



Phenotypic characterization of Macherla goat of Andhra Pradesh

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ABSTRACT

The present study was conducted with an objective to determine the phenotype and characterize the lesser-known indigenous Macherla goat of Andhra Pradesh, on the basis of randomly sampled individuals (n= 771) from 24 villages across the breeding tract. The research focused on habitat, body biometry, and growth of these goats. Macherla goats were observed to be of medium to large size, exhibiting three primary coat color patterns: predominantly patchy (84.6%), followed by plain (12.0%) and spotted patterns (3.4%). Horn morphology revealed that curved horns were most prevalent, followed by straight horns. All the goats of this genetic group had pendulous ears and the head profile was slightly convex in majority. Tail shapes included both curved and straight variations, while the back exhibited both straight and sloping characteristics. The overall least-squares mean for height at withers for individuals over 36 months was recorded at 91.0 ± 0.6 cm (n=199). Specifically, bucks measured an average of 96.5 ± 1.0 cm (n=18), whereas does measured 85.4 ± 0.4 cm (n=181). Statistical analysis indicated that sex had a significant effect on body measurements in the >36month age group. The least-squares means for body length and chest girth for individuals over 36 months were 83.8 ± 0.6 cm and 86.0 ± 0.6 cm, respectively. Adult body weights for individuals over 36 months were 54.0 ± 0.7 kg for males and 42.0 ± 0.3 kg for females.

Keywords: Biometry, Characterization, Macherla Goat, Phenotype

Goats are often referred to as the “Poor Man’s Cow” and are valuable for their milk, and for their role as a source of animal protein. India is home to about 43 distinct goat breeds. Apart from them, there is a wealth of unlisted, uncharacterized lesser known genetic groups often locally adapted, that are currently outside formal classification and identified by local nomenclatures. Efforts to document, evaluate, and improve these genetic groups is essential for understanding the biodiversity. Livestock genetic diversity can be assessed using various approaches, including morphological, biochemical, and molecular information (Mohammadi and Prasanna, 2003). Defining a breed population involves recording its physical characteristics (Rege, 1992) and is regarded as the initial phase of characterization (Gizaw *et al.* 2007). Goats of Palnadu with distinct morphology, despite their population size, are not well-documented in terms of morphological and morphometric characteristics. This study was conducted from January to September 2024 across various villages within the home tract of this genetic group in Andhra

Pradesh to document the physical traits in order to facilitate the recognition of these goats as a distinct breed

MATERIALS AND METHODS

The current study was focused on a lesser-known genetic group, Macherla goats, to determine morphometric features by visiting 24 villages along 13 mandals, (sub-divisions of revenue blocks), in the Palnadu and Guntur districts of Andhra Pradesh. Palnadu district, situated in the Krishna River Zone of Andhra Pradesh, is categorized under the agroclimatic regions of the Southern Plateau and Hills, and the East Coast Plains and Hills. The district, is located in a tropical climate zone, positioned between latitudes $16^{\circ}03'$ and $16^{\circ}37'$ N and longitudes $79^{\circ}22'$ and $80^{\circ}21'$ E. Its climate is semi-arid, characterized by a normal annual rainfall of 775.3 mm.

The census data from 2019, sourced from the Department of Animal Husbandry, Andhra Pradesh, was employed to estimate the population of Macherla goat at the mandal level. Simple Random Sampling without Replacement (SRSWOR) method was employed with each mandal as single stratum and the first stage units were census villages. From each mandal about 10% of villages were selected. The second stage units were farmers and the third stage units comprised of animals belonging to this particular genetic group (Supplementary Table 1). In total 58 flocks

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across the twenty-four villages were studied. The National Bureau of Animal Genetic Resources, Karnal, Haryana, recommendations and the descriptors of the Food and Agriculture Organization (FAO 2012 and ICAR-NBAGR 2016) were followed to characterize Macherla goats. Features like color of coat, pattern and shape of horns, color and orientation of horns, orientation of ears, head profile, and type and shape of the tail were documented. The animals were divided into seven categories based on age: 0-1 month, 4-6 months, 7-12 months, 13-24 months, and >36 months. Data was recorded by using standard measuring tape to measure the length of the body, height at withers, chest circumference, horn, ear, face, tail, and width of the face for different age groups. The analysis was conducted using the General Linear Model within SPSS Statistics Base 17 (2008).

RESULTS AND DISCUSSION

Habitat and distribution: The genetic group of goats locally known as ‘Macherla goat’ due to their abundance in the region, are also named as ‘batta meka’ and ‘chukka meka’ (Fig. 1) for their distinctive patchy coat coloration (in vernacular language meaning “patchy” and spotty respectively). According to information gathered from elderly shepherds during the survey, these goats have been present in the area for ages and are typically kept in small holdings.



Fig. 1. Macherla adult buck and doe

The breeding area for this genetic group is restricted to certain mandals in Palnadu and Guntur district, Andhra Pradesh (Fig. 2). A higher proportion of true-to-type Macherla goats were predominantly located in Durgi, Dachepalle, Gurajala, Veldurthi and Rompicherla mandals of Palnadu and Thullur mandal of Guntur districts of Andhra Pradesh. In contrast, flocks that exhibited intermixing with other local non-descriptive goat populations were identified in Narsaraopeta, Amaravati, and Nekarikallu mandals, as well as in Savalyapuram, Ipur, Krosuru, and Atchampeta mandals of Palnadu district.

In a comprehensive enumeration of 58 flocks, it was observed that Macherla goats were predominantly maintained as pure flocks, comprising 84.5% of the total, while the remaining flocks were mixed, incorporating varying proportions of local nondescript goats. The size of pure Macherla flocks (Fig. 3) ranged from 20 to 120 goats,



Fig. 2. Map showing distribution of Macherla goat in Andhra Pradesh



Fig. 3. Flocks of goats with true to type

whereas mixed flocks could contain up to 200 goats. In the current study, the proportion of pure flocks was identified 84.5%.

Morphological characteristics: The observation on various morphological traits of these goats in their native tract is depicted in Supplementary Table 2.

Body coat colour: The analysis of body coat colour (Fig. 4) revealed a significant predominance of brown, black, and white combination, which accounted for 70.5% (543). Other observed colours included white 6.0% (46), black 1.7% (13), brown 4.4% (34), black and white 3.7% (29), brown and white 10.4% (47) and black/brown with white spots 3.4% (26). The Macherla goat exhibited a distinctive patchy coat that sets it apart from other goat breeds (Osmanabadi, Nandidurga, Bidri, Kodi adu and Salem black) found in bordering regions in neighboring states of Andhra Pradesh.

Tantia *et al.* (2018) noted that Kodi Adu goats predominantly featured a white coat, with some individuals displaying black spots on the ears and forehead. In contrast,



Fig. 4. Coat colour variants in Macherla (Spotted, Patchy, Plain)

Bidri goats are characterized by a black coat with white spots located on the ears, forehead, neck, and knees. Thiruvankadan *et al.* (2020) categorized Kodi Adu goats into two primary color varieties: Chem-Porai and Karum-Porai. The Chem-Porai variety is characterized by a white coat with varying degrees of reddish-brown coloration, while the Karum-Porai variety features a white coat with distinctive black splashes. Macherla goats, however, were identifiable by their distinct coat colors, which included patchy combinations of brown, black, and white; with few individuals exhibiting a spotted appearance while others possessed a solid coat.

Head, horn and ear: Pendulous ears were characteristic among Macherla goats. Among the goat breeds in the adjacent states of Andhra Pradesh, Mahabubnagar (Ekambaram *et al.* 2010) were with pendulous or flat, Nandidurga, (Tantia *et al.* 2018) were with pendulous or leafy ears. Semi-pendulous ear orientation was observed in Kodi Adu goats (Thiruvankadan *et al.* 2020). The predominant head type (Supplementary Table 2) was slightly convex, seen in 93% of individuals, with the remaining 7% showing a straight head profile. This convex head shape was typical of Macherla goats, though some individuals exhibited a straight head, as reported in Mahabubnagar goats (Ekambaram *et al.* 2010). Horn orientation in Macherla goats (Supplementary Fig. 1) varied, with the most common being back and down (49.4%), followed by back orientation (40.5%). Other orientations included back and forward (2.2%), back and outward (1.9%), back down out (3.5%) and upward (2.6%). In comparison, Bidri goats (Inamdar *et al.* 2021) showed a higher prevalence of horned individuals (78%), with upward, backward, outward, and curved orientations. Additionally, Nandidurga goats (Tantia *et al.* 2018) were characterized by backward, downward, and inward horn orientations.

Tail shape: Macherla goats exhibited both curved and straight tails, with straight tails being the predominant type (79.9%). In contrast, curved tails are more commonly observed in Kodi Adu goats (Thiruvankadan *et al.* 2020) and Salem Black goats (Thiruvankadan and Karunanithi 2006).

The analysis of characteristics across genders revealed distinct patterns (Supplementary Table 3). In terms of back type, 73.2% of females exhibited a slope, compared to only 10.5% of males, while 11.2% of females and 3.0% of males had a straight back; notably, 2.2% of females displayed a dipped back. Regarding tail type, 77.4% of females had a

slender tail, contrasted with 12.2% of males, while 9.1% of females and 1.3% of males presented a bunchy tail. For tail shape, 70.0% of females had straight tails compared to 9.9% of males, while 16.5% of females and 3.6% of males exhibited curved tails. Finally, the majority of both genders lacked beards, with 85.0% of females and 6.0% of males being beard-free, whereas 1.6% of females and 7.5% of males had beards. This data highlighted significant gender disparities in these characteristics.

As the phenotype are the primary criteria for breed characterization the significant difference ($P < 0.01$) in proportion of body coat colour of goats between the districts revealed that the true to breed type of the goats are more predominant in Palnadu district.

Height at withers: The analysis of height at withers (Table 1) at >36 month age group showed on overall height of 91.0 ± 0.6 cm, males at 96.5 ± 1.0 cm, and females at 85.4 ± 0.4 cm, highlighting a difference in adult height. In terms of adult size, Macherla goats exhibited greater measurements for height at the withers compared to other South Indian goat breeds, including Bidri (Inamdar *et al.* 2021; Tantia *et al.* 2018), Salem Black (Thiruvankadan and Karunanithi 2006), Kodi Adu (Jain *et al.* 2000; Thiruvankadan *et al.* 2020), and Nandidurga (Tantia *et al.* 2018).

Body length: In analyzing the body length across various age groups and regions, significant variations were observed at 0-1 month, 7-12 months, and >36 months. Overall, the average body length at >36 months was 83.8 ± 0.6 cm, respectively. Notably, male goats demonstrated greater lengths compared to female goats at >36 months (89.3 ± 1.1 cm and 78.3 ± 0.5 cm). Regions further revealed disparities; Gurazala showed a length of 82.9 ± 0.7 cm at >36 months, while Narsaraopeta recorded 85.6 ± 0.7 cm at the same intervals. In terms of adult size, Macherla goats exhibited greater measurements for body length compared to other South Indian goat breeds, including Bidri (Inamdar *et al.* 2021; Tantia *et al.* 2018), Salem Black (Thiruvankadan and Karunanithi 2006), Kodi Adu (Jain *et al.* 2000; Thiruvankadan *et al.* 2020), and Nandidurga (Tantia *et al.* 2018).

Chest girth: The males demonstrated a greater overall least-squares mean for chest girth at >36 months (90.1 ± 1.0 cm) compared to females (81.9 ± 0.5 cm). When comparing regions, Gurazala reported a chest girth of 86.0 ± 0.7 cm at >36 months, which was similar to Narsaraopeta (87.2 ± 0.7 cm), while Sattenapalli and Guntur exhibited lower measurements of 85.8 ± 0.8 cm and 85.0 ± 1.5 cm, respectively. In terms of adult size, Macherla goats exhibited greater measurements for chest girth compared to other South Indian goat breeds, including Bidri (Inamdar *et al.* 2021, Tantia *et al.* 2018), Salem Black (Thiruvankadan and Karunanithi 2006), Kodi Adu (Jain *et al.* 2000; Thiruvankadan *et al.* 2020), and Nandidurga (Tantia *et al.* 2018).

Head profile: The overall least-squares means for ear length across age intervals (13-24 months and > 36 months) were 14.3 ± 0.3 cm and 15.8 ± 0.2 cm, respectively. At >36 months of age, males exhibited a longer ear length of 16.3 ± 0.4 cm compared to females, whose mean was 15.4 ± 0.2

Table 1. Least-squares mean ($\pm$ SE) of physical traits of Macherla goats

Classes	0-1 month	4-6 months	7-12 months	13-24 months	>36 months
Height at withers					
Over all	43.4 $\pm$ 0.8 (33)	67.6 $\pm$ 1.0 (35)	72.4 $\pm$ 1.1 (109)	85.4 $\pm$ 0.9 (116)	91.0 $\pm$ 0.6(199)
Male	41.8 $\pm$ 1.3 (11)	68.5 $\pm$ 1.8 (10)	71.7 $\pm$ 1.4 (21)	88.3 $\pm$ 1.6** (10)	96.5 $\pm$ 1.0** (18)
Female	45.1 $\pm$ 1.0 (22)	66.7 $\pm$ 1.1 (25)	73.1 $\pm$ 1.1 (88)	82.4 $\pm$ 0.6 (106)	85.4 $\pm$ 0.4 (181)
Body length					
Overall	38.7 $\pm$ 0.9 (33)	60.0 $\pm$ 0.8 (35)	66.2 $\pm$ 1.1(109)	74.4 $\pm$ 1.0 (116)	83.8 $\pm$ 0.6(199)
Male	36.8 $\pm$ 1.6(11)	59.5 $\pm$ 1.5 (10)	66.9 $\pm$ 1.4 (21)	74.1 $\pm$ 1.7 (10)	89.3 $\pm$ 1.1** (18)
Female	40.5 $\pm$ 1.1 (22)	60.5 $\pm$ 0.9 (25)	65.5 $\pm$ 1.1 (88)	74.8 $\pm$ 0.6 (106)	78.3 $\pm$ 0.5 (181)
Chest girth					
Over all	36.7 $\pm$ 0.9 (33)	60.9 $\pm$ 1.0(35)	67.2 $\pm$ 0.9 (109)	80.3 $\pm$ 0.9(116)	86.0 $\pm$ 0.6 (199)
Male	34.0 $\pm$ 1.5(11)	61.5 $\pm$ 1.7 (10)	67.5 $\pm$ 1.2 (21)	83.4 $\pm$ 1.7** (10)	90.1 $\pm$ 1.0** (18)
Female	39.4 $\pm$ 1.1* (22)	60.3 $\pm$ 1.1(25)	67.0 $\pm$ 1.0 (88)	77.2 $\pm$ 0.6 (106)	81.9 $\pm$ 0.5 (181)
Paunch girth					
Over all	36.4 $\pm$ 2.4 (33)	57.9 $\pm$ 1.1 (35)	63.7 $\pm$ 1.0 (109)	75.7 $\pm$ 1.0 (116)	81.2 $\pm$ 0.6 (199)
Male	33.9 $\pm$ 4.2 (11)	58.2 $\pm$ 2.0 (10)	63.6 $\pm$ 1.3 (21)	77.6 $\pm$ 1.7* (10)	85.1 $\pm$ 1.1** (18)
Female	38.8 $\pm$ 3.0 (22)	57.6 $\pm$ 1.2 (25)	63.8 $\pm$ 1.0 (88)	73.8 $\pm$ 0.6 (106)	77.4 $\pm$ 0.5 (181)
Ear length					
Over all	11.0 $\pm$ 0.4(28)	13.5 $\pm$ 0.4(31)	14.0 $\pm$ 0.3 (88)	14.3 $\pm$ 0.3 (70)	15.8 $\pm$ 0.2(111)
Male	9.8 $\pm$ 0.6 (11)	13.6 $\pm$ 0.6 (8)	14.1 $\pm$ 0.4 (21)	13.5 $\pm$ 0.5(10)	16.3 $\pm$ 0.4* (18)
Female	10.6 $\pm$ 0.5 (17)	13.5 $\pm$ 0.4 (23)	14.0 $\pm$ 0.3(67)	15.0 $\pm$ 0.2** (60)	15.4 $\pm$ 0.2 (93)
Face length					
Over all	12.2 $\pm$ 0.6 (33)	17.1 $\pm$ 0.4 (35)	18.4 $\pm$ 0.4(109)	21.4 $\pm$ 0.3 (116)	22.7 $\pm$ 0.2 (199)
Male	11.5 $\pm$ 1.0(11)	17.0 $\pm$ 0.7 (10)	19 $\pm$ 0.5* (21)	22.7 $\pm$ 0.6 ** (10)	23.7 $\pm$ 0.3** (18)
Female	12.8 $\pm$ 0.7(22)	17.3 $\pm$ 0.4 (25)	17.9 $\pm$ 0.4(88)	20.2 $\pm$ 0.2 (106)	21.7 $\pm$ 0.1 (181)
Face width					
Over all	9.4 $\pm$ 0.5 (33)	14.0 $\pm$ 0.3(35)	14.3 $\pm$ 0.3 (109)	16.6 $\pm$ 0.3 (116)	17.6 $\pm$ 0.2(199)
Male	8.8 $\pm$ 0.9 (11)	13.8 $\pm$ 0.6(10)	14.3 $\pm$ 0.4 (21)	17.4 $\pm$ 0.5** (10)	18.7 $\pm$ 0.3 ** (18)
Female	10.0 $\pm$ 0.6 (22)	14.3 $\pm$ 0.4(25)	14.3 $\pm$ 0.3 (88)	15.9 $\pm$ 0.2 (106)	16.6 $\pm$ 0.1(181)
Horn length					
Over all	-	-	11.9 $\pm$ 0.6(24)	18.2 $\pm$ 0.7 (104)	21.0 $\pm$ 0.5 (196)
Male	-	-	11.6 $\pm$ 0.9(4)	21.0 $\pm$ 1.2** (10)	24.6 $\pm$ 0.8** (18)
Female	-	-	12.2 $\pm$ 0.7 (20)	15 .5 $\pm$ 0.5(94)	17.3 $\pm$ 0.4 (178)
Tail length					
Over all	11.3 $\pm$ 0.3(33)	14.7 $\pm$ 0.2 (35)	15.5 $\pm$ 0.3 (109)	15.1 $\pm$ 0.3 (116)	16.6 $\pm$ 0.2 (199)
Male	11.2 $\pm$ 0.6(11)	15.3 $\pm$ 0.4* (10)	15.5 $\pm$ 0.4 (21)	14.8 $\pm$ 0.5 (10)	17.1 $\pm$ 0.4* (18)
Female	11.3 $\pm$ 0.4(22)	14.1 $\pm$ 0.3(25)	15.5 $\pm$ 0.3 (88)	15.4 $\pm$ 0.2 (106)	16.1 $\pm$ 0.2 (181)
Bodyweight					
Overall	5.2 $\pm$ 0.1(33)	16.2 $\pm$ 0.5 (35)	30.3 $\pm$ 0.5 (109)	39.8 $\pm$ 0.4(116)	48.0 $\pm$ 0.4 (199)
Male	5.3 $\pm$ 0.2(11)	16.9 $\pm$ 0.9 (10)	32.7 $\pm$ 0.7** (21)	44.8 $\pm$ 0.8** (10)	54.0 $\pm$ 0.7** (18)
Female	5.1 $\pm$ 0.2(22)	15.5 $\pm$ 0.6 (25)	27.9 $\pm$ 0.5 (88)	34.9 $\pm$ 0.3 (106)	42.0 $\pm$ 0.3 (181)

*Significant (P<0.05) **Highly Significant (P<0.01); Figures in parenthesis are number of observation

cm. Analyzing by regions, Gurazala recorded an average ear length of 15.0 $\pm$ 0.4 cm at 13-24 months. For face length and width at >36 month age, the overall means were recorded as 22.7 $\pm$ 0.2 cm and 17.6 $\pm$ 0.2 cm. The average horn length for the >36 month group was 21.0 $\pm$ 0.5 cm,

with buck demonstrating longer horns than doe.

Body weight: The overall least-squares means for > 36 month age group males reached a weight of 54.0 $\pm$ 0.7, while females recorded 42.0 $\pm$ 0.3. Among the revenue divisions, Gurazala achieved a weight of 48.2 $\pm$ 0.5;

while Sattenapalli reported 45.5 ± 0.6 and Narsaraopeta recorded 47.0 ± 0.5 . The pooled adult body weights of Macherla goats, irrespective of sex, were recorded at 54.0 ± 0.7 kg for males and 42.0 ± 0.3 kg for females. These figures exceeded those reported for Nandidurga (Tantia *et al.* 2018), Bidri (Tantia *et al.* 2018; Inamdar *et al.* 2021), Salem Black (Thiruvankadan and Karunanithi 2006), Kodi Adu (Jain *et al.* 2000; Thiruvankadan *et al.* 2020), and Mahabubnagar (Kumar *et al.* 2018).

Housing: The housing system employed by farmers in Macherla was characterized as an open-closed model. Most goat farmers opted to keep their animals in open areas, providing shelter primarily during night time. Among those who did offer housing, the majority utilized open sheds or semi-open structures. Goats were typically housed in open fields, surrounded by nylon nets approximately five feet high, which were supported by bamboo or subabul stumps distributed throughout the area. Macherla goats were primarily reared under an extensive management system, with housing provided mainly at night in an open setting, reflecting management practices similar to Kodi Adu goats (Jain *et al.* 2000) and Salem Black goats (Thiruvankadan and Karunanithi 2006).

Feeding: Flocks were primarily maintained within an extensive production system, where animals relied exclusively on grazing for 7 to 10 hours daily across common grazing lands, harvested fields, uncultivable areas, and along roadways and windmill sites, with no supplementary feeding provided. The daily distance traveled for grazing ranged from 3 to 10 kilometers, typically averaged round 5 to 6 kilometers. Grazing occurred daily from approximately 7:00 a.m. to 6:00 p.m., with slight variations in timing.

Body measurements and growth patterns are essential for breed characterization. Specifically, body length and height at the withers serve as indicators of skeletal development, while chest girth reflects the growth of muscle, bone, and fat (Pomeroy 1955). In the Southern Peninsular region, most goat breeds are classified as meat types, with the exception of the Malabari and Sangamneri breeds, which are recognized as dual-purpose (Ramachandran and Sejian, 2022). An examination of observations from other South Indian goat breeds located near the native range of the Macherla genetic group indicates that Macherla goats are notably larger and taller. The current findings on biometric traits, alongside body weight, suggested that the Macherla goat is a promising meat-type breed with a distinct genetic build.

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REFERENCES

- Ekambaram B, Ramesh B G, Prakash M G, Sudhaker K and Reddy VR. 2010. A Study on the performance of Mahabubnagar goats. *Indian Journal of Animal Research* **44**(1): 48–51.
- FAO. 2012. Phenotypic characterization of animal genetic resources. *FAO Animal Production and Health Guidelines* No. 11. Rome.
- Gizaw S, Van Arendonk J A, Komen H, Windig J J and Hanotte O. 2007. Population structure, genetic variation and morphological diversity in indigenous sheep of Ethiopia. *Animal Genetics* **38**: 621–628.
- ICAR-NBAGR. 2016. Guidelines for management of animal genetic resources of India. National Bureau of Animal Genetic Resources (ICAR), Karnal, Haryana, India.
- Inamdar B, Nagaraja R, Kumar N G, Yathish H M, Kumar N S and Sudha K V 2021. Husbandry practices and phenotypic characterization of Bidri goats in Karnataka. *Asian Journal of Dairy and Food Research* **40**(4): 365–370.
- Jain A, Sahana G, Kandasamy N and Nivsarkar A E. 2000. Kodi Adu-A new goat breed of Tamil Nadu. *The Indian Journal of Animal Sciences* **70**(6). 636–643.
- Kumar D A P, Kunnath S K, Reddy, K A K and Sreenivas D. 2018. Characterization of local Mahabubnagar goat under field conditions. *International Journal of Livestock Research* **8**(6): 322–327.
- Mohammadi S and Prasanna B. 2003. Analysis of genetic diversity in crop plants—salient statistical tools and considerations. *Crop Science* **43**:1235–1248.
- Pomeroy R W. 1955. Live-weight growth. In: *Progress in the physiology of Farm Animals*. Hammond, J. (Ed.) Butterworths Scientific Publications, London, pp.395–429.
- Ramachandran N and Sejian V. 2022. Climate resilience of goat breeds in India: A review. *Small Ruminant Research* **208**: 106630.
- Rege, J E O.1992. Background to ILCA's AGR characterisation project, project objectives and agenda for the research planning workshop. In Research Planning Workshop on African Animal Genetic Resources: their Characterisation, Conservation and Utilisation, Addis Ababa (Ethiopia). ILCA.
- Tantia MS, Vij PK, Yathish HM, Kulkarni VS, Shettar VB, Gopala G T and Sharma H and Sharma R. 2018. Characterization of Nandidurga and Bidri goat populations of Karnataka. *Indian Journal of Animal Sciences* **88**(9): 1058-1063.
- Thiruvankadan A K and Karunanithi K 2006. Characterisation of Salem Black goats in their home tract. *Animal Genetic Resources/Resources génétiques animales/Recursos genéticos animales* **38**: 67–75.
- Thiruvankadan 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**: 31–42.