

ATTAPPADY

A Mutton Breed of Kerala



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1. Introduction

Attappady black is one of the two native goat breeds of Kerala, which is found exclusively in the Attappady region of Palakkad district. This breed of goat has been developed and reared by the tribal people for meat purpose since long time. Attappady black goats, well adapted to the agro ecological conditions of the Attappady region are maintained mainly on grazing. These goats have better immunity than the goats of other breeds. In the absence of clear cut breeding policies for small ruminants this breed is facing dilution of its genetic uniqueness due to indiscriminate breeding either by non descriptive or other breeds. Consequently, there is a reduction in number of pure Attappady black goats. The estimated population of Attappady black goats is less than 10,000 (ICAR- NBAGR Network Project report- 2003). In view of decreasing population size and dilution of genetic make up this breed needs immediate attention for its conservation.

2. Habitat and body bio-metrics of the breed

2.1 Native tract

The Attappady black goats are mainly concentrated in the Attappady block, which lies in the north-eastern side of the Palakkad district (Fig. 1). The place is situated between $10^{\circ}55'0''$ to $11^{\circ}14'9''$ northern latitude and $76^{\circ}27'11''$ to $76^{\circ}48'8''$ eastern longitude. This is one of the high range areas of Kerala and lies between two hills of western ghats viz., Nilgiri hills in the North and the

Muthikulam hills in the South. The height of the most of the areas of this region ranges from 500 to 575 meters above m.s. l.



Fig1. The Breeding tract of Attappady goat in Kerala

The total geographical area of Attappady block is 874.23 sq. kms. and is divided into Agali, Pudur and Sholayur panchayats. The Irulas, Mudukas and Kurumbas tribes of the Attappady hills are the stake holders involved in rearing and developing of this goat breed (ICAR- NBAGR Network Project report-2003) and earn their livelihood through Attappady goat farming.

2.2 Climatic conditions of the region

The Attappady block in the Kerala state is delineated as one of the high range agro ecological zones, where rainy seasons are southwest monsoon from June to September and northeast monsoon from October to November. The average annual rainfall of the area is 3848.64 mm. The average humidity is maximum (92.46%) in June and minimum (83.77%) in December. The main soil type of the area is red loam with pH ranging from 5 to 5.5. Banana, Coconut, Groundnut and Cotton are the main crops of the region, however, Spices (Pepper, Ginger, Cardamom, Turmeric), Cashew, Rubber, Sugarcane, Tea and Coffee is also grown in the region. A view of topography of breeding tract of Attappady goats is shown in Figure 2.



Fig. 2 Topography of breeding tract of Attappady goat

2.3 Body conformation traits

Attappady black goats are medium sized, lean, slender bodied and leggy animals. They are maintained on extensive system of feeding mainly for meat and manure. The animals are black in colour and the extremities including face, ears and legs are also black. White spots on forehead are noticed in some animals. The colour of skin is light black and sometime gray (Fig. 3). Horns in adult goats are black in colour and are curved with backward oriented tips. The average size of horns in males and females were observed as 9.2 and 7.2 cms. respectively. Ears are black coloured, long, pendulous and cover the lateral side of the face (Fig 4). The average ear length in male and female were measured 13.4 and 13.6 cms. respectively. The hairs are glossy and straight. The tail is bunchy type and curved upward and backward (Fig 5). Generally, these goats are poor milk producers and does have bowl shaped udders with funnel shape and pointed teats (Fig 6) .



Fig3. Different colours of skin in Attappady goats



Fig. 4. Pendulous ear of Attappady goat



Fig 5. Bunchy type tail in adult male



Fig 6. Adult female having bowl shaped udders with funnel shape and pointed teats

The average birth weight of Attappady kids is 1.73 kg, which increases up to 34.47 kg by the age of above 18 months in males, whereas in females it reaches up to 31.31 kgs. The male animals were found to be heavier than the females of same age group (Table 1).

Table 1. Body weight (kg) of Attappady black goats

Sr. No.	Age Group	Male	Female
1.	At Birth	1.73 ± 0.04	1.60 ± 0.04
2.	0-3 months	4.80 ± 0.25	5.28 ± 0.24
3.	4-6 months	10.14 ± 0.28	9.78 ± 0.26
4.	7-12 months	15.68 ± 0.30	14.61 ± 0.22
5.	Above 12 months	26.17 ± 0.71	23.05 ± 0.25
6.	Above 18 months	34.47 ± 1.08	31.31 ± 0.35

Source; ICAR- NBAGR Network Project report, 2003

The measures of various body traits (Body Length, Height at withers, Height at rump, Chest Girth, Paunch Girth, Ear length, Horn length, Eye to eye length, Face length, Face width, Tail length) of Attappady black goats are given in Table 2. It is obvious from the measurements that female kids have better body morphometrics than the male kids during the first three months of age. However with the increase in age the males show faster growth and attain better body parameters than the females of the same age groups. The difference is more prominent in case of body length and heights of the two sexes (Table 2).

Table 2. Average body measurements (cm) in Attappady Black Goat.

Trait	Age groups in months							
	0-3		4-6		7-12		Adult	
	Male	Female	Male	Female	Male	Female	Male	Female
Body Length	37.2±0.66	37.8±0.59	46.4±0.43	46.5±0.40	53.8±0.42	53.5±0.33	66.6±0.83	62.8±0.35
Height at withers	40.8±0.72	42.8±0.69	51.1±0.49	50.6±0.40	58.3±0.40	57.7±0.31	79.5±0.77	66.8±0.35
Height at rump	43.8±0.79	45.0±0.76	54.5±0.45	54.6±0.44	62.5±0.40	61.5±0.32	75.7±0.76	71.0±0.32
Chest Girth	40.1±0.59	40.5±0.59	50.0±0.40	49.5±0.44	58.2±0.38	57.8±0.33	71.0±1.30	68.9±0.35
Paunch Girth	42.7±0.71	42.6±0.71	54.1±0.47	53.9±0.54	63.5±0.39	62.8±0.44	74.7±1.26	75.0±0.33
Ear length	10.1±0.18	10.0±0.18	11.8±0.12	11.7±0.14	12.3±0.19	12.6±0.11	13.4±0.12	13.6±0.06
Horn length	0.8±0.66	0.6±0.59	1.9±0.11	1.5±0.09	4.3±0.19	3.7±0.15	9.2±0.42	7.2±0.18
Eye to eye length	6.6± 0.72	6.7±0.69	7.7±0.08	7.6±0.07	8.4±0.08	8.3±0.06	10.0±0.13	9.4±0.05
Face length	8.6± 0.15	8.6±0.13	10.7±0.11	10.7±0.09	12.7±0.13	12.1±0.09	14.0±0.59	14.0±0.22
Face width	14.5±0.15	14.5±0.13	16.8±0.18	16.5±0.12	18.7±0.15	17.9±0.14	20.8±0.23	19.4±0.09
Tail length	9.2±0.21	9.3±0.28	11.2±0.12	11.0±0.12	12.5±0.12	11.9±0.09	13.8±0.14	12.6±0.07

Source; Stephen et al., 2005

3. Management practices

3.1 Feeding

All the flocks are maintained entirely on extensive grazing/ browsing system (Fig. 7, 8). Goats are taken for grazing in the morning and brought back in the evening. Community grazing is common practice among goat farmers. The pregnant animals are sometimes fed with concentrate mixture. Kids below the age of three months are maintained mainly on suckling. After three months they are sent for grazing alongwith other goats. The goats drink water from the river both in



Fig 7. Goats grazing under tree



Fig 8. Goats grazing in forest area under tree

morning and evening hours during grazing. At home also water is given ad lib to these goats.

Country grass and local tree leaves are the main source of greens fed to the goats. Locally named tree varieties like Lipee, Kattu kadala, Arasu, Chinnai, Thadachi, Kodamba kodi, Athimaram, Seppulinchai are used as sources of greens for the goats. Banana leaves, straws of Jowar, Maize and dried vegetative parts of cow pea and groundnut are also used as fodder.

3.2 Flock size

The flock size ranges from 5 to 80 and includes males and females of all age groups except the kids of less than three months age. The larger flocks include one or two breeding bucks. The Attappady black goat flocks (Fig 8) are stationery and do not cover long distances. They are taken out for grazing in the morning hours and allowed grazing till evening. The kids below three months of age are kept at home.



Fig 9. A flock of Attappady goats

3.2 Housing

The goats are provided either close or open type of housing. Most of the goat houses are kutchra type and are made on raised platform (Fig. 10 a, b, c, d,

e). The floor and the sidewalls are constructed using bamboo sticks or other locally available wooden materials. Roofs are made of coconut or other tree leaves. This type of arrangement helps in proper cleaning of the goat houses. The houses are not fitted with proper electric and water supplies. The goats are housed only in the night. The sheds are cleaned daily in the morning after the goats are sent for grazing.



Fig 10a



Fig 10b



Fig 10c



Fig 10d



Fig 10e

Fig10 a,b,c,d,e Different kinds of houses for Attappady goats

3.3 Health

Attappady black goats are generally considered to be resistant to various diseases in comparison to other types. The kids are generally affected by the respiratory tract infection and worm infestation during rainy season. This sometimes results in kids mortality. The goat keepers treat the diseased animals using herbal or sometime allopathic medicines.

4. Performance

4.1 Production performance

Milk Yield: The Attappady black goats are meat purpose animals and milking of the does is generally not in practice (Fig 11). The kids up to the age of three months are maintained mainly on the dam's milk. The average daily milk yield of Attappady does is 170.96 ± 18.36 ml and the average lactation yield is recorded as 17.33 ± 2.82 ltrs in an average lactation length of 101.09 ± 2.15 days. The average milk fat percentage is 4.11 ± 0.06 . The milk was found to be moderately rich in fat contents.



Fig 11. Attappady milching doe

Carcass characteristics: The dressing percentage is maximum at 6 months of age (43% for males and 42.96% for females) followed by animals at 12 months of age (42.83% for males and 41.43% for females).

4.2 Reproduction performance

Breeding: Natural service is the only method of breeding, which occurs mainly during the grazing time. Although there is no season of breeding, but incidence of kidding is more during the months of September to March with a maximum in November. Farmers having large flocks have their own breeding bucks, whereas the owners of small flocks share the bucks from large flocks for mating their goats. The bucks not used for breeding purpose are castrated so that they gain a better growth rate and the body weight, which on sale fetch better prices to the farmers. The castration is done by the experienced people using country method. The locally available wooden rods and stones are used for crushing the spermatic chord. The castrated males are also kept for sacrificing them at the temples during festivals.



Fig12. Adult Attappady breeding buck

The goats generally gives singlets. Twinning is rare. The average litter size over three panchayats in breeding tract is 1.28, which is low in first kidding and increases gradually to maximum up to forth kidding. The age at first ejaculation in Attappady bucks is 257.27 ± 10.95 days. They are used for breeding at the age of 267.3 ± 10.64 days and the average frequency of service is 3.92 ± 0.20 . The estimated values for various reproduction traits is given in Table 3.

Table 3. Reproduction traits in Attappady black goats (Females)

Sr. No.	Traits	Values
1.	Age at first estrus (days)	234.10 ± 2.83
2.	Age at first mating (days)	259.80 ± 2.57
3.	Age at first kidding (days)	413.27 ± 2.62
4.	Gestation length (days)	153.47 ± 0.45
5.	Service interval (days)	77.15 ± 1.92
6.	Inter kidding interval (days)	247.33 ± 2.47
7.	Length of estrus cycle (days)	20.48 ± 0.23
8.	Duration of estrus (hours)	39.77 ± 0.69

5. Genetic studies

5.1 Molecular genetic variations

Methodology

Blood samples of 48 unrelated animals of Attappady goat breed were collected at random from different villages of three districts in the breeding tract. The genomic DNA was utilized to generate genotypic data using a battery of 25 microsatellite markers (Table 4) based on the guidelines of ISAG & FAO's DADIS programme. Each forward primer was tagged on 5' end with one dye out of four dyes (FAM, PET, VIC, NED) as supplied by Applied Biosystems, U.K. The microsatellite genotyping was carried out using AVANT 3100 automated DNA sequencer (Applied Biosystems) with LIZ 500 as internal lane standard. The data was generated and analyzed using Gene Mapper Software (Version 3.0, Applied Biosystems). For 25 microsatellites loci analyzed, observed and expected heterozygosity estimates were calculated as per Levene (1949) and Nei (1973) and as implemented in POPGENE software (Yeh et al., 1999). The

observed and effective number of alleles (Kimura and Crow, 1964) were also calculated using POPGENE software.

The deviation from Hardy-Weinberg equilibrium were derived using the F statistics of F-STAT programe. Tests for pair wise linkage (genotypic) disequilibrium among the microsatellite loci were also done using FSTAT version 2.9.3, an updated version of 1.2 (Goudet, 1995) for 25 microsatellite loci whose genotypes were determined directly. Polymorphic information content was calculated as per Botstein (1980). Finally the bottleneck hypothesis was investigated using BOTTLENECK 1.2.01 (Cornuet and Luikart, 1996). The BOTTLENECK tests for the departure from mutation drift equilibrium based on heterozygosity excess or deficiency and requires only measurement of alleles frequencies from 5-20 polymorphic loci in a sample of approximately 20-30 individuals. The bottleneck compares heterozygosity expected (H_E) at Hardy-Weinberg equilibrium to the heterozygosity expected (H_{eq}) at mutation drift equilibrium in same sample, that has the same size and the same number of alleles. The strict one stepwise mutation model (Ohta and Kimura, 1973), the infinite allele model (Kimura and Crow, 1964) were used to calculate H_{eq} .

Genotypic information

Various measures of genetic variation in Attappady goat population are presented in Table 5. The observed number of alleles across studied loci ranged from 4 (ILSTS 005) to 20 (ILSTS058) with an overall mean of 11.08 ± 4.17 . The observed number of alleles was more than effective number of alleles, which ranged from 2.39 (ILSTS 008) to 11.35 (OMHC1). The average observed heterozygosity (0.60) was lower than expected heterozygosity (0.77). The average expected gene diversity within the population ranged

from 0.58 (ILSTS008) to 0.91 (OMHC1) with an over all mean of 0.77 ± 0.09 . The PIC values varied from 0.53 (ILSTS008) to 0.85 (ILSTS002) with an over all mean of 0.736 and average value of Shanon's information index was 1.85 ± 0.45 (Aggarwal et al., 2006).

17 of 25 loci studied had larger F_{is} than observed ($p \leq 0.05$), thus showing deviations from Hardy-Weinberg equilibrium. All these loci showed heterozygote deficiency in the Attapady goat population. Within population inbreeding estimate (F_{is}) for investigated loci was 0.223 (Table 2). Such heterozygote deficiency found in Attapady breed of goat may be due to one or more of the following reasons: segregation of non-amplifying (null) alleles, wahlund effects, scoring biases or inbreeding, however distinguishing among these generally is difficult. The moderate level of inbreeding ($F_{is} = 0.223$) observed in present study suggests unplanned and indiscriminate breeding. This moderate level of inbreeding may be due to the fact that few bucks are used for the whole and nearby villages in the breeding region. Significant linkage disequilibrium detected at 18 out of 300 loci pairs revealed non random association of alleles across these studied loci. The significant linkage disequilibrium was in accordance with measures of inbreeding (F_{is}).

The different tests of bottleneck hypothesis under TPM and SMM models indicated significant deficiency of heterozygosity, possibly caused by introduction of unique/rare alleles by immigrants.

The breed seems to be receiving new genetic materials through introduction of immigrants (Fig 13). Appropriate breeding strategies should, therefore, be designed under field conditions for its conservation and improvement of its unique attributes like adaptability and fitness under harsh climatic conditions.

Table 4. Microsatellite markers, their sequences, type of repeat, size range, location and accession numbers.

S.N.	Locus	primer sequence	Type of repeat	Size Range	Chr. No.*	Gene Bank Acc.No.**
1.	ILST008	gaatcatggattttctgggg tagcagtgagtgaggtggc	(CA) ₁₂	167-195	14	L23483
2.	ILSTS059	gctgaacaatgtgatgttcagg gggacaactgtcttagatgctgc	(CA) ₄ (GT) ₂	105-135	13	L37266
3.	ETH225	gatcacctggcactatttct acatgacagccagctgctact	(CA) ₁₈	146-160	14	Z14043
4.	ILST044	agtcacccaaaagtaactgg acatgtgtattccaagtgc	(GT) ₂₀	145-177	Ann	L37259
5.	ILSTS002	tctatacacatgtgctgtgc cttaggggtgaagtgacacg	(CA) ₁₇	113-135	Ann	L23479
6.	OarFCB304	ccctaggagctttcaataaagaatcgg cgctgctgcaactgggtcaggg	(CT) ₁₁ (CA) ₁₅	119-169	Ann	L01535
7.	OarFCB48	gagttagtacaaggatgacaagaggcac gactctagaggatcgcaagaaccag	(GT) ₁₀	149-181	17	M82875
8.	OarHH64	cgttccctcactatggaaagtatatatgc cactctattgtaagaattgaatgagagc	-	120-138	4	212 ^a
9.	OarJMP29	gtatacacgtggacaccctttgtac gaagtggcaagatcagaggggaag	(CA) ₂₁	120-140	Ann	U30893
10.	ILSTS005	ggaaaccaatgaaatctatagcc tgttctgtgagttgtaagc	(nn) ₃₉	174-190	10	L23481
11.	ILSTS019	aagggacctcatgtagaagc actttggaccctgtagtgc	(TG) ₁₀	142-162	Ann	L23492
12.	OMHC1	atctggtgggactacagtccatg gcaatgctttctaaattctgaggaa	-	179-209	Ann	228 ^b
13.	ILSTS087	agcagacatgatgactcagc ctgcctctttctgagagc	(CA) ₁₄	142-164	Ann	L37279
14.	ILSTS30	ctgcagttctcatalgtgg cttagacaacaggggtttgg	(CA) ₁₃	159-179	2	L37212
15.	ILSTS34	aagggtctaagtccactggc gacctggttagcagagagc	(GT) ₂₉	153-185	5	L37254
16.	ILSTS033	tattagatggctcagtgcc atgcagacagtttagaggg	(CA) ₁₂	151-187	12	L37213
17.	ILSTS049	caattttctgtctctcccc gctgaatctgtcaaacagg	(CA) ₂₆	160-184	11	L37261
18.	ILSTS065	gctgcaaaaggtgaaacacc aaactattacaggaggctccc	(CA) ₂₂	105-135	24	L37269
19.	ILSTSO58	gccttactaccattccagc catcctgactttggctgtgg	(GT) ₁₅	136-188	17	L37225
20.	ILSTSO29	tgttttgatggaacacagcc tggatttagaccagggttgg	(CA) ₁₉	148-191	3	L37252
21.	RM088	gatcctctctgggaaaaagagac cctgttgaagtgaacctcagaa	(CA) ₁₄	109-147	4	U10392
22.	ILSTS022	agtctgaaggcctgagaacc cttacagtcttgggttgc	(GT) ₂₁	186-202	Ann	L37208
23.	OarAE129	aatccagtgtgaaagactaatccag gtagatcaagatatagaatattttcaacacc	(CA) ₁₄	130-175	7	L11051
24.	ILSTS082	tttgtctcatagtgtgg agaggattacaccaatcacc	(GT) ₁₇	100-136	2	L37236
25.	RM4	cagcaaaaatcagcaaacct ccacctgggaagccttta	(CA) ₁₃	104-127	15	U32910

*Chr.No.-Chromosome number; ** Acc. No. – Accession number; ^a- Accession number of Arkdb data base

(<http://www.thearkdb.org>).

Table 5 . Number of alleles (observed, n_a ; effective, n_e), heterozygosity (observed, H_o ; expected, H_e), polymorphic information content (PIC) and inbreeding estimate (F_{is}) for each of microsatellite loci and mean estimates of different parameters for Attappady goat

Sr. no.	Locus	No	Ne	Ho	He	PIC	Information index	F_{is}
1	ILST008	7	2.398	0.400	0.583	0.532	1.166	0.314
2	ILSTS059	11	3.935	0.777	0.745	0.709	1.660	-0.042
3	ETH225	8	2.945	0.138	0.660	0.632	1.452	0.789
4	ILSTS044	13	5.114	0.074	0.804	0.782	1.979	0.161
5	ILSTS002	14	9.301	0.760	0.892	0.855	2.388	0.147
6	OarFCB304	18	8.076	0.978	0.876	0.854	2.416	-0.117
7	OarFCB48	14	6.594	0.723	0.848	0.817	2.194	0.147
8	OarHH64F	10	6.694	0.775	0.850	0.833	2.051	0.088
9	OarJMP29	6	4.430	0.297	0.774	0.738	1.577	0.616
10	ILSTS005	4	2.663	0.340	0.624	0.549	1.064	0.454
11	ILSTS019	11	6.697	0.770	0.850	0.833	2.069	0.093
12	OMHC1	16	11.353	0.893	0.912	0.845	2.566	0.020
13	ILSTS087	13	7.736	0.782	0.870	0.854	2.221	0.101
14	ILSTS30	14	6.530	0.775	0.846	0.824	2.187	0.084
15	ILSTS34	8	2.620	0.195	0.618	0.551	1.211	0.684
16	ILSTS033	9	3.387	0.695	0.704	0.680	1.626	0.064
17	ILSTS049	10	3.639	0.558	0.725	0.685	1.631	0.230
18	ILSTS065	9	5.231	0.478	0.808	0.786	1.861	0.408
19	ILSTS058	20	10.527	0.739	0.905	0.838	2.600	0.183
20	ILSTS029	7	3.229	0.435	0.690	0.635	1.361	0.368
21	RM088	13	5.640	0.500	0.822	0.798	2.073	0.392
22	ILSTS022	5	3.329	0.575	0.699	0.644	1.320	0.178
23	OarAE129	10	4.426	0.595	0.774	0.748	1.802	0.231
24	ILSTS082	18	6.644	0.809	0.849	0.655	2.338	0.047
25	RM4	9	3.977	0.500	0.748	0.715	1.622	0.332
	Mean	11.08	5.485	0.605	0.779	0.736	1.857	0.223



Fig. 13. Introduction of new genetic materials through immigrants

6. Conclusion and recommendations

Attappady black goats have been developed and reared by the tribal communities of Attappady region since long time for meat purpose. These goats are well adapted to the agroecological conditions of the region and reared mostly on grazing. The goats have excellent immunity to most of the disease. These goats are not being managed scientifically and breed is getting diluted due to indiscriminate breeding either by non-descript goats or animals of other breeds. Hence there is need to conserve the breed employing in situ conservation methods and linking it with genetic improvement measures. This necessitates developing farm for these animals and improving its herd through Open Nucleus Breeding System. Superior males and females developed in the farm can be distributed among farmers in the field, which can also help in economic development of farmers.

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