptability to the farming system, better foraging ability, long productive life, less prone to diseases, well integration with other farming system and easy management. As per the 20th Livestock Census (Anonymous 2020) of India, total duck population in the country was 33.51 million and 87% of them were being reared under backyard and most of the duck population were of indigenous in origin. Average egg production of indigenous desi duck per annum under backyard and commercial system were 110.97 and 181.12 eggs; whereas average egg production of improved duck under backyard and commercial system of rearing were 178.71 and 202.20 eggs. The production data indicates that the duck egg production may be increased with different scientific intervention. Different aspects in respect to growth, production and reproduction of indigenous ducks of India were reported (Padhi *et al*. 2019, Kamal *et al*. 2020a, Padhi *et al*. 2021, Padhi *et al*. 2022, Kamal *et al*. 2022). The cross performance of the indigenous ducks with exotic one were positive and better than the indigenous duck (Padhi 2010). However, periodic evaluation of the cross performance of indigenous ducks with exotic breeds in respect to various traits and its comparison with indigenous duck is important to know the benefits of crossbreeding, for different economic traits in crossbred. Keeping this in view, the present study was undertaken to study the comparative performance of Kuzi ducks (one indigenous ducks of Odisha state in India) and its two crossbreds with exotic Khaki Campbell in respect to various production, egg weight, age at different production level and egg quality traits at different ages.

MATERIALS AND METHODS

Experimental ducks: Kuzi ducks used for the present study are being maintained in the Regional Centre of ICAR-Central Avian Research Institute, which is presently being maintained at Regional station of ICAR-Directorate of Poultry Research, Bhubaneswar, Odisha, India. The duck base population being formed by collection of fertile duck egg from different district of Odisha and hatching of ducklings at the station, and also by using the Kuzi duck

Present address: [1]Regional Station, ICAR-Directorate of Poultry Research, Baramunda, Bhubaneswar, Odisha. ✉Corresponding author email: padhi16@rediffmail.com

population available in the station. The breed is being maintained as a pedigree population and the S1 and S2 generation was produced using 40 sires and 160 dams after selection of the S0 generation stocks with higher 8 week body weight. During regeneration of S2 generation, male and female of the S1 generation are being used to produce two crosses using Khaki Campbell and with them pure Kuzi ducklings were hatched for comparative study of crosses with pure Kuzi ducks. Khaki Campbell used for the production of the crosses with Kuzi ducks were being kept in the centre as non-pedigreed random bred population. Number of fertile egg set in Kuzi, Khaki Campbell × Kuzi (KD) and Kuzi × Khaki Campbell (DK) were 274, 175 and 193 eggs, respectively. Out of the total 479 ducklings hatched, a total of 88 Kuzi ducks, 69 DK and 70 KD duck were used for the present study.

Management and feeding: The ducklings hatched were wing banded, weighed and reared under deep litter system with standard brooding, growing, feeding and healthcare management system. The females at 16 weeks of age were reared in three replicates for each genetic group to study the production performance. Birds were provided wheat based starter ration from 0-8 weeks of age, grower feed from 9 to 17 weeks of age and then layer mash from 18 weeks onward till the end of the experiment. The feed ingredients used in the ration formulations were wheat, soybean meal, fish meal, de-oiled rice bran, salt and vitamin premix, lysine, DL-methionine, trace minerals, shell grit, and di-calcium phosphate. The layer ration was supplemented with extra shell grit so that the calcium content made up 4.5% of the ration. During laying period, ducks were fed diet containing 19% CP and 2600 kcal/kg ME. Drinking water and feed were provided *ad lib.* throughout the experiment up to 80 weeks of age.

Data collected: Body weights were recorded at 20, 40, 52, 60 and 72 weeks of age. Daily numbers of egg production in each replicate of all the genetic groups were recorded and mortality if any was recorded. Age of the flock at first egg and at 20%, 50% and 80% duck day production were calculated for each replicate. Egg production (EP) from first egg of the flock to 16 weeks of age, 16 to 20, 20-40, 40-60, 60-72, 72 to 80, 20-72, up to 40, up to 60, up to 72 and EP up to 80 weeks per bird were calculated along with average duck day production % during the above period. Individual egg weights were recorded at four weeks interval for sample of eggs from 16 to 80 weeks of age. Mortality % from 20-40, 40-60, and 60-72 and 72-80 weeks of age were calculated for each genetic group. Internal and external egg quality parameters were recorded in 20 eggs of each genetic group at 40, 44, 48, 52, 60, 68 and 72 weeks of age as described by Padhi *et al*. (2009d). Shape index, albumen index, yolk index and Haugh unit were calculated as per the formula of Shultz (1953), Heiman and Carver (1936), Funk (1948) and Haugh (1937), respectively. Yolk colour was measured using a DSM yolk fan™ (DSM 2016) as per the guidelines.

Statistical analysis: The mean and SE for various traits were calculated according to standard statistical procedures (Snedecor and Cochran 1994). Significant differences between the genetic groups for various body weight, production, egg weight, body weights, egg quality traits were tested by one-way ANOVA. Duncan (1955) Multiple Range Test was used to see the differences between means of the traits studied.

RESULTS AND DISCUSSION

Body weight: Laying period body weights of the three genetic groups are presented in Table 1. The results indicated that the body weights at different period differ significantly ($P<0.05$) and the Kuzi ducks recorded significantly ($P<0.05$) higher body weight than the DK and KD. Further, in each genetic groups, the weight at different ages differ significantly ($P<0.05$) at different ages. The body weight at 20 weeks of age was higher than at 40 and 52 weeks of age in all the genetic groups in duck. The increase and decrease in body weight at different ages may be due to better egg production during this period.

Table 1. Laying period body weight (g) in Kuzi, DK and KD

Age in weeks	Kuzi (88)	DK (69)	KD (70)
20	$1737^{AB}\pm23_{a}$	$1650^{B}\pm23_{b}$	$1642^{A}\pm17_{b}$
40	$1663^{CD}\pm21_{a}$	$1534^{C}\pm24_{b}$	$1566^{B}\pm18_{b}$
52	$1584^{E}\pm23_{a}$	$1562^{C}\pm22_{b}$	$1420^{C}\pm26_{b}$
60	$1784^{A}\pm23_{a}$	$1715^{A}\pm14_{b}$	$1681^{A}\pm19_{b}$
72	$1702^{BC}\pm27_{a}$	$1652^{B}\pm21_{b}$	$1587^{B}\pm15_{b}$

DK, Kuzi × Khaki Campbell; KD, Khaki Campbell × Kuzi. Average in a column for a particular genetic group having even one superscript in capital letter common it did not differ significantly ($P\leq0.05$). Means in a row having different subscript in small letter differ significantly ($P\leq0.05$). g=gram. Figure in parenthesis are number of observation.

The decrease in body weights of duck after reaching the peak production of laying in different genetic groups was also reported by Padhi (2010). Similar observation was also observed in White Pekin (Padhi *et al*. 2010a) and in Desi ducks, Khaki Campbell and their crosses (Padhi *et al*. 2009b). The body weight during laying period obtained in crosses both in male and females were lower than the Kuzi, however earlier reports findings shows that the crosses of native/Desi duck of Odisha with Khaki Campbell have better body weight than the native/desi (Padhi *et al*.2009a, Padhi, 2010). This may be due to effect of selection on Kuzi which attains better body weight than the stock used in the earlier study.

Age of flock at different production level: Age of the flock at different production level in different genetic groups are presented in Supplementary Table 1. First egg of the flock was laid by the flock in different genetic groups did not differ significantly ($P<0.05$). However, age at 20%, 50% and 80% duck day egg production differ significantly ($P<0.05$). Significant differences between different genetic groups were also reported by Padhi (2010) which is in agreement with the present findings. Kamal *et al*. (2020a)

Table 2. Production performance of different genetic groups at different periods

EP period	Egg prod./bird and DD prod. %	Kuzi (N=88)	DK (N=69)	KD(N=70)
From first egg of the flock up to 16 weeks	No. of egg prod/bird	0.92[b]±0.01	0.75[c]±0.05	1.51[a]±0.03
	Avg. DD prod % during the period	7.67±0.10[b]	6.77±0.46[b]	13.74±0.30[a]
EP from 16-20 weeks	No. of egg prod/bird	11.12[c]±0.07	16.34[a]±0.53	14.96[b]±0.13
	Avg. DD prod % during the period	39.73±0.25[c]	58.37±1.90[a]	53.43±0.48[b]
EP from 20 to 40 weeks	No. of egg prod/bird	98.06±2.98	106.61±3.89	107.30±0.28
	Avg. DD prod % during the period	70.04±2.12	76.15±2.78	76.64±0.20
EP from 40-60 weeks	No. of egg prod/bird	85.58[c]±5.18	106.06[ab]±4.79	92.46[bc]±0.06
	Avg. DD prod % during the period	61.13±3.70[b]	75.77±3.42[a]	66.04±0.04[ab]
EP from 60-72 weeks	No. of egg prod/bird	51.54[c]±2.62	75.63[a]±0.45	63.71[b]±0.09
	Avg. DD prod % during the period	60.64±3.08[c]	90.03±0.54[a]	75.84±0.10[b]
EP from 72-80 weeks	No. of egg prod/bird	31.00±0.04[c]	48.36±0.09[a]	44.40±0.18[b]
	Avg. DD prod % during the period	55.36±0.08[c]	86.35±0.16[a]	79.41±0.31[b]
EP from 20-72 weeks	No. of egg prod/bird	235.18[b]±8.51	288.31[a]±9.12	263.47[a]±0.27
	Avg. DD prod % during the period	64.21±2.45[b]	79.20±2.51[a]	72.38±0.73[a]
EP up to 40 weeks	No. of egg prod/bird	110.10[b]±2.96	123.70[a]±4.47	123.76[a]±0.38
	Avg. DD prod % during the period	61.17±1.64[b]	69.11±2.50[a]	69.14±0.21[a]
EP up to 60 weeks	No. of egg prod/bird	195.68[b]±7.78	257.97[a]±9.55	216.23[b]±0.40
	Avg. DD prod % during the period	61.15±2.43[b]	73.70±2.73[a]	67.78±0.13[ab]
EP up to 72 weeks	No. of egg prod/bird	247.23[b]±8.50	305.39[a]±9.70	279.94[a]±0.45
	Avg. DD prod % during the period	61.03±2.10[b]	75.78±2.41[a]	69.47±0.11[a]
EP up to 80 weeks	No. of egg prod/bird	277.60±8.47[c]	353.74±9.77[a]	324.75±0.19[b]
	Avg. DD prod % during the period	60.35±1.84[c]	77.07±2.13[a]	70.68±0.10[b]

EP, Egg production; Avg. DD prod%, Average duck day production per cent; wk, week; K D, Khaki Campbell × Kuzi and DK. Kuzi × Khaki Campbell. Average showing even one common superscript in a row for no of egg produced per bird and average duck day production % did not differ significantly (P≤0.05).

reported late age at first laying in Maithili duck of Bihar. The early starts of laying and reaching different production level than the above reports may be due to genetic potential of the birds and effect of crossbreeding. A positive effect of crossbreeding of indigenous duck with Khaki Campbell in respect to age at different production level was also reported by Padhi (2010).

Production performance: Production performances of the three genetic group per bird basis and average duck day production % during the period are presented in Table 2. Significant difference (P<0.05) between genetic groups were observed for different production performance traits between the genetic groups which was in agreement with the findings of Padhi (2010).

Lower production than the present study were reported by Sarma *et al*. (2015) in Chara-Chembali duck, Das and Rahman (2019) in Desi ducks of Tripura. Kamal *et al*. (2020b) reported very low production per annum in native duck of Jharkhand, Odisha and Chhattisgarh. This may be due to different genetic potential of the stock used compared to reported literature and the cross performance showing better production indicating it may be exploited for commercial use. Further, the production % of the two crosses of Kuzi ducks with Khaki Campbell showed better % even between periods of 72 to 80 weeks of age indicating the crosses may be use for the second year of production. However, the production % decreased more in Kuzi ducks towards later part of the laying cycle which indicates that the Kuzi duck may be use for one year production. The production of egg observed in the present study indicates the crosses of Kuzi and Khaki Campbell may be used for higher egg production.

Table 3. Egg weight (g) at different weeks of age in different genetic groups

Age in weeks	Kuzi	DK	KD
16	48.06±0.53	47.67±0.78	48.35±0.98
20	62.87±0.96[a]	57.35±0.60[b]	57.30±0.88[b]
24	61.46±0.54	59.88±0.35	60.26±0.33
28	63.67±0.48[a]	62.61±0.46[ab]	62.23±0.44[b]
32	66.03±0.59	64.58±0.40	65.76±0.87
36	70.81±0.55	69.91±0.43	69.65±0.42
40	71.17±0.46[a]	67.13±0.31[c]	68.61±0.45[b]
44	72.03±0.32[a]	70.48±0.34[b]	70.68±0.36[b]
48	73.23±0.38[a]	71.65±0.25[b]	72.66±0.37[a]
52	72.49±0.35[a]	70.25±0.31[c]	71.23±0.32[b]
56	72.61±0.42[a]	70.56±0.31[b]	71.29±0.31[b]
60	74.63±0.45[a]	72.45±0.25[b]	72.37±0.41[b]
64	74.23±0.30[a]	73.16±0.22[b]	72.99±0.28[b]
68	75.16±0.30[a]	74.16±0.27[b]	74.03±0.28[b]
72	73.56±0.28[a]	72.00±0.20[b]	72.66±0.30[b]
76	72.26±0.48	71.57±0.45	71.57±0.48
80	72.18±0.45	71.70±0.46	72.83±0.45

Means bearing even one common superscript in a row did not differ significantly (P≤0.05). g, gram; KD, Khaki Campbell × Kuzi and DK, Kuzi × Khaki Campbell.

Egg weight: Egg weight recorded starting from 16 weeks of age up to 80 weeks of age at four week interval are presented in Table 3. At most of the ages, the egg weights of Kuzi were significantly (P<0.05) higher than the two crosses. As the age advances, the egg weight also increases irrespective of the genetic groups. In all the genetic groups, the egg weight reaches more than 70 g between 36 to 40 weeks of age.

The egg weights recorded at different week of age were comparable to the report of Sarma *et al*. (2015) in Chara-Chemballi ducks. The egg weight recorded at different weeks of age in different genetic groups also corroborate with the report of Padhi (2014) and Padhi *et al*. (2021) in indigenous duck of Odisha.

Egg quality: Egg quality parameters recorded at different weeks of age starting from 40 weeks of age in the three genetic groups are presented in Table 4 for egg weight, shape index, albumen index, yolk index and yolk colour and Supplementary Table 2 for content %, shell thickness and Haugh unit. The shape indexes differ significantly (P<0.05) between genetic groups at 44, 52, 60 and 72 weeks of age and KD recorded higher shape index value than other two genetic groups. However, there was no significant (P<0.05) difference between different ages in a particular genetic group. Similar findings of significant (P<0.05) difference between genetic groups had been also reported by Padhi *et al*. (2009a). The albumen index differs significantly (P<0.05) between three genetic groups at 40 and 60 weeks of age which agrees with the report of Padhi *et al*. (2009a). The albumen index in Kuzi and DK differ significantly between different age of measurements and though there were some instances where the albumen index increases at higher ages but most of the occasion, the index values decreases as the age of measurement advances which were in agreement with the findings of Padhi *et al*. (2009a, 2009c) and Padhi and Sahoo (2011) in native duck of Odisha and its crosses with Khaki Campbell. Varied albumen index may be due to environment in respect of climate, feed, production level etc. which were observed in all the three genetic groups; indicating decrease in albumen index in a particular age in all the three genetic groups. Yolk index differed significantly (P<0.05) only at 40 weeks of age between genetic groups, however as the ages, advances no significant difference observed. Yolk colours differed significantly between different ages in Kuzi and differ between the genetic groups only at 44 weeks of age. Non-significant difference between the genetic groups may be due to feeding of same layer mash to all the genetic groups. The yolk colour values were comparable to the report of Padhi *et al*. (2021) and the lower values of yolk color may be due to wheat based ration.

The albumen % differs (P<0.05) between genetic groups for the traits measured at 40, 60 and 68 weeks of age (Supplementary Table 2). Significant differences (P<0.05) between genetic groups for albumen % were also reported by Padhi *et al*. (2009b) and Padhi and Sahoo (2011). Varied values of albumen % in different genetic groups at different

Table 4. Egg quality parameters at different age in Kuzi S2 generation and KD, DK

Parameter	Genetic groups	40 wk	44 wk	48 wk	52 wk	60 wk	68 wk	72 wk
Egg weight (g)	KD	$68.30^{e}\pm0.55_{B}$	$70.45^{de}\pm0.48$	$72.73^{cd}\pm0.84_{B}$	$69.38^{e}\pm0.82_{B}$	$74.70^{bc}\pm1.18_{AB}$	$78.08^{a}\pm1.07_{A}$	$76.65^{a}\pm0.98_{A}$
	DK	$67.64^{c}\pm0.65_{B}$	$70.25^{b}\pm0.86$	$70.33^{b}\pm0.81_{B}$	$66.32^{c}\pm0.92_{C}$	$73.13^{ab}\pm0.89_{B}$	$74.40^{a}\pm1.03_{B}$	$71.03^{b}\pm1.21_{B}$
	Kuzi	$74.42^{bc}\pm1.03_{A}$	$72.00^{c}\pm0.84$	$78.48^{a}\pm0.80_{A}$	$73.05^{c}\pm1.10_{A}$	$76.73^{ab}\pm1.27_{A}$	$74.35^{bc}\pm0.75_{B}$	$76.65^{ab}\pm1.47_{A}$
Shape index	KD	75.00±1.22	$75.43\pm0.48_{A}$	72.73±0.95	$74.98\pm1.17_{A}$	$75.39\pm1.00_{A}$	74.49±0.89	$75.38\pm0.87_{A}$
	DK	73.67±0.48	$73.38\pm0.60_{B}$	73.88±0.76	$72.19\pm0.61_{B}$	$72.85\pm0.75_{B}$	73.45±0.74	$72.27\pm0.63_{B}$
	Kuzi	74.82±0.75	$74.06\pm0.67_{AB}$	73.14±0.63	$73.96\pm0.56_{AB}$	$74.94\pm0.77_{AB}$	74.73±0.93	$74.96\pm0.71_{A}$
Albumen index	KD	$0.148\pm0.005_{A}$	0.151±0.006	0.134±0.005	0.1411±0.001	$0.126\pm0.002_{B}$	0.142±0.008	0.142±0.008
	DK	$0.159^{a}\pm0.004_{A}$	$0.144^{abc}\pm0.007$	$0.142^{bc}\pm0.006$	$0.135^{bc}\pm0.005$	$0.130^{c}\pm0.004_{AB}$	$0.150^{ab}\pm0.004$	$0.141^{bc}\pm0.005$
	Kuzi	$0.131^{b}\pm0.004_{B}$	$0.150^{a}\pm0.004$	$0.140^{ab}\pm0.006$	$0.138^{ab}\pm0.004$	$0.136^{b}\pm0.003_{A}$	$0.141^{ab}\pm0.005$	$0.139^{ab}\pm0.002$
Yolk index	KD	$0.416\pm0.004_{B}$	0.413±0.005	0.412±0.005	0.428±0.006	0.413±0.006	0.422±0.008	0.418±0.008
	DK	$0.424^{abc}\pm0.004_{AB}$	$0.413^{c}\pm0.005$	$0.417^{bc}\pm0.005$	$0.428^{abc}\pm0.005$	$0.432^{ab}\pm0.007$	$0.436^{a}\pm0.005$	$0.428^{abc}\pm0.006$
	Kuzi	$0.436^{ab}\pm0.005_{A}$	$0.401^{c}\pm0.006$	$0.420^{abc}\pm0.004$	$0.434^{a}\pm0.005$	$0.421^{ab}\pm0.008$	$0.424^{ab}\pm0.007$	$0.415^{abc}\pm0.007$
Yolk colour	KD	1.80±0.16	$2.2\pm0.14_{A}$	2.25±0.22	2.15±0.20	2.25±0.19	2.16±0.22	2.05±0.20
	DK	1.75±0.11	$1.70\pm0.13_{B}$	2.15±0.18	2.20±0.17	2.10±0.19	2.15±0.17	2.11±0.21
	Kuzi	$2.10^{ab}\pm0.26$	$2.0^{ab}\pm0.16_{AB}$	$2.35^{ab}\pm0.23$	$2.45^{ab}\pm0.22$	$2.55^{a}\pm0.20$	$2.30^{ab}\pm0.25$	$1.85^{b}\pm0.17$

STM, shell thickness with membrane; ST, shell thickness; KD, Khaki Campbell × Kuzi; DK, Kuzi × Khaki Campbell; g, gram. Means having even one common superscript in a row for a particular traits in a genetic group at different ages did not differ significantly (P≤0.05). Average showing even one one subscript in capital letters for a particular traits at same age between different genetic groups did not differ significantly (P≤0.05).

ages also reported in the above reports. Significant (P<0.05) age effects on albumen % were observed in Kuzi and DK which was in agreement with the reports of Padhi *et al.* (2010b) in Khaki Campbell ducks. As the age advances, albumen % decreases, this trend published in different crosses and purebreds duck by Padhi *et al*, (2009b). Yolk % did not differ between the different genetic groups except two measurements at 60 and 68 weeks of age. Significant (P<0.05) differences for yolk % for different genetic groups were in agreement with the findings of Padhi *et al* (2009b). Age effect in each genetic group for yolk % differs significantly (P<0.05) and this finding was in agreement with the report of Padhi *et al*. (2010b) in Khaki Campbell. Shell % did not differ significantly between different genetic groups but age effect was significant (P<0.05) within a genetic group for the shell % at different weeks of age. As the age of measurement increases, the shell % decreases which was in agreement with findings of Padhi *et al* (2009b) in different genetic groups and Padhi *et al*. (2021) in Kuzi duck. Shell thicknesses with shell membrane and without membrane differ significantly (P<0.05) between the genetic groups in most of the measurement. Further, the two traits differ significantly (P<0.05) within a genetic group for different ages of measurement. Shell thicknesses with membrane observed in different genetic groups were in agreement with the report of Padhi and Sahoo (2011). Significant (P<0.05) age effects on egg quality also reported by different authors (Padhi *et al*. 2009a, Padhi *et al*. 2010a, Padhi *et al*. 2010b).Though some variation were there but as a whole the trend was clear and as the age advances, the shell thickness decreased which was in agreement with the reports of Padhi *et al*. (2009b), Padhi *et al*. (2010b). Haugh unit differ significantly (P<0.05) between different genetic groups only at 40 weeks of age which was in agreement with the report of Padhi *et al*. (2009c), Padhi *et al*. (2009b). However, the Haugh units measured at different weeks of age differed significantly (P<0.05) within the genetic group. This was in agreement with the report of Padhi *et al*. (2021) in Kuzi ducks. Lower Haugh unit in Pati ducks egg than the present study was reported by Nath *et al*. (2021).

Mortality: The mortality % observed in different genetic groups at different periods are presented in Supplementary Table 3. In the late part of laying period, there was more mortality in Kuzi and KD, however in DK, very low mortality was recorded throughout the experimental period. Higher mortality during later part of the laying cycle in Indigenous desi duck of Odisha was also reported by Padhi *et al*. (2009c), Padhi *et al*. (2021) which were in agreememt with the present findings. Lower mortality in crosses than pure was also reported by Padhi *et al* (2009c). Higher mortality % in the farmer's field were also reported by Kamal *et al*. (2020b) in indigenous duck of Jharkhand, Odisha and Chhattisgarh in day-old to 2 months of age. The mortality indicates the superiority of cross DK over other genetic groups studied.

In the study, Kuzi ducks were found to be better in respect to adult body weight compared to KD and DK. The production potential of both the crosses was better than the Kuzi; and DK performed best indicating this cross may be used for egg production as a laying duck. Encouraging egg production % towards end of first cycle of the production in both the crosses indicated the crosses potential. Overall the egg qualities were in the acceptable range towards the later part of the production. The study suggested using crosses of Kuzi and Khaki Campbell for better egg production and for dual purpose indigenous duck, Kuzi may be preferred.

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