Indian Journal of Animal Sciences **96** (4): 302–309, April 2026/Article
https://doi.org/10.56093/ijans.v96i4.169231

Phenotypic characterization and performance evaluation of Molai Adu goats in their native tract of Tamil Nadu

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Received:24 July 2025; Accepted: 22 June 2026

ABSTRACT

This study documented the habitat, morphological, morphometric, production and reproductive traits of Molai Adu goats in Tamil Nadu. Data was collected from 699 goats of both sexes across different age groups (birth, 3, 6, 9 and 12 months; 2-tooth, 4-tooth, 6-tooth and full-mouth stages) through field survey conducted in 29 villages within the Gobichettipalayam, Perundurai, Nambiyur, Bhavani and Erode blocks of Erode district. Morphological traits, body weights, and linear body measurements were recorded, and information on reproductive traits was obtained through direct observation and farmer interviews. Molai Adu goats are medium-sized, predominantly white in colour with occasional light brown patches. The pooled means for height at withers at 2-tooth, 4-tooth, 6-tooth and full-mouth stages were 61.25 ± 0.14, 63.92 ± 0.62, 65.96 ± 0.14 and 68.44 ± 0.26 cm, respectively. Corresponding chest girth values were 66.26 ± 0.22, 70.81 ± 0.58, 72.18 ± 0.26 and 74.02 ± 0.24 cm. The least-squares means for body weight across sexes were 25.28 ± 0.33 kg (2-tooth), 27.82 ± 0.26 kg (4-tooth), 31.24 ± 0.36 kg (6-tooth) and 35.42 ± 0.28 kg (full mouth). The average kidding interval was 8.2 months, with a mean litter size of 1.74 across parities. The findings indicated that Molai Adu goats possess distinct physical and functional traits that differentiate them from other native breeds of Tamil Nadu, emphasizing the importance of formal recognition to safeguard this unique genetic resource.

Keywords: Molai Adu goat, Morphometric traits, Morphological traits, Reproductive performance

India possesses one of the richest repositories of livestock genetic resources, with 43 registered goat breeds and several region-specific populations awaiting official recognition (ICAR-NBAGR, 2026). Indigenous goat breeds play a crucial role in sustaining rural livelihoods, particularly in marginal and rain fed agro-ecosystems, due to their adaptability, low input requirements and multifunctional utility. In Tamil Nadu, goat farming is an integral component of mixed farming systems, supporting income, nutrition and resilience among smallholder farmers.

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Recognizing the importance of documenting unexplored native livestock resources, the ICAR–National Bureau of Animal Genetic Resources (ICAR-NBAGR) launched the initiative "Mission towards Zero Non-Descript Animal Genetic Resources of India" in 2021. This mission aimed to identify, characterize and register distinct indigenous breeds across the country. As of recent reports, over half of India's total goat population remains uncharacterized (Sharma *et al.* 2020), highlighting the urgent need for systematic breed-level documentation. Identification and characterization of distinct germplasm in specific regions are essential to conserve valuable genetic diversity and guide targeted breeding programs.

The Molai Adu is a lesser-known, unregistered goat population predominantly reared in the Erode district of western Tamil Nadu. It is well-adapted to the semi-arid, undulating terrain of the region and is traditionally maintained under extensive, low-input systems by small and marginal farmers. Despite its local economic and ecological significance, scientific documentation on the breed's physical characteristics, performance traits and habitat is limited. Comprehensive phenotypic characterization is thus crucial for recognition and sustainable utilization of this valuable genetic resource.

The present study was undertaken to characterize

the habitat, morphological features, morphometric traits and production and reproductive performance of Molai Adu goats in their native tract. The data generated in this study provide baseline information for evaluating the distinctiveness of Molai Adu goats and may contribute to future breed recognition and genetic improvement strategies.

MATERIALS AND METHODS

Study area and home tract: Based on the report by Ravimurugan and Kirubakaran (2019), initial reconnaissance visits were conducted in the districts of Salem, Namakkal, Karur, Erode and Tiruppur to identify the breeding tract of Molai Adu goats. However, detailed field investigations confirmed that the population is currently confined to five blocks of Erode district: Gobichettipalayam, Perundurai, Nambiyur, Bhavani and Erode. Therefore, all subsequent sampling and data collection were restricted to these areas.

Sample size and data collection: A total of 699 Molai Adu goats were surveyed from 29 villages across the five identified blocks. Animals were grouped by age and dentition into birth, 3, 6, 9 and 12 months; and 2-tooth, 4-tooth, 6-tooth and full-mouth stages. Data were recorded for both sexes. For breed characterization, 84 herds (comprising 699 goats) were randomly selected from the same 29 villages.

Morphological characterization: Qualitative traits such as coat colour, horn status, facial profile, ear orientation, presence of beard and wattles, tail carriage, udder shape and teat orientation were recorded through visual observation using the breed descriptor guidelines of FAO (2012) and ICAR-NBAGR (2016). Photographs were taken to support documentation.

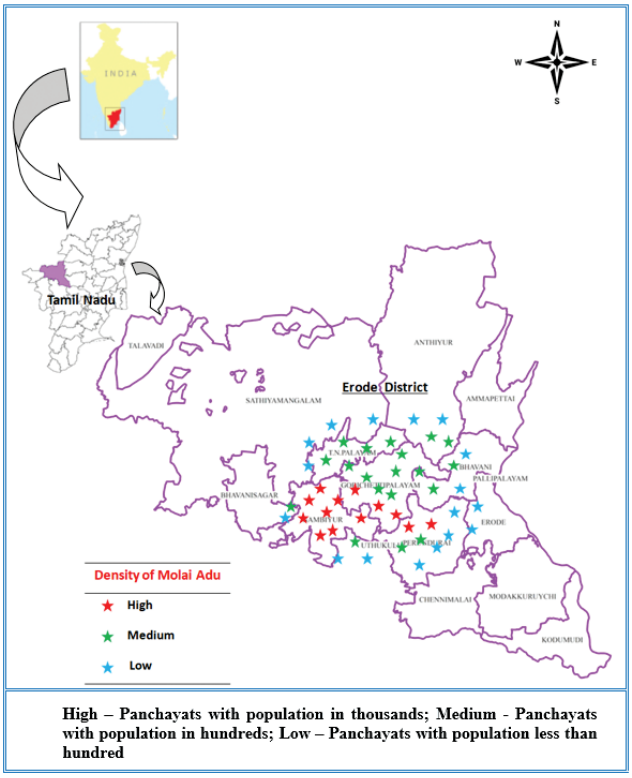

Fig. 1. Breeding tract of Molai Adu

Morphometric and performance traits: Quantitative traits including height at withers, body length, chest girth, paunch girth, ear length and face length were measured using a measuring tape to the nearest 0.5 centimetre. Body weight was recorded using a digital spring balance. Reproductive traits such as age at first kidding, kidding interval, gestation length and litter size were collected through farmer interviews and verified with available flock records.

Statistical analysis: Descriptive statistics were calculated for reproductive traits. Parity-wise percentages of single, twin, triplet and quadruplet births were also computed. For morphometric and body weight traits, least-squares means were estimated separately within each age group using the General Linear Model (GLM) procedure in IBM SPSS Statistics (Version 23.0), with sex included as the fixed effect. The statistical model used was:

$$Y_{ij} = \mu + S_i + e_{ij}$$

where is the observed trait, is the overall mean, is the fixed effect of sex and is the random residual error. Although the sample sizes were unbalanced between sexes within some age groups, least-squares means estimated using the GLM appropriately account for unequal subclass frequencies when estimating fixed effects.

RESULTS AND DISCUSSION

Habitat and distribution: The present study investigated the habitat and distribution of Molai Adu goats. Locally, the breed is referred to as "Molai Adu" or "Mottai Adu" in the Tamil language. Both terms translate to 'polled', referring to the breed's naturally hornless condition. Due to the absence of prior scientific records or documentary evidence, tracing the origin of this breed was quite challenging. The study revealed that Molai Adu goats are primarily distributed in the Gobichettipalayam, Perundurai, Nambiyur, Bhavani and Erode blocks of Erode district in Tamil Nadu, with a higher concentration in the Gobichettipalayam and Nambiyur blocks (Fig. 1). This observation aligned with the findings of Ravimurugan and Kirubakaran (2019), who reported that Molai Adu goats were widely present in Chithode, Kavundapadi, Siruvaloor, Nambiyur, Kanjikovil and Nallampatty areas of the district. The breeding tract was located in the southern part of Erode district and was predominantly characterized by red loamy soil, which are well-drained and moderately fertile, making them suitable for agriculture and grazing.

Based on field surveys in the breeding tract, the average herd size of Molai Adu goats was found to be 12.64 ± 0.28. This value was lower than the reported herd sizes of Kanni Adu (16.8), Salem Black (31), Sangamneri (25), Nandidurga (31), Kodi Adu (17.60), and Bidri (33.43) goats (Thiruvenkadan *et al.* 2000; Thiruvenkadan and Karunanithi, 2006; Verma *et al.* 2010; Tantia *et al.* 2018;

Molai Adu - Buck

Molai Adu - Doe

Molai Adu - Doe with kids

Molai Adu - Herd

Fig. 2. Morphological appearance of Molai Adu

Thiruvenkadan *et al.* 2020).

Morphologic characteristics: Molai Adu goats are medium in size with a predominantly white coat colour, which varies from milky white to yellowish white. In some animals, especially bucks, light brownish patches were also observed. Representative images of Molai Adu bucks, does, kids, and herds are shown in Fig. 2. The coat colour pattern of Molai Adu was distinctly different from that of Kanni Adu goats, which are typically black with white or reddish-brown markings on the face, underbelly, and the inner sides of the legs (Thiruvenkadan *et al.* 2000). Kodi Adu goats, by contrast, are found in white with reddish brown (chem-porai) or black (karum-porai) coloration (Thiruvenkadan *et al.* 2020). The uniform white colour of Molai Adu goats, which is uncommon among other Tamil Nadu breeds, made them unique and distinguishable.

The head profile was straight with a narrow face and a greyish-pink muzzle, similar to that of Kanni Adu and Salem Black goats (Thiruvenkadan *et al.* 2000; Thiruvenkadan and Karunanithi, 2006). The ears were pendulous and leaf-shaped. Does possessed well-developed udders with prominently placed teats.

The morphological features of Molai Adu goats also differed from those of the Malabari (Tellicherry) goats of Kerala. Malabari goats exhibit considerable variation in coat colour, ranging from completely white to mixtures of white, brown, and black, and many animals possess horns, with approximately 20% showing beards (Verma *et al.* 2009). In contrast, Molai Adu goats were predominantly white with occasional light brown patches and were characteristically naturally polled in both sexes, making hornlessness one of their most distinctive breed features. Furthermore, although both breeds possess pendulous ears and a straight facial profile, the uniform white appearance and complete absence of horns in Molai Adu provided clear phenotypic distinctions from Malabari goats.

A distinguishing characteristic of Molai Adu is that both males and females are polled, which is rare among Indian goat breeds. Although polledness has been reported in breeds such as Ganjam, Black Bengal and Barbari, these breeds are not entirely hornless. In traditional farming systems, horns are often considered advantageous for survival and self-defense. However, naturally polled animals reduce the risk of injury to themselves and handlers, improve ease of management and enhance animal welfare, making them well-suited for modern goat farming systems.

Wattles were observed in a few males and females. In comparison, earlier studies reported that 55% of Kanni Adu males and 15% of females had beards (Thiruvenkadan *et al.* 2000). In Salem Black goats, beards and wattles were observed in 43% of males and 22% of females, and in 89% of males and 76% of females, respectively (Gopu *et al.* 2013).

Morphometric characteristics: The least squares mean of body measurements of Molai Adu kids and adults are presented in Tables 1 and 2, respectively. Compared to the

Table 1. Least-squares means (± S.E.) for body measurements of Molai Adu kids

Trait	Birth	Three-month	Six-month	Nine-month	12-month
			Height at withers (cm)		
Overall	35.26±0.24 (24)	43.72±0.24 (112)	49.53±0.58 (138)	53.68±0.42 (68)	58.63±0.78 (80)
Sex	**	NS	**	**	**
Male	36.63±0.31 (11)	44.20±0.18 (53)	51.00±0.29 (66)	54.80±1.02 (30)	60.10±0.66 (24)
Female	33.68±0.36 (13)	43.30±0.17 (59)	48.20±0.76 (72)	52.80±0.65 (38)	58.00±0.84 (56)
			Chest girth (cm)		
Overall	34.48±0.23 (24)	43.62±0.19 (112)	49.72±0.24 (138)	56.63±0.40 (68)	62.52±0.48 (80)
Sex	**	NS	NS	**	NS
Male	35.44±0.32 (11)	44.20±0.14 (53)	50.30±0.26 (66)	58.20±0.61 (30)	62.80±0.63 (24)
Female	33.26±0.35 (13)	43.10±0.16 (59)	49.20±0.24 (72)	55.40±0.33 (38)	62.40±0.52 (56)
			Pelvic girth (cm)		
Overall	34.28±0.24 (24)	44.57±0.28 (112)	51.62±0.36 (138)	59.52±0.42 (68)	65.08±0.58 (80)
Sex	NS	NS	NS	*	**
Male	34.26±0.32 (11)	45.00±0.23 (53)	51.00±0.32 (66)	58.30±0.44 (30)	62.00±0.71 (24)
Female	34.33±0.35 (13)	44.20±0.31 (59)	52.20±0.42 (72)	60.50±0.29 (38)	66.40±0.60 (56)
			Body length (cm)		
Overall	32.54±0.31 (24)	43.79±0.28 (112)	49.32±0.23 (138)	54.79±0.26 (68)	61.19±0.16 (80)
Sex	NS	NS	**	**	NS
Male	33.28±0.44 (11)	44.00±0.15 (53)	51.20±0.38 (66)	56.50±0.24 (30)	61.50±0.28 (24)
Female	32.26±0.46 (13)	43.50±0.15 (59)	48.20±0.20 (72)	53.50±0.24 (38)	61.00±0.23 (56)
			Face length (cm)		
Overall	13.24±0.13 (24)	14.24±0.10 (112)	15.44±0.11 (138)	16.32±0.13 (68)	18.70±0.14 (80)
Sex	NS	*	NS	*	NS
Male	13.22±0.18 (11)	14.96±0.12 (53)	15.98±0.15 (66)	16.98±0.22 (30)	18.88±0.20 (24)
Female	13.00±0.22 (13)	13.48±0.16 (59)	15.16±0.18 (72)	15.71±0.17 (38)	18.42±0.18 (56)
			Ear length (cm)		
Overall	11.22±0.12 (24)	12.90±0.48 (112)	14.14±0.42 (138)	15.27±0.28 (68)	16.35±0.42 (80)
Sex	NS	NS	NS	NS	NS
Male	11.10±0.15 (11)	12.80±0.64 (53)	14.20±0.36 (66)	15.00±0.36 (30)	16.25±0.48 (24)
Female	11.32±0.18 (13)	13.00±0.34 (59)	14.10±0.55 (72)	15.50±0.30 (38)	16.40±0.58 (56)
			Tail length (cm)		
Overall	8.76±0.12 (24)	10.76±0.22 (112)	11.90±0.33 (138)	13.66±0.41 (68)	14.59±0.44 (80)
Sex	*	NS	NS	NS	NS
Male	9.28±0.16 (11)	10.50±0.26 (53)	11.80±0.16 (66)	13.50±0.24 (30)	14.80±0.44 (24)
Female	8.02±0.19 (13)	11.00±0.23 (59)	12.00±0.30 (72)	13.80±0.26 (38)	14.50±0.62 (56)
			Skin-fold thickness -Neck (mm)		
Overall	1.63±0.01 (16)	1.89±0.02 (65)	2.01±0.02 (62)	2.12±0.04 (44)	2.50±0.04 (48)
Sex	NS	NS	NS	*	NS
Male	1.77±0.03 (9)	2.02±0.03 (30)	2.16±0.02 (30)	2.33±0.05 (18)	2.68±0.05 (22)
Female	1.54±0.04 (7)	1.76±0.04 (35)	1.86±0.05 (32)	1.90±0.05 (26)	2.46±0.06 (26)
			Skin-fold thickness –Flank (mm)		
Overall	1.73±0.03 (16)	1.90±0.03 (65)	2.25±0.03 (62)	2.35±0.03 (44)	2.44±0.04 (48)
Sex	NS	NS	NS	NS	*
Male	1.80±0.03 (9)	1.93±0.04 (30)	2.30±0.04 (30)	2.44±0.04 (18)	2.54±0.06 (22)
Female	1.66±0.05 (7)	1.87±0.06 (35)	2.21±0.07 (32)	2.24±0.06 (26)	2.34±0.04 (26)

Figures in parentheses are number of observations; NS – Not significant; * Significant (P<0.05); **Highly significant (P<0.01)

Table 2. Least-squares means (± S.E.) for body measurements of adult Molai Adu goats

Trait	2-tooth	4-tooth	6-tooth	Full mouth
		Height at withers (cm)		
Overall	61.25±0.14 (83)	63.92±0.62 (59)	65.96±0.14 (57)	68.44±0.26 (78)
Sex	**	**	**	**
Male	64.22±0.21 (20)	73.10±1.06 (11)	75.28±0.28 (11)	78.42±0.45 (14)
Female	60.24±0.12 (63)	61.60±0.59 (48)	63.26±0.13 (46)	66.26±0.18 (64)
		Chest girth (cm)		
Overall	66.26±0.22 (83)	70.81±0.58 (59)	72.18±0.26 (57)	74.02±0.24 (78)
Sex	**	**	**	**
Male	70.28±0.31 (20)	76.80±0.80 (11)	78.18±0.41 (11)	79.92±0.41 (14)
Female	64.26±0.18 (63)	67.30±0.70 (48)	69.88±0.19 (46)	71.16±0.16 (64)
		Pelvic girth (cm)		
Overall	68.28±0.16 (83)	72.42±0.64 (59)	76.65±0.66 (57)	78.42±0.24 (78)
Sex	**	**	**	**
Male	66.44±0.31 (20)	70.28±0.80 (11)	74.50±0.78 (11)	76.44±0.41 (14)
Female	69.26±0.20 (63)	73.48±0.72 (48)	77.20±0.68 (46)	79.32±0.18 (64)
		Body length (cm)		
Overall	65.26±0.18 (83)	67.17±0.62 (59)	70.28±0.24 (57)	73.59±0.18 (78)
Sex	**	**	**	**
Male	70.42±0.32 (20)	74.20±0.72 (11)	76.64±0.44 (11)	78.62±0.32 (14)
Female	63.22±0.18 (63)	65.40±0.52 (48)	68.62±0.19 (46)	71.44±0.14 (64)
		Face length (cm)		
Overall	18.82±0.18 (83)	20.20±0.21 (59)	21.22±0.22 (57)	22.20±0.23 (78)
Sex	*	*	**	**
Male	19.54±0.26 (20)	20.78±0.39 (11)	22.18±0.39 (11)	23.62±0.46 (14)
Female	18.05±0.16 (63)	19.40±0.20 (48)	20.15±0.22 (46)	20.66±0.22 (64)
		Ear length (cm)		
Overall	16.86±0.18 (83)	17.73±0.44 (59)	18.24±0.38 (57)	18.82±0.24 (78)
Sex	NS	NS	*	NS
Male	16.92±0.27 (20)	17.50±0.38 (11)	17.92±0.50 (11)	18.44±0.52 (14)
Female	16.78±0.20 (63)	17.80±0.55 (48)	18.48±0.30 (46)	19.05±0.22 (64)
		Tail length (cm)		
Overall	15.39±0.22 (83)	16.26±0.60 (59)	17.65±0.36 (57)	18.51±0.38 (78)
Sex	NS	NS	*	*
Male	15.75±0.44 (20)	16.24±0.68 (11)	18.72±0.63 (11)	19.72±0.69 (14)
Female	15.02±0.25 (63)	16.28±0.44 (48)	16.58±0.30 (46)	17.31±0.27 (64)
		Skin-fold thickness -Neck (mm)		
Overall	2.52±0.04 (38)	2.78±0.08 (36)	3.61±0.08 (32)	4.49±0.10 (44)
Sex	*	*	**	**
Male	2.88±0.08 (18)	3.16±0.16 (17)	4.19±0.15 (12)	5.38±0.15 (18)
Female	2.18±0.04 (20)	2.36±0.08 (19)	3.02±0.08 (20)	3.59±0.06 (26)
		Skin-fold thickness –Flank (mm)		
Overall	2.50±0.04 (38)	2.72±0.10 (36)	3.05±0.08 (32)	3.82±0.08 (44)
Sex	NS	*	NS	**
Male	2.58±0.07 (18)	2.96±0.16 (17)	3.18±0.15 (12)	4.60±0.13 (18)
Female	2.41±0.04 (20)	2.40±0.08 (19)	2.86±0.08 (20)	3.22±0.08 (26)

Figures in parentheses are number of observations; NS – Not significant; * Significant (P<0.05); **Highly significant (P<0.01)

recognized breeds of Tamil Nadu such as Kanni Adu, and Salem Black, which are known for their tall, long and leggy appearance, Molai Adu goats were observed to be small to medium in size.

In Molai Adu does, pelvic girth was the largest linear measurement, followed by chest girth, body length, and height at withers. In contrast, Molai Adu bucks showed chest girth as the largest measurement, followed by pelvic girth, body length and height at withers. This distribution pattern differed from that of Kanni Adu (Thiruvenkadan *et al.* 2000), Kodi Adu (Thiruvenkadan *et al.* 2020), Salem Black (Gopu *et al.* 2013) and Attappady Black (Stephen *et al.* 2005), where height at withers exceeded chest girth, which in turn was greater than body length.

Across all age groups, the morphometric measurements of Molai Adu goats were generally lower than those reported for Kanni Adu, Kodi Adu and Salem Black breeds (Thiruvenkadan *et al.* 2000; Thiruvenkadan, 2012; Thiruvenkadan *et al.* 2017). However, the adult body dimensions of Molai Adu goats were comparable to those of Malabari goats of Kerala (Verma *et al.* 2009). For example, the average height at withers of adult Molai Adu goats (68.44 cm) was very similar to that reported for adult Malabari goats (67.06 cm), while chest girth values were also comparable (74.02 vs. 74.36 cm). In contrast, Molai Adu goats exhibited slightly greater body length (73.59 vs. 70.34 cm) and a longer face (22.20 vs. 17.14 cm). The ear length of Molai Adu goats was also marginally longer than that reported for Malabari goats (18.82 vs. 18.44 cm), indicating subtle but distinct breed-specific differences despite their overall similarity in body size. Recent phenotypic characterization studies of indigenous goats from the Vindhyan region of Eastern Uttar Pradesh (Kumar *et al.* 2024) and Northern India (Singh *et al.* 2019) have similarly shown that body height, body length, chest girth, face length and horn pattern are useful descriptors for differentiating local goat populations and supporting breed recognition.

Statistical analysis revealed a highly significant ($P<0.01$) difference in height at withers between sexes in all age groups except at three months of age. Bucks had significantly higher chest girth values than does from the 2-tooth stage onwards ($P<0.01$). Similarly, a highly significant ($P<0.01$) difference in pelvic girth between bucks and does was observed from twelve months of age onward. Body length also differed significantly ($P<0.01$) between the sexes at six months, nine months, 2-tooth, 4-tooth, 6-tooth, and full-mouth age groups. These results indicated sexual dimorphism in body conformation traits, particularly from later growth stages.

Overall, the morphometric characteristics of Molai Adu goats were consistent with those of medium-sized Indian goat breeds, while exhibiting specific breed-level distinctions that warrant recognition.

Body weight: The least squares means for body weight of Molai Adu goats are presented in Table 3. The pooled least squares mean body weights at birth, three months, six months, nine months, twelve months, 2-tooth, 4-tooth, 6-tooth and full-mouth age groups were 1.92 ± 0.18, 8.76 ± 0.23, 13.31 ± 0.17, 17.37 ± 0.25, 22.47 ± 0.29, 25.28 ± 0.33, 27.82 ± 0.26, 31.24 ± 0.36 and 35.42 ± 0.28 kg, respectively.

Molai Adu males had higher body weights than females across all age groups, except at three months of age. Statistical analysis revealed that sex had a highly significant ($P < 0.01$) effect on body weight at the 2-tooth, 4-tooth, 6-tooth and full-mouth age groups. In general, the pooled average body weights of Molai Adu goats were lower than those reported for other recognized breeds of Tamil Nadu, such as Kanni Adu, Salem Black and Kodi Adu (Thiruvenkadan *et al.* 2000; Gopu *et al.* 2013; Thiruvenkadan *et al.* 2017; Thiruvenkadan *et al.* 2020). When compared with Malabari goats, the body weights of Molai Adu kids at 6 and 12 months were similar, whereas the average adult body weight of Molai Adu goats (35.42 kg) was marginally lower than that reported for adult Malabari goats (36.31 kg) (Verma *et al.* 2009). Thus, both breeds can be categorized as medium-sized indigenous meat-type goats, although they differed in several phenotypic characteristics, particularly horn status and coat colour.

Table 3. Least-squares means (± S.E.) for body weight (kg) of Molai Adu

Age group	Overall		Male	Female	Sex effect
	Mean ± SE	Range	Mean ± SE	Mean ± SE	
Birth	1.92 ± 0.18 (24)	1.1 – 2.8	2.12 ± 0.32 (11)	1.88 ± 0.24 (13)	*
3 months	8.76 ± 0.23 (112)	6.2 – 11.5	8.50 ± 0.20 (53)	9.00 ± 0.26 (59)	NS
6 months	13.31 ± 0.17 (138)	10.5 – 17.2	14.10 ± 0.24 (66)	12.60 ± 0.22 (72)	*
9 months	17.37 ± 0.25 (68)	13.3 – 22.8	18.10 ± 0.26 (30)	16.80 ± 0.19 (38)	*
12 months	22.47 ± 0.29 (80)	17.5 – 28.5	21.70 ± 0.83 (24)	22.80 ± 0.61 (56)	*
2-tooth	25.28 ± 0.33 (83)	20.1 – 34.3	27.78 ± 0.62 (20)	24.26 ± 0.24 (63)	**
4-tooth	27.82 ± 0.26 (59)	22.2 – 38.8	29.85 ± 0.88 (11)	27.22 ± 0.31 (48)	**
6-tooth	31.24 ± 0.36 (57)	25.1 – 43.0	33.40 ± 0.66 (11)	29.78 ± 0.42 (46)	**
Full-mouth	35.42 ± 0.28 (78)	27.0 – 48.2	37.28 ± 0.82 (14)	33.24 ± 0.24 (64)	**

Figures in parentheses are number of observations; NS – Not significant; * Significant ($P<0.05$); **Highly significant ($P<0.01$)

Table 4. Reproduction performance of Molai Adu

Sex	Traits	Mean ± S.E.	Range
Male (n=95)	Age at first mating (months)	9.30 ± 0.22	8.0-14.0
Female (n=112)	Age at first mating (months)	9.80 ± 0.17	7.0-14.0
	Length of estrus cycle (days)	20.30 ± 0.24	17.0-24.0
	Gestation length (days)	151.50 ±0.40	147.0-155.0
	Age at first kidding (months)	15.40 ± 0.13	11.5-19.0
	Kidding interval (months)	8.20 ± 0.33	7.5-14.0
	Service period (months)	2.50 ± 0.11	2.0-8.5
	Life time number of kidding	5.30 ± 0.12	3.0-8.0
	Litter size	1.74 ± 0.06	1.0-4.0

Table 5. Parity-wise incidence of single and multiple births in Molai Adu

Parity	N	Type of birth (%)			
		Single	Twin	Triplet	Quadruplet
Overall	172	43.02 (74)	40.69 (70)	15.11 (26)	1.16 (2)
First	51	80.39 (41)	17.64 (9)	1.96 (1)	0.0 (0)
Second	47	23.40 (11)	57.44 (27)	14.89 (7)	4.25 (2)
Third	30	23.33 (7)	53.33 (16)	23.33 (7)	0.0 (0)
Fourth	22	31.81 (7)	45.45 (10)	22.72 (5)	0.0 (0)
Fifth and above	22	36.36 (8)	36.36 (8)	27.27 (6)	0.0 (0)

Figures in the parentheses are the number of observations

Reproductive traits: Mating in Molai Adu goats generally occur through herd mating, mostly during grazing periods. The reproductive performance of Molai Adu goats is presented in Table 4. The mean age at first mating was 9.3 months in bucks (ranging from 8 to 14 months) and 9.8 months in does (ranging from 7 to 14 months). The average gestation period was 151.5 days, and the mean age at first kidding was 15.4 months. The mean kidding interval and service period were 8.2 months and 2.5 months, respectively. The average lifetime number of kidding per doe was 5.3. The kidding rate in Molai Adu goats was 174.42% (calculated as the total number of kids born divided by the total number of kidding events and multiplied by 100). The parity-wise incidence of multiple births is presented in Table 5. The overall average litter size across all parities was 1.74. This was in agreement with recent work on Southern Odisha goats, where production and reproductive traits were also used as key criteria in the characterization of indigenous goat populations (Majumder *et al.* 2023). Among the births, single births accounted for 43.02%, followed by twins (40.70%), triplets (15.11%) and quadruplets (1.16%). The twinning rate was relatively higher in the second parity. These results suggested that selection for twinning could enhance productivity in Molai Adu goats. However, appropriate management practices must be adopted to support the survival and growth of kids born in multiple births.

In conclusion, the present study comprehensively documented the habitat, morphological, morphometric, and reproductive traits of Molai Adu goats reared in the Erode district of Tamil Nadu. The findings revealed that Molai Adu is a distinct, medium-sized, predominantly white, polled goat population with unique physical characteristics and moderate reproductive performance. The breed exhibited significant sexual dimorphism in body measurements, and its morphometric traits align with those of other medium-sized indigenous goats of India. Despite its adaptability and economic significance to smallholder farmers, Molai Adu remains unrecognized in the official breed registry. The data generated from this study can serve as a scientific foundation for formal breed recognition, conservation planning and future genetic improvement programmes aimed at preserving this valuable indigenous germplasm.

ACKNOWLEDGEMENT

The authors express their sincere gratitude to the Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) for providing the necessary facilities, support, and encouragement to carry out this research. The cooperation extended by the farmers of Erode district during field investigations is also gratefully acknowledged.

REFERENCES

FAO. 2012. Phenotypic characterization of animal genetic resources. FAO Animal Production and Health Guidelines No. 11, Rome.

Gopu P, Raman K S, Thangaraju P, Saravanan R and Paneerselvam S. 2013. Breed characteristics of Salem Black Goat of Tamil

Nadu. *Shanlax International Journal of Veterinary Science Research* **1**: 15–19.

ICAR-NBAGR. 2016. Guidelines for management of animal genetic resources of India. ICAR–National Bureau of Animal Genetic Resources, Karnal, Haryana.

ICAR-NBAGR. 2026. ICAR–National Bureau of Animal Genetic Resources in Registered Breeds of Goat. https://nbagr.res.in/goat-breed retrieved on 20/06/2026.

Kumar P R, Choubey M and Kumar A. 2024. Phenotypic characterization of distinct indigenous goats from Vindhyan region of Eastern Uttar Pradesh. *Indian Journal of Animal Sciences* **94**(7): 592–597.

Majumder S, Dash S K, Samal L, Mishra C and Karna D K. 2023. Characterization, production and reproduction performance of Southern Odisha goats. *Indian Journal of Animal Research* **57**(11): 1432–1437.

Ravimurugan T and Kirubakaran A. 2019. Molai Adu goat warrant immediate registration and conservation. *International Journal of Current Microbiology and Applied Sciences* **8**(1): 1755–1759.

Sharma R, Vij P K, Aggarwal R, Chandran P C, Kamal R K, Dey A and Tantia M S. 2020. Characterization of a new potential goat breed (Palamu) from Jharkhand, India. *Indian Journal of Animal Sciences* **90**(12): 1606–1611.

Singh K V, Dixit S P, Sharma A, Vohra V, Neel Kant, Dangi P S and Kumar R. 2019. Differentiating characteristics among three new goat populations from northern India. *Indian Journal of Animal Sciences* **89**(7): 746–751.

Stephen M, Raja T V and Sosamma I. 2005. Survey and characterization of Attappady Black goats of Kerala, India. *Animal Genetic Resources* **37**: 43–52.

Tantia M S, Vij P K, Yathish H M, Kulkarni V S, Shettar V B, Gopala G T, Sharma H and Sharma R. 2018. Characterization of Nandidurga and Bidri goat populations of Karnataka. *Indian Journal of Animal Sciences* **88**(9): 1058–1063.

Thiruvenkadan A K, Panneerselvam S and Kandasamy N. 2000. Distribution, characteristics and production performance of Kanni Adu goats of Tamil Nadu. *Indian Journal of Animal Sciences* **70**(7): 723–727.

Thiruvenkadan A K and Karunanithi K. 2006. Characterisation of Salem Black goats in their home tract. *Animal Genetic Resources* **38**: 67–75.

Thiruvenkadan A K. 2012. Kodi Adu Goat – A Monograph. Tamil Nadu Veterinary and Animal Sciences University and International Foundation for Science, Sweden.

Thiruvenkadan A K, Muralidharan J, Senthilkumar P, Sankar V and Ramesh Saravana Kumar V. 2017. Salem Black Goat – A Monograph. Tamil Nadu Veterinary and Animal Sciences University, Chennai.

Thiruvenkadan A K, Saravanan R and Chellapandian M. 2020. Characterization of Kodi Adu goats of Tamil Nadu, India. *Indian Journal of Veterinary and Animal Sciences Research* **49**(3): 31–42.

Verma N K, Dixit S P, Dangi P S, Aggarwal R A K, Kumar S and Joshi B K. 2009. Malabari goats: Characterization, management, performance and genetic variability. *Indian Journal of Animal Sciences* **79**(8): 813–818.

Verma N K, Dixit S P, Aggarwal R A K, Dangi P S and Joshi B K. 2010. Phenotypic and genetic characterization of Sangamneri goat breed. *Indian Journal of Animal Sciences* **80**(11): 1109–1114.