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# Genetic characterization of growth and adaptive biometrics in Kuttanad ducks of Kerala

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## ABSTRACT

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The present study aimed at the genetic characterization of Kuttanad duck varieties of Kerala based on their body weight and body measurements. The mean body weight at hatch, 2, 4, 6, 8, 10, 12, 14 and 16 weeks of age in Kuttanad ducks were found to be 36.54±0.30 g, 234.80±5.94 g, 472.76±11.18 g, 753.92±20.99 g, 1044.98±20.85 g, 1262.22±18.53 g, 1423.10±17.69 g, 1529.65±17.04 g and 1654.46±18.13 g, respectively. The mean length of trunk to neck (LTN), length of trunk (LT), length of neck (LN), length of breast bone (LBB), chest girth (CG) and shank length (LS) at 16 weeks of age were found to be 43.23±0.21 cm, 25.16±0.17 cm, 20.12±0.17 cm, 12.27±0.07 cm, 31.73±0.17 cm and 7.76±0.04 cm respectively. The body weight at 8, 10 and 16 weeks of age differed significantly among the sexes ($p \leq 0.05$). Among ecotypes, Chara ducks were significantly heavier with higher fortnightly body weight gain than Chemballi ducks from the grower (8-10 weeks) to finisher or pre-pullet stages (14-16 weeks). They also had significantly longer breast bones and larger chest girth than Chemballi at stages from 10 to 16 weeks of age ($p \leq 0.05$). The dominant patterns of growth and biometry of breast bone or chest revealed possibly higher meatiness and meat-type attributes in Chara making it a more promising meat-type variety than Chemballi. The significantly longer necks of Chemballi suggested a probable superior swimming efficiency than Chara in the flood-hit home tract ($p \leq 0.05$). The necks and shanks of Kuttanad were also longer than those of most other Indian ducks and hence likely served as indicators of acquired traits of adaptability to feeding and swimming in the turbulent waters of the home tract.

**Keywords:** Body weight, Body measurements, Growth, Kuttanad ducks

## INTRODUCTION

Duck farming in India serves as a traditional livelihood option for the rural landless farmers and women-folk in coastal areas to earn high returns under a low input system of short duration (Veeramani *et al*., 2021; Jalaludeen and Churchil, 2022; Kamal *et al*., 2022). The desi ducks of Kerala known as Kuttanad ducks are dual purpose with adult body weight of 1.6 Kg and an average annual production of 192.60 eggs in the breeding tract (Bindya and Priya, 2021). Kuttanad ducks are known for their excellent adaptability to the varied agro-climatic zones of the country earning a pan-India popularity of having been adopted by the Government of Assam and Andaman - Nicobar Islands as the model duck for the genetic improvement of their native ducks under free-range farming (Senani *et al*., 2005a; Mahanta *et al*., 2009; Deka *et al*., 2014; Bharali *et al*., 2020).

Kuttanad ducks are famous for their symbiotic relationship with the paddy farmers of the home tract, wherein they feed on the pests, snails and weeds and in return, lay eggs on the harvested fields. However, the severe Kerala floods of 2018 and 2019 led to the wiping off of several elite duck clusters and fertile eggs of native ducks. The subsequent fragmentation of the breeding tract and the derangement of the ecosystem have also led to further aggravation in the decline of duck germplasm in the State (Bindya and Priya, 2021). Kuttanad ducks are found in two varieties *viz.*, Chara and Chemballi. The males of Chara and Chemballi are differentiated by the plumage colour of the head region. However, the females of both varieties cannot be easily differentiated based on plumage colour (Jalaludeen *et al.*, 2004).

Growth indicators like body measurements determine the body size of any meat-type poultry, making these traits crucial in selecting breeding stock. Body measurements, together with body weight form the basis for assessing growth and hence most relevant in the economic and marketing decisions in the poultry industry. Body biometrics are known to play key roles not only in body size and body conformation but also in the flight and swimming abilities of ducks, which in turn decide their survivability and adaptability (Veeramani *et al.*, 2014). These measurements hence assume much more significant roles in Kuttanad ducks which survive in flood-prone habitats. Given the importance of body measurements to influence the body size, body conformation, body contours, meatiness, carcass yield and the overall characterization of ducks, biometrics have been studied in various Indian and exotic duck populations (Veeramani *et al*., 2014; Ihuoma and Okata, 2016; Steczny *et al*., 2017; Arundhati *et al*., 2018; Kamal *et al.*, 2019; Purabi *et al.*, 2021; Padhi *et al*., 2022). In

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this context, the present study aimed at the genetic characterization and growth performance of Kuttanad duck varieties and the effect of various non-genetic factors on these traits to influence their overall utility and adaptability.

## MATERIALS AND METHODS

A total of 125 Kuttanad ducks hatched at the breeding tract and brought as day-old chicks for rearing under standard management conditions at the University Poultry and Duck farm, College of Veterinary and Animal Sciences, Mannuthy from June 2022 to May 2023 formed the material for the study. The birds were fed with starter feed (CP: 22-23 per cent and ME: 2800 Kcal/kg) from 0 to 12 weeks of age and grower feed (CP: 18-19 per cent and ME: 2600 Kcal/kg) from 13 to 16 weeks of age (BIS, 2007). Ducklings were wing-banded for identification, vaccinated against *Pasteurella* and duck plague and routinely dewormed. Data were recorded on body weight at hatch (BW0) and at different stages of growth (BW) from 2 to 16 weeks of age. Body measurements were also recorded on the length of the trunk to neck (LTN), length of trunk (LT), length of the neck (LN), length of the breast bone (LBB), chest girth (CG) and length of shank (LS) at fortnightly intervals. The effect of non-genetic factors like sex and ecotypes on body weight at all stages of growth and body measurements from 8 to 16 weeks of age were studied using the General Linear Model for fixed effects as given below:

$$y_{ijk} = \mu + s_i + v_j + e_{ijk}$$

Where $y_{ijk}$ is the body weight/ measurement measured on ijk$^{th}$ bird at different stages; ì is the overall mean; $s_i$ is the fixed effect associated with i$^{th}$ sex (i=1, 2); $v_j$ is the fixed effect associated with j$^{th}$ variety/ecotype (j=1, 2) and $e_{ijk}$ is the random error. The phenotypic data were adjusted for non-genetic effects and the Least squares means and their standard errors were computed using SPSS V.21. Duncan Multiple Range Test (Kramer, 1957) was used for the comparison of means.

## RESULTS AND DISCUSSION

*Body weight*

The mean fortnightly body weight from hatch to 16 weeks of age in Kuttanad ducks is presented in Table 1. The hatch weight (BW0) of Kuttanad ducks in the present study was 36.54±0.30 g, which was lower than the earlier reports in Kuttanad under the free-range conditions of Assam (Mahanta *et al*., 2009), in the backyard system of Assam (Bharali *et al*., 2020) and in their own home tract (Bindya and Priya, 2021) but higher than that reported by Senani *et al.* (2005a) in Andaman-Nicobar Islands. Body weight at four weeks of age (BW4) was also found to be lower and body weight at six (BW6) and eight (BW8) weeks of age was higher than the earlier reports (Mahanta *et al*., 2009). The body weight at 12 weeks of age (BW12) was in accordance with the earlier reports (Renchi *et al*., 1979; Mahanta *et al*., 2009) and slightly higher than that of other Indian ducks like Pati, Tripura and Nageshwari of North Eastern India (Arundhati *et al.*, 2018). The body weight from hatch to 12 weeks of age in overall was found to be lower than the earlier report on the $S_3$ generation of Kuttanad ducks (Cyriac *et al.*, 2020) wherein the higher body weight could be attributed to the individual selection for body weight practiced over generations in the concerned experiment. The differences in body weight could also have arisen due to differences in the environmental conditions, managemental practices and the type of rearing. The body weight at 16 weeks of age (BW16) was slightly higher than that reported for Pati, Tripura and Nageshwari ducks (Arundhati *et al*., 2018), Maithili ducks of Bihar (Kamal *et al.,* 2020) and the *desi* ducks of West Bengal (Vij *et al*., 2010) but lower than that reported for Kuzi ducks of Odissa (Padhi *et al.,* 2022). When compared to the exotic breeds, the body weight at 12 weeks of age (BW12) was found to be higher than those of Aylesbury (Ihuoma and Okata, 2016) and lower than that of Pekin (Steczny *et al*., 2017) and Mulard ducks (Mazurowski *et al.,* 2015).

*Body measurements*

The mean fortnightly body measurements of Kuttanad ducks from hatch to 16 weeks of age are given in Table 1. The necks of Kuttanad were found to be longer than that of Nageshwari (Sharma *et al.,* 2003), *desi* ducks of West Bengal (Vij *et al*., 2010), indigenous ducks of Tamil Nadu (Veeramani *et al.,* 2014), Pati, Tripura, Manipuri and Nageshwari (Arundhati *et al*., 2018), *desi* ducks of Odisha (Kamal *et al.,* 2019) and Pati ducks of Assam (Purabhi *et al.*, 2021). The estimates of the length of breast bone and chest girth were also higher in Kuttanad than Sanyasi and Keeri ducks of Tamil Nadu, *desi* ducks of Odisha and Tripura, Nageshwari and Maithili (Veeramani *et al*., 2014; Kamal *et al*., 2019; Arundhati *et al*., 2018) but found to be lower than that of Pati (Purabi *et al.*, 2021). The shank length of Kuttanad was found to be higher than most Indian duck varieties like *desi* ducks of Bengal (Vij *et al.*, 2010), Sanyasi and Keeri (Veeramani *et al*., 2014), *desi* ducks of Odisha (Kamal *et al*., 2019), Tripura and Nageshwari (Arundhati *et al*., 2018), Maithili ducks of Bihar (Kamal *et al*., 2020) and the Pati ducks (Purabhi *et al.,* 2021).

A comparison of the body measurements of Kuttanad ducks with exotic breeds revealed most of the body measurements (LTN, LBB, CG) except the shank length (LS) to be lower than that of Aylesbury (Ihuoma and Okata, 2016), Pekin (Steczny *et al*., 2017) or comparable with that of Mulard (Mazurowski *et al.*, 2015). However, the shank length of Kuttanad was higher than that of these exotic breeds. The differences in body measurements when compared to the exotic breeds might be attributed to the variation in the genotype as well as the environment where they were reared.

The morphometric characterization of native ducks of Kerala has been a subject of study ever since its 40-year-old first report (Renchi *et al*., 1979) and the subsequent reports (Ajith *et al*., 2009). The mean shank length ranged from 6.03 cm to 6.81 cm over the generations. On making a comparison, it was understood that the mean shank length of Kuttanad ducks in the present study has increased by more than one centimeter over the generations, ever since its first report. Duggan *et al*. (2015) has reported that a change in leg morphology and morphometry of ducks occurs as a result of adaptation to swimming with limitation to terrestrial locomotion. This could particularly be true of the Kuttanad ducks in the background of the yearly episodes of Kerala Floods since 2018 that washed away several clusters of ducks and ducklings. The observation may be significant from the point of view of the evolutionary development of ducks over generations while thriving in habitats under constant threat of floods as in the case of Kuttanad ducks, where they require longer shanks and necks for efficient swimming as well as feeding underwater below the level of feet in the turbulent waters. The finding may also suggest an adaptive value to the trait of shank length for native ducks surviving in flood-prone breeding tracts. The variation in body measurements in the present study hence may be attributed not only to the variation in the conformation and size of the distinct variety or breed as decided by its germplasm but also to its adaptability to the thriving habitat.

*Effect of sex and ecotype on body weight*

The effect of sex and ecotype on body weight (g) at different stages in Kuttanad ducks from hatch to 16 weeks of age is depicted in Table 2. Sex of the ducks had a significant effect on their body weight at different stages of growth ($p \leq 0.05$), especially at the end of the grower stage and at the beginning of the pullet stage at 8, 10, and 16 weeks of age ($p \leq 0.05$) indicating sexual dimorphism for body weight. The females were significantly ($p \leq 0.05$) heavier than males during 8 to 10 weeks which is regarded as the grower stage where a primary selection of superior ducks for egg or meat purpose is generally undertaken in the breeding programmes. They almost achieved their optimum pullet weight by the 14$^{th}$ week, beyond which there was no significant increase in body weight. However, towards the terminal marketing age of 16 weeks, males weighed significantly heavier than females by around 64 g ($p \leq 0.05$). The result is further significant in the backdrop of the general practice of the secondary selection for breeder ducks with good growth performance undertaken towards the pre-pullet or finisher stage of 16-18 weeks of age. The findings are in agreement with Sarma *et al.* (2015) that males and females of Chara and Chemballi ducks differed significantly with respect to body weight from 4 to 12 weeks of age in the agro-climatic conditions of Assam. Padhi *et al*. (2009) also reported significant differences between body weight of males and females in Moti ducks of Odisha from nine weeks of age. Sexual dimorphism was also reported to be more prominent for body weight from four weeks of age in Kuzi ducks of Odissa (Padhi *et al*., 2022) and the local ducks of Andaman (Senani *et al*., 2005b; Sujatha *et al*., 2021).

The effect of ecotypes on body weight was highly significant ($p \leq 0.01$) at almost all stages of growth from 8 to 16 weeks of age. The varieties *viz*., Chara and Chemballi differed significantly for the body weight at 2, 8, 10, 12, 14 and 16 weeks of age ($p \leq 0.05$). Chara were heavier than Chemballi at these stages, more precisely from the grower (8-10 weeks) to finisher or pre pullet stage (14-16 weeks). The result can be utilized to make an effective selection of superior ducks with superior growth performance, primarily at 8 to 10 weeks of age followed by a secondary screening at 14 to 16 weeks of age.

*Effect of sex and ecotype on body measurements*

The effect of sex of the bird on fortnightly body measurements (cm) from 8 to 16 weeks of age in Kuttanad ducks is depicted in Table 3. The effect of sex on body measurements was evident in the sexual dimorphism revealed with the males possessing longer breast bones and shanks and wider chest than the females at all stages beyond the grower phase of eight weeks of age ($p \leq 0.05$). The results are in accordance with the reports in African Muscovy (Yakubu, 2009).

The effect of ecotype of the bird on fortnightly body measurements (cm) from 8 to 16 weeks of age in Kuttanad

**Table 1:** Mean body weight (g) and body measurements (cm) at different stages in Kuttanad ducks

| Weeks of age | BW | LTN | LT | LN | LBB | CG | LS |
|---|---|---|---|---|---|---|---|
| Hatch | 36.54±0.30 | - | - | - | - | - | - |
| 2 | 234.80±5.94 | 19.05±0.18 | 8.74±0.10 | 9.88±0.11 | 3.63±0.04 | 10.84±0.10 | 4.39±0.04 |
| 4 | 472.76±11.18 | 26.69±0.25 | 15.68±0.16 | 11.35±0.13 | 5.39±0.06 | 16.78±0.16 | 5.93±0.05 |
| 6 | 753.92±20.99 | 33.08±0.29 | 18.92±0.20 | 13.51±0.16 | 6.84±0.09 | 21.19±0.22 | 6.46±0.04 |
| 8 | 1044.98±20.85 | 36.50±0.27 | 20.95±0.17 | 15.16±0.17 | 8.83±0.12 | 24.08±0.19 | 6.9±0.03 |
| 10 | 1262.22±18.53 | 38.42±0.25 | 22.38±0.17 | 16.29±0.17 | 10.13±0.09 | 27.08±0.17 | 7.12±0.03 |
| 12 | 1423.10±17.69 | 40.31±0.23 | 23.27±0.16 | 17.34±0.18 | 11.12±0.07 | 28.64±0.14 | 7.33±0.03 |
| 14 | 1529.65±17.04 | 41.65±0.22 | 24.19±0.17 | 18.58±0.16 | 11.8±0.06 | 30.18±0.16 | 7.55±0.03 |
| 16 | 1654.46±18.13 | 43.23±0.21 | 25.16±0.17 | 20.12±0.17 | 12.27±0.07 | 31.73±0.17 | 7.76±0.04 |

**Table 2:** Effect of sex and ecotype on body weight (g) at different stages in Kuttanad ducks

| | BW0 | BW2 | BW4 | BW6 | BW8 | BW10 | BW12 | BW14 | BW16 |
|---|---|---|---|---|---|---|---|---|---|
| Female(47) | 37.00$^{a}$±0.48 | 232.32$^{a}$±7.29 | 495.38$^{a}$±18.52 | 769.34$^{a}$±30.57 | 1114.43 $^{a}$±30.30 | 1301.47$^{a}$±24.951 | 1420.34$^{a}$±20.96 | 1582.13$^{a}$±19.68 | 1592.13$^{b}$±19.68 |
| Male(54) | 36.13$^{a}$±0.36 | 236.96$^{a}$±5.94 | 453.07$^{a}$±12.89 | 740.50$^{a}$±29.03 | 984.54$^{b}$±26.30 | 1228.06$^{b}$±26.34 | 1425.50$^{a}$±27.20 | 1549.35$^{a}$±25.20 | 1656.30$^{a}$±21.08 |
| Chara(55) | 36.98 $^{a}$±0.36 | 255.84$^{a}$±5.64 | 471.56$^{a}$±16.81 | 744.60$^{a}$±28.42 | 1080.55$^{a}$±29.94 | 1333.33$^{a}$±23.66 | 1484.55$^{a}$±20.28 | 1590.00$^{a}$±19.24 | 1660.73$^{a}$±17.04 |
| Chemballi(46) | 36.01$^{a}$±0.51 | 209.55$^{b}$±5.74 | 474.20$^{a}$±14.29 | 765.07$^{a}$±31.42 | 1002.46 $^{b}$±20.85 | 1177.20$^{b}$±24.02 | 1349.63$^{b}$±26.76 | 1457.50$^{b}$±25.94 | 1575.22$^{b}$±24.09 |

Means with different superscripts within each column differ significantly (p≤0.05)
Figures in parenthesis represent number of observations

**Table 3:** Effect of sex on body measurements (cm) from 8 to 16 weeks of age in Kuttanad ducks

| Weeks of age | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|
| *Length of breast bone* | | | | | |
| Female (47) | 9.10 $^{a}$±0.15 | 10.22 $^{a}$±0.13 | 11.02 $^{a}$±0.11 | 11.66 $^{b±}$0.09 | 12.15 $^{b±}$0.08 |
| Male (54) | 8.59 $^{b±}$0.17 | 10.05 $^{a}$±0.13 | 11.20 $^{a}$±0.09 | 11.92 $^{a±}$0.09 | 12.37 $^{a}$±0.08 |
| *Chest girth* | | | | | |
| Female (47) | 24.56 $^{a}$±0.26 | 27.15 $^{a}$±0.22 | 28.77 $^{a}$±0.22 | 29.97 $^{a}$±0.24 | 31.29 $^{b±}$027 |
| Male (54) | 23.67 $^{b}$±0.26 | 27.01 $^{a}$ 0.26 | 28.53 $^{a}$±0.19 | 30.36 $^{a}$±0.21 | 32.11 $^{a}$±0.20 |
| *Length of neck* | | | | | |
| Female (47) | 14.61 $^{b±}$0.28 | 15.74 $^{b±}$0.30 | 16.72 $^{b±}$0.31 | 18.08 $^{b±}$0.27 | 19.67 $^{b±}$0.28 |
| Male (54) | 15.64 $^{a}$±0.19 | 16.77 $^{a}$±0.16 | 17.88 $^{a}$±0.16 | 19.02 $^{a}$±0.17 | 20.52 $^{a}$±0.20 |
| *Length of trunk with neck* | | | | | |
| Female (47) | 35.81 $^{b±}$.46 | 37.61 $^{b±}$0.39 | 39.54 $^{b±}$0.40 | 40.83 $^{b±}$0.37 | 42.35 $^{b±}$0.38 |
| Male (54) | 37.09 $^{a}$±0.29 | 39.12 $^{a}$±0.28 | 40.97 $^{a}$±0.24 | 42.37 $^{a}$±0.20 | 43.99 $^{a}$±0.17 |
| *Length of shank* | | | | | |
| Female (47) | 6.86 $^{a}$±0.06 | 7.08 $^{a}$±0.06 | 7.28 $^{a}$±0.06 | 7.46 $^{b±}$0.05 | 7.66 $^{b±}$0.05 |
| Male (54) | 6.92 $^{a}$±0.04 | 7.15 $^{a}$±0.04 | 7.37 $^{a}$±0.03 | 7.62 $^{a}$±0.04 | 7.84 $^{a}$±0.04 |

Means with different superscripts within each column differ significantly (p≤0.05)
Figures in parenthesis represent number of observations

ducks is depicted in Table 4. The ecotypes of Chara and Chemballi varieties exhibited significant differences with respect to LBB, CG, LN, LTN and LS from 8 to 16 weeks of age. Chara ducks had longer breast bones and larger chest girth when compared to Chemballi at almost all stages from 10 to 16 weeks of age. On the other hand, Chemballi had longer necks than Chara (pd”0.05) and the differences in shank length between the two varieties were not significant (pe”0.05). The results are in accordance with the differences reported for neck length, shank length and length of trunk with neck in Sanyasi and Keeri ducks (Veeramani *et al.*, 2014).

**Table 4:** Effect of ecotype on body measurements (cm) from 8 to 16 weeks of age in Kuttanad ducks

| Weeks of age | 8 | 10 | 12 | 14 | 16 |
|---|---|---|---|---|---|
| *Length of breast bone (cm)* | | | | | |
| Chara (55) | 8.78$^{a}$±0.17 | 10.38$^{a}$±0.12 | 11.35$^{a}$±0.08 | 12.02$^{a}$±0.07 | 12.36$^{a}$±0.07 |
| Chemballi (46) | 8.89$^{a}$±0.16 | 9.83$^{b±}$0.12 | 10.84$^{b±}$0.09 | 11.54$^{b±}$0.09 | 12.16$^{a}$±0.09 |
| *Chest girth (cm)* | | | | | |
| Chara (55) | 24.32$^{a}$±0.29 | 27.55 $^{a}$±0.22 | 29.17$^{a}$±0.18 | 30.78$^{a}$±0.19 | 32.25$^{a}$±0.19 |
| Chemballi (46) | 23.79$^{a}$±0.19 | 26.51$^{b}$±0.17 | 28.04$^{b}$±0.14 | 29.45$^{b}$±0.16 | 31.11$^{b}$±0.17 |
| *Length of neck (cm)* | | | | | |
| Chara (55) | 14.68$^{b}$±0.24 | 15.65$^{b}$±0.24 | 16.66$^{b}$±0.24 | 18.06$^{b}$±0.23 | 19.73$^{b}$±0.26 |
| Chemballi (46) | 15.74$^{a}$±0.23 | 17.05$^{a}$±0.18 | 18.15$^{a}$±0.20 | 19.21$^{a}$±0.20 | 20.59$^{a}$±0.20 |
| *Length of trunk with neck (cm)* | | | | | |
| Chara (55) | 36.60$^{a}$±0.38 | 38.62$^{a}$±0.34 | 40.48$^{a}$±0.32 | 41.86$^{a}$±0.30 | 43.43$^{a}$±0.30 |
| Chemballi (46) | 36.38$^{b±}$0.38 | 38.19$^{b±}$0.36 | 40.10$^{b±}$0.36 | 41.40$^{b±}$0.31 | 42.99$^{b}$±0.30 |
| *Length of shank (cm)* | | | | | |
| Chara (55) | 6.91$^{a}$±0.04 | 7.13$^{a}$±0.04 | 7.32$^{a}$±0.04 | 7.55$^{a}$±0.04 | 7.71$^{a}$±0.05 |
| Chemballi (46) | 6.87$^{a}$±0.06 | 7.10$^{a}$±0.06 | 7.34$^{a}$±0.06 | 7.52$^{a}$±0.05 | 7.81$^{a}$±0.05 |

Means with different superscripts within each column differ significantly (p≤0.05)
Figures in parenthesis represent number of observations

Body measurements like shank length (LS) and chest girth (CG) are important indicators of leg and breast development, respectively (Ojo *et al.*, 2014) and they are also the most valuable parts of chicken or duck meat from the consumer’s point of view.

**Table 5:** Mean fortnightly body weight gain (g) in Chara - Chemballi Kuttanad ducks

| Ecotype | AG2 | AG4 | AG6 | AG8 | AG10 | AG12 | AG14 | AG16 |
|---|---|---|---|---|---|---|---|---|
| Chara (55) | 173.64$^{a}$±5.63 | 264.54 $^{a}$±12.94 | 273.04 $^{a}$±14.74 | 335.95 $^{a}$±14.20 | 252.78 $^{a}$±17.13 | 172.43 $^{a}$±19.66 | 107.87 $^{a}$±11.94 | 117.72 $^{a}$±11.25 |
| Chemballi (46) | 155.70$^{b}$±6.31 | 215.73 $^{b}$±15.15 | 290.87 $^{b}$±25.63 | 237.39 $^{b}$±23.66 | 174.74 $^{b}$±15.45 | 151.22 $^{b}$±11.45 | 105.45 $^{b}$±11.92 | 70.73 $^{b}$±9.07 |

Means with different superscripts within each column differ significantly ($p \leq 0.05$)
Figures in parenthesis represent number of observations

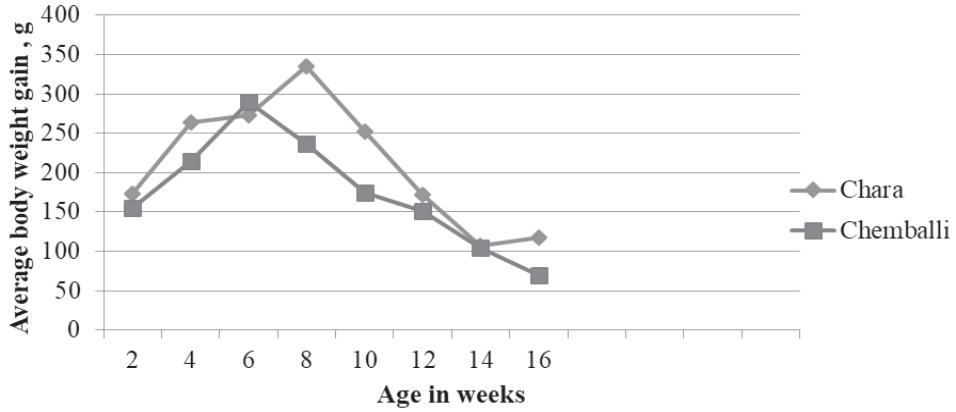


**Fig.1:** Mean fortnightly body weight gain (g) in Chara - Chemballi Kuttanad ducks

Chest girth (CG) is also indicative of meatiness (Yakubu *et al.*, 2011). The length of neck (LN) indicates the efficiency of the ducks in feeding below the level of their feet, underwater (Christine *et al.*, 2019). Hence, looking at the overall biometrics, it can be concluded that on account of the longer trunks and breast bones and a wider chest, Chara is bigger with possibly better meat-type attributes than Chemballi and the Chemballi ducks possessed significantly longer necks (LN) than Chara, indicating a probable superior ecological adaptation of the Chemballi variety to the flood-prone breeding tract of Kuttanad.

*Fortnightly body weight gain in Kuttanad ducks*

The gain in body weight of Chara and Chemballi varieties of Kuttanad ducks at fortnightly intervals are presented in Table 5 and Fig.1. The results revealed that the average gain in body weight was highest at six to eight weeks of age which is regarded as the grower stage in ducks. Chara ducks had higher body weight and higher body weight gain than Chemballi from the grower (8-10 weeks) to finisher or pre-pullet stage (14-16 weeks). This dominant pattern of the growth rate of Chara when compared to Chemballi at these crucial stages points out the potential of Chara to emerge as a promising meat-type duck.

## CONCLUSION

The present study revealed the morphometry and growth performance of Chara-Chemballi varieties of Kuttanad ducks from hatch to 16 weeks of age. The males of Kuttanad possessed a larger biometry than the females. The Chara variety with a meat-type biometry of longer breast bones and wider chest as well as a higher fortnightly weight gain from grower to finisher stages of 8 to 16 weeks of age indicated it's potential to emerge as a meat-type duck. Chemballi ducks, on the other hand, possessed better adaptability features like longer necks suggestive of their probable superior swimming and feeding efficiency in their flood-hit home tract. Kuttanad ducks in overall, also had longer necks and shanks when compared to most other indigenous ducks of India, making them excellent swimmers and foragers in turbulent waters - an acquired trait of adaptability to the recurrent flood situation in their breeding tract. The study throws light on the efficacy of body biometrics as an effective tool for the genetic characterization of ducks as well as for their selection for adaptability in disaster-hit environments.

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