Indian Journal of Animal Sciences **96** (5): 372–376, May 2026/Article
https://doi.org/10.56093/ijans.v96i5.168199

Effect of selection on growth and carcass traits in Chemballi ducks

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Received: 26 August 2025; Accepted: 10 July 2026

ABSTRACT

The present study was conducted to evaluate the impact of individual selection at higher body weight at 8th week age on growth and carcass characteristics of Kuttanad Chemballi ducks at Institute Duck Farm, Regional Station, ICAR-Directorate of Poultry Research, Bhubaneswar, Odisha. One thousand fertile eggs of Kuttanad - Chemballi ducks were procured from Government Duck farm, Kerala and were set at Institute hatchery for hatching. Ducklings (637) hatched (base S0 generation) were wing banded for individual recording of data. Individual selection was applied based on higher 8th week body weight in male ducks. Top 60 males and 140 females were used for regeneration of S1 and S2 generations. Body weights were recorded at bi-weekly intervals till 8th week followed by 4-week intervals till 20th week in each generation. Carcass characteristics were studied at 12 weeks of age in all the three generations. An improvement of 103.22 gram in 8th week body weight of male birds was recorded in S2 generation over S0. The average daily gain was highest during 4th and 5thweek, and body weight declined in male ducks beyond 12-week age indicating that for a profitable enterprise, the male ducks should be sold by 12th week. A compensatory growth mechanism was observed in S1 generation where the reduced growth in early stages was compensated in later weeks of age. The study on carcass traits proved that there was improvement in the slaughter weight, edible carcass yield in S2 generation over S0 indicating the positive result of individual selection for body weight on carcass yield.

Key words: Carcass traits, Chemballi, Ducks, Growth, Kuttanad, Selection

The demand for animal protein has up scaled to meet the nutritional requirements of the expanding human population (Joshi *et al.* 2014). Poultry products-eggs and meat are nutritionally enriched protein, essential amino acids, vitamins, minerals etc. Eggs and meat serve as comparatively budget-friendly sources of high-class animal protein (Miller *et al.* 2022). Among different poultry species, duck production has fetched the attention of farmers, enterprises and researchers as an alternate poultry species to chicken. The global duck population was 1075 million in 2014 which rose sluggishly to 1191 million in 2019, however in 2020 the global duck population reached 1.155 billion (FAO, 2020). The global duck population grew by 7.04% during the period of 2014- 2020 (Padhi and Giri, 2024). Asia has the highest contribution to global duck meat basket sharing almost 84.2% (Biswas *et al.* 2019). Duck population in India (33.51 million) has hiked by 42.36% in 2019 compared to the previous census (Anonymous, 2019) which means an up scaled demand of duck farming in the country especially backyard duck rearing that constitutes about 97% of the total duck population in the country. Indigenous ducks predominate in the Indian duck population (Padhi 2014). Despite the rising numbers, India's broiler ducks have poor market weights in comparison to the global standards attributable to the lack of suitable target- oriented breeding programs. Duck meat production in India was 43,941 tonnes in 2019, with an average per duck carcass yield of 1,069 gram per duck (Padhi and Giri 2024, Kumar and Dwivedi, 2025).

Kuttanad ducks are indigenous ducks of Kuttanad region of Kerala state and are primarily of two varieties – Chara and Chemballi both of which are dual type ducks (Padhi and Giri, 2024). The duck breed has been registered as a breed by ICAR- NBAGR, Karnal under the Accession number INDIA_DUCK_0900_KUTTANAD_11007 (Anonymous, 2025). The Kuttanad duck meat being tasty and nutritious is relished well by the consumers. However, owing to their low body weight and poor feed efficiency, these ducks are reared for dual purposes; surplus drakes and spent ducks usually slaughtered for meat purposes. Some previous studies have reported Kuttanad ducks achieving a body weight of 2.20 kg at eight-weeks of age, demonstrating good genetic potential of these ducks for meat production

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(Cyriac 2020). Meat yield potential of Kuttanad Chemballi ducks has not been studied extensively and scanty literature is available on it. The Regional Station of ICAR-Directorate of Poultry Research located at Bhubaneswar, Odisha is one of the leading duck research institutes in the country. For improving meat production potential, body weight is the prime choice of trait owing to its high heritability and ease of selection (Lin *et al.* 2016). Individual selection is a highly effective tool for improving high heritable traits. Therefore, the goal of present study was to analyze the outcome of individual selection on growth parameters and carcass characteristics in Kuttanad ducks selected for higher body weight at 8th week age. Carcass parameters were studied to assess the potential of Kuttanad ducks for meat production.

MATERIALS AND METHODS

Study location: The study was undertaken at the Regional Station of ICAR-Directorate of Poultry Research (DPR), Bhubaneswar, which has predominantly hot-humid climate with annual rainfall of 200 cm. The average minimum and maximum temperature of the region typically ranges from 28^0C to 38^0C. Sometimes the peak temperature during summer rises to 45^0C. The average relative humidity ranges from 68% during winter to 88% during monsoon (Padhi *et al.* 2022).

Study population: Fertile eggs (1000 Nos) were procured from Duck Farm, Niranam, Kerala and were hatched at the Institute hatchery. Ducklings (637) were hatched (treated as base generation S0) and were wing banded for individual recording of growth and carcass data. The ducklings were reared under the deep litter system at the Institute duck farm under standard management practices. Male ducklings were selected for higher 8th week body weight. S_1 and S_2 generations were generated using 40 sires and 160 dams. The body weight was taken every two-week interval till 8th week; followed by 4-week interval till the 20th week.

Rearing management: The ducklings were brooded for 4 weeks and reared under a deep litter system with rice husk as litter material. Each hatch was reared separately all through the experimental phase. Wheat based starter feed with 20% CP and ME 2900kcal/kg was offered for 8 weeks. The selected males for higher 8th week body weight and available females were kept for growing under standard management practices and were offered duck grower ration (16% CP and ME of 2600 kcal/kg). Ducks were offered duck layer ration (CP 19%, ME of 2600Kcal/kg) at 17 weeks of age. Shell grits were added to the layer ration to upscale the calcium level in the diet to 4.5%. The birds were offered *ad libtum* clean drinking water in water tub with water depth of minimum 6 inch that would be sufficient for the ducks to immerse their head.

Traits recorded: The body weight was taken at day old followed by at every two-week interval till 8th week; at 4-week interval till 20th week using a sensitive weighing scale balance with a precision up to 0.5 g. At the end, 6 males and 6 female ducks were selected randomly slaughtered as per standard procedures and evaluated for carcass traits with approval from institutional animal ethics committee.

Statistical analysis: Juvenile and grower body weight were analyzed using Least Squares technique (Harvey, 1990). The carcass quality parameters were analyses as per Snedecor and Cochran (1989).

RESULTS AND DISCUSSION

Growth parameters of Chemballi ducks: The mean bi-weekly juvenile body weight of Kuattanad-Chemballi ducks in three generations is presented in Table 1. The body weight of Chemballi grower ducks is presented in Table 2. The body weight of all ages among the generations differed significantly. The average body weight of day-old Chemballi ducklings was significantly higher in S_1 and

Table 1. Effect of Individual selection on juvenile bodyweights of Kuttanad – Chemballiducks over generations

Age of ducklings	Sex	S0	S1	S2
Day–old	Pooled sex	37.97±0.13^a (637)	40.89±0.51^b (747)	40.85±0.21^b (585)
	Male	38.77±0.11^a (313)	41.36±0.69^b (366)	41.12±0.39^b (270)
	Female	37.69±0.11^a (324)	40.19±0.56^b (381)	40.35±0.23^b (315)
2nd week	Pooled sex	170.04±1.62^a (635)	197.11±1.38^b (731)	327.29±1.70^c (580)
	Male	170.99±2.59^a (312)	200.01±2.32^b (357)	333.65±2.77^c (268)
	Female	169.86±2.47^a (317)	196.49±2.33^b (373)	326.89±2.69^c (312)
4th week	Pooled sex	508.55±6.80^b(629)	462.57±2.91^a(721)	756.87±3.81^c(577)
	Male	515.16±7.89^b(312)	467.88±4.31^a (353)	767.99±5.63^c (268)
	Female	506.06±8.23^b (317)	458.07±5.33^a (368)	749.13±5.28^c (309)
6th week	Pooled sex	901.39±13.79^b (629)	860.28±7.56^a (706)	1075.65±3.11^c (575)
	Male	921.89±15.21^b (312)	888.33±4.44^a (345)	1177.39±4.42^c (267)
	Female	889.05±14.87^b (317)	841.67±4.51^a (359)	975.03±4.69^c (308)
8th week	Pooled sex	1237.21±4.37^a (629)	1243.91±8.28^a (705)	1302.18±2.67^b (569)
	Male	1281.34±6.2^a (312)	1284.97±9.17^a (344)	1384.56±5.13^b (264)
	Female	1193.06±5.28^a (317)	1198.35±10.25^a (359)	1217.33±4.25^b (305)

Means bearing different superscripts (a, b, c) in the rows differ significantly ($p<0.05$)

Table 2. Sex wise least squares mean grower bodyweights and of Kuttanad – Chemballiducks over generations

Age of ducks (weeks)	Sex	S0	S1	S2	Significance
12th	Male	1694.28±9.86 (95)	1706.32±9.15 (87)	1711.64±10.23 (294)	NS
12th	Female	1432.87±5.52a (288)	1516.85±12.41b (271)	1512.61±12.41b (92)	P<0.01
16th	Male	1661.41±10.78a (87)	1698.57±6.22b (81)	1700.80±9.91b (71)	P<0.05
16th	Female	1505.85±7.89a (271)	1511.61±6.25a (265)	1553.81±9.99b (252)	P<0.05
20th	Male	1654.44±10.97a (85)	1679.21±15.26b (81)	1677.68±8.59b (71)	P<0.05
20th	Female	1589.03±8.78a (271)	1613.65±11.94b (263)	1582.29±10.24a (248)	P<0.05

Means bearing different superscripts (a, b, c) in the rows differ significantly (p<0.05)

S_2 generation over S_0. The body weight at 2, 4 ,6 and 8th week was significantly higher in S_2 generation over both S_0 and S_1 generations. The significantly higher body weight in S2 generation Chemballi ducklings might be due to the selection applied for body weight advocating good genetic potential of Kuttanad-Chemballi ducks for meat purposes. The positive impact of selection for higher 8th week body weight in male Kuttanad ducks was also recorded by Cyriac *et al.* (2020). Baeza *et al.* 1997 observed selection induced increase in body weight by 8 to 10% in Muscovy ducks.

Day old body weight was improved by +2.89 gram (40.85±0.21 g in S2 vs 37.97 ± 0.13 g in S_0). The 8th week male body weight (S2) improved by 103.22 gram over S0 (1384.56±5.13 S_2 vs 1281.34 ±5.28 g S0). Cyriac *et al.* (2020) recorded a higher improvement in 8th week body weight in S3 generation of Kuttanad ducks. The 12lth week body weight of male ducks was improved by 17.36 gram (1711.64 ± 10.23 g in S2 vs 1694.28 ±9.86 g in S0); 16th week body weight (male) 39.66 gram (1700.80 ± 9.99 g in S2 vs 1661.14 ± 10.78 g in S0); 20th week male body weight gains 23.24 g (1677.68 ±8.59 S2 vs 1679.21±15.70 S0). The female birds also exhibited improvement in growth parameters viz; 8th week body weight by 24.27 gram (1217.33± 4.25 g in S_2 vs 1193.06±5.28g in S0) and 12th week 79.74 gram (1512.61±9.91 g in S2 vs 1432.87±5.51g in S0). The 8th weeks body weight was significantly lower in S0 and S1 compared to S2 which was compensated for in the subsequent weeks, and the 12th week body weight of drakes was similar across the groups. The increased body weight at 16thweek body weight of male in S1 and S2 generation were similar. The reduced body weight at 4th and 6th week of S1 generation ducks was also compensated in the subsequent weeks. Therefore, it is evident that a compensatory growth mechanism exists in ducks and the reduced growth in earlier weeks is compensated in the later stages of growth.

From 4th week onwards, effect of sex was highly significant (P<0.01) on body weight. Males were heavier than females in all generation at all ages. Our findings agreed to the findings of Padhi *et al.* (2022) who recorded sexual dimorphism in body weight of Kuzi ducks from 4 weeks onwards. Several researchers have reported heavier body weight in male ducks viz;Cyriac *et al.* (2020) in Kuttanad ducks, Omojola (2007) in Rouen ducks, Senani *et al.* (2005) in Anaman local ducks. Padhi *et al.* (2009) reported sexual dimorphism in body weight of Moti ducks from 9th week onwards. Contrary to our findings, Easwaran, (1983) recorded a higher body weight in female ducklings than males Khaki Campbell day-old ducklings.

The average daily gain (ADG) was highest during 4th and 5th week (29.57 g and 37.24 g, respectively) in S_0 generation; 5th and 7th week in S_1 generation (36.04 g and 35.76 g, respectively) and 3rd and 4th week in S2 generation (32.94 g and 28.42 g, respectively). The body weight started declining after 12lth week age in case of male growers while the gain was very marginal in female grower birds. A similar trend was observed across the three generations (Figure 1 and 2). The present finding agreed with the findings of many researchers (Szasz, 1997, Pingel 1999, Cyriac *et al.* 2020) who recorded marginal gain in body weight from 12 to 18 in Kuttanad ducks. The present findings recommended that the active growth age of Chemballi ducks is from 0 to 12 weeks. Therefore, the marketing of male birds should be done by 12lth week to fetch maximum profit since beyond

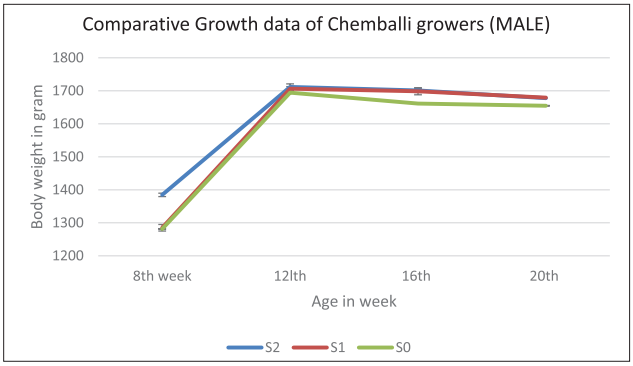

Fig. 1. Impact of selection for higher 8th week body weight on Chemballi Male ducks (8th to 20th week) over generations

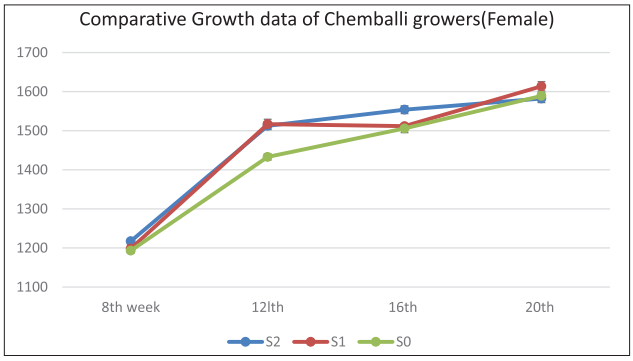

Fig. 2. Growth records of Chemballi female ducks (8th to 20th week)

Table 3. Carcass traits of Kuttanad- Chemballi (Male) ducks slaughtered at 12-week age

Carcass Parameters	S2	S1	S0	Significance level
Slaughter Weight (Kg)	1.61±0.01[b]	1.56±0.01[a]	1.55±0.01[a]	P<0.05
Eviscerated Carcass (% of live weight)	69.35±0.2[b]	68.77±0.2[a]	68.73±0.2[a]	P<0.05
Giblet%	4.32±0.09	4.33±0.09	4.32±0.08	NS
Total Edible Carcass (% of live weight)	73.67± 0.26	73.10± 0.26	73.05± 0.26	NS
Neck	10.49±0.09	10.03±0.09	10.51±0.11	NS
Wing	12.65±0.34	12.98±0.19	13.28±0.19	NS
Breast	28.89±0.13	28.69±0.23	28.23±0.27	NS
Back	24.29±0.38	24.26±0.38	24.16±0.31	NS
Leg	19.45±0.33	19.37±0.33	19.32±0.33	NS

Means bearing different superscripts (a, b, c) in the rows differ significantly (p<0.05)

Table 4. Carcass traits of Kuttanad- Chemballi (Female) ducks slaughtered at 12-week age

Carcass Parameters	S2	S1	S0	Level of significance
Slaughter Weight (Kg)	1.48± 0.01	1.49± 0.01	1.47± 0.01	NS
Eviscerated Carcass (% of live weight)	66.32±0.1	66.19±0.1	66.16±0.1	NS
Giblet%	6.09±0.18	6.44±0.09	6.27±0.11	NS
Total Edible Carcass (% of live weight)	72.42± 0.29	72.53± 0.29	72.33± 0.29	NS
Neck	10.39±0.13	10.45±0.11	10.51±0.11	NS
Wing	13.49±0.18	13.53±0.15	13.84±0.15	NS
Breast	27.33±0.21	27.57±0.38	27.14±0.22	NS
Back	23.48±0.34	23.13±0.47	23.19±0.51	NS
Leg	19.23±0.12	19.18±0.23	19.21±0.27	NS

12thweek the body weight gain reduced.

The juvenile stage mortality was 1.26% in 0-4 weeks and nil during 4-8 weeks in S_0 generations and was below 6% in all the three generations. The mortality during grower stage 8–20 weeks period was lower than the juvenile periods in all the generations. This signified that optimal care should be taken during brooding period to check duckling mortality. Several researchers have reported a higher juvenile stage mortality (Islam *et al.* 2012, and Kamal *et al.* 2020, Padhi *et al.* 2022).

Carcass characteristics of Kuttanad -Chemballi ducks: Carcass traits of Kuttanad- Chemballi ducks slaughtered at 12-week age are being presented in Table 3 and Table 4 for comparison over generation. The slaughter weight of S_2 drakes (1.61±0.01 kg) was significantly higher than that of S1 (1.56±0.01 kg) and S0 (1.55±0.01 kg). The slaughter weight of Chemballi females ranged from 1.47± 0.01 kg (S_0) to 1.49± 0.01 kg (S1) and was similar among the groups. The males exhibited heavier slaughter weight than females (a superiority of 70-120 gram) in all the three generations. The mean eviscerated carcass weight of S_2 Chemballi males was significantly (P<0.05) higher than S_0 and S_1males. While in Chemballi females the mean eviscerated carcass weight ranged from 66.16 (S0) to 66.32 (S_2) and was statistically non-significant across the groups. Total edible carcass weight expressed as percentage of slaughter weight in Chemballi females ranged 72.33 (S_0) to 72.53 (S_1) and was statistically non-significant across the groups. Total edible carcass expressed as percentage of slaughter weight in Chemballi males was higher than females and ranged 73.05 (S_0) to 73.67 (S_2) and was statistically non-significant across the generations. The mean value for different cut up parts was comparable across the generations of Chemballi ducks. Breast portion was the heaviest cut-up part followed by back in both male and female ducks. In contrary to our study, Padhi *et al.* (2022) recorded back as the heaviest cut-up part in Kuzi ducks of Odisha. Breast, back and leg cuts were heavier in males compared to female ducks in all the three generations. The breast cut ranged from 28.23±0.27% (S_0) to 28.89±0.13 (S_1) in males while varied from 27.14±0.22% (S_0) to 27.57±0.38 (S_1) and the difference among the generations was statistically non-significant. The back cut ranged from 24.16±0.31 % (S0) to 24.29±0.38 (S2) in males while varied from 23.13±0.47% (S_0) to 23.48±0.34 (S_2) and the difference among the generations was statistically non-significant. However, Antony *et al.* (2023) reported a marginally higher cut up percentage of breast muscle and lower percentage of back cut in both male and female Chemballi ducks. The leg cut ranged 19.18% in S_1 to 19.23% in S_2 Chemballi females while it ranged from 19.32% in S_0 to 19.45% in S_2 in male ducks. The giblet percentage was significantly higher (P<0.05) in females (range 6.09±0.18 to 6.44±0.09%) over the males (range 4.32 to 4.33%) across the three generations. Antony *et al.* (2023) observed a similar leg cut percentage in Chemballi females; a marginally lower percentage in male ducks and

recorded higher giblet percentage in females compared to the drakes, which agreed to our findings. Similarly, wing and neck cuts were also significantly heavier (P<0.05) in females in all the three generations. In contrary to our findings, Antony *et al.* 2023 recorded heavier wing cuts in male Chemballi ducks compared to females.

The present study indicated a positive impact of selection for higher body weight at 8th weeks in Kuttanad Chemballi ducks. Selection exhibited positive effect in terms of higher body weight recorded in S_2generation over the S1 and S0 generations. Day old body weight was improved by 2.89 gram and 8th weeks male body weight (S2) improved by 103.22 gram over S_0. The present study recorded a compensatory growth mechanism in ducks where the reduced bodyweight in the early weeks of age was compensated in later weeks. The active growth period was from 0-12 weeks after which the male birds body weight declined, and female ducks gained marginally. The carcass characteristics study revealed better slaughter weight and carcass yield in S_2 ducks indicating the impact of improved body weight due to selection. With proper designed breeding program, scientific feeding and management, meat production of Kuttanad Chemaballi duck can be harnessed to improve meat production.

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