

Phenotypic and genetic characterization of Sangamneri goat breed

N K VERMA¹, S P DIXIT², R A K AGGARWAL³, P S DANGI⁴ and B K JOSHI ⁵

National Bureau of Animal Genetic Resources, Karnal, Haryana 132 001 India

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ABSTRACT

The Sangamneri goat (Accession number: INDIA_Goat_0011_ Sangamneri _06018) is a dual-purpose breed existing in the villages of Nasik, Ahmednagar and Pune districts of Maharashtra. The animals are small- to medium-sized. The coat colour is complete white but admixtures of black and brown are also available. The average measurements for height at wither, body length, chest girth, paunch girth, face length, horn length, ear length, tail length (cm) and b. wt (kg) are as 55.16±1.02, 50.79±0.79, 55.26±0.78, 57.21±1.00, 13.74±0.27, 3.47±0.21, 14.63±0.52, 11.53±0.36, 14.47±0.13 in 3 months; 60.31±1.06, 57.63±1.13, 60.89±1.10, 66.94±0.27, 14.68±0.41, 5.00±0.42, 14.84±0.32, 14.15±0.82, 20.26±0.82 in 6 months; and 71.11±0.38, 71.00±0.38, 74.65±0.43, 78.85±0.46, 17.16±0.09, 14.45±0.10, 17.66±0.08, 15.76±0.08, 34.21±0.22 in adult animals of the age more than 15 months. Animals are kept on stall feeding. A battery of 25 selected micro-satellite markers was used to study the genetic variability in Sangamneri breed. The number of alleles observed varied from 3 (ILSTS 022) to 21 (OarFCB304) with an overall mean of 9.0. Most of the studied loci showed the polymorphic information content value greater than 0.5 except ILST008, OarJMP29, ILSTS005 and ILSTS029 locus. The PIC values varied from 0.271 (OarJMP29) to 0.878 (ILSTS 082) across loci with an average value of 0.711. The average expected gene diversity within the population ranged from 0.2769 (OarJMP 29) to 0.8880 (ILSTS 082) with an overall mean of 0.6970±0.033, whereas observed heterozygosity ranged from 0.0435 (ETH 225) to 0.8571 (ILSTS 002) with an average of 0.5399±0.0549. Sixteen out of total 25 studied loci showed significant heterozygote deficiency (positive F_{is} value). The significant positive values of the F_{is} ranged from 0.118 (OarFCB304) to 1.0 (ETH225) with an over all mean of 0.245. The genetic analysis based on the selected micro-satellites clearly pinpointed the need for suitable genetic management so as to retain the founder alleles to the extent possible in the population.

Key words: Allele number, Breed, Heterozygosity, Management, Micro-satellites, Performance, Sangamneri goat

The Sangamneri goat (Accession number: INDIA_Goat_0011_ Sangamneri _06018) is important in some pockets of Maharashtra. The animals of this breed are reared mainly for meat purpose. It has made its place in the rural economy of Nasik, Ahmednagar and Pune district of Maharashtra. The breed has derived its name from Sangamner town of Ahmednagar district of Maharashtra. The farmers of rural area of this region keep small flocks of Sangamneri goats to meet out the family requirement of milk and finally sell the live animals for meat. This breed has proved their adaptability in semi-arid region of Maharashtra and performs well under poor quality range condition. The base line survey conducted by Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) indicated a decline in the population of Sangamneri goats and advocated for its conservation and characterization for the genetic improvement. Further as a mandated activity of the bureau

for characterization of indigenous goat germplasm an attempt has been made to study the phenotypic and genetic profile of Sangamneri goats.

MATERIALS AND METHODS

To collect the information on this breed, 2 visits were made to the breeding tract of Sangamneri goats. Information on the breed morphological traits (height at wither, body length, chest girth, paunch girth, face length, horn length, ear length, tail length), Body weights, were collected on 300 animals belonging to different age groups and sex distributed over 26 villages of Ahmed Nagar, Nasik and Pune districts of Maharashtra. Information on performance traits and managerial practices was obtained through personal interaction with the goat keepers in the breeding tract.

For genetic characterization 46 blood samples were taken from randomly distributed unrelated animals. DNA was isolated using the standard phenol/chloroform protocol of Sambrook *et al.* (1989). A battery of 25 micro-satellite markers used earlier for genetic characterization of other

Present address: ^{1,3}Principal Scientist (e-mail: directornbagr@gmail.com), ² Senior Scientist, ⁴ Technical Officer, ⁵Director.

breeds (Verma *et al.* 2007a,b,c and 2009) was also used for this breed. Polymerase chain reaction (PCR) was carried out using the same standardized parameters following “touchdown” PCR protocol. After ensuring the amplification, the PCR products were run on automated DNA Sequencer of Applied Biosystems (ABI 3100 Avant).

Data analysis: average means for body length, height at withers, chest girth, paunch girth, face length, ear length horn length and tail length were estimated using spss 11.5 for windows. The genetic data were analysed using POPGENE (Yeh *et al.* 1999) to calculate the allele frequencies, number of alleles (Kimura and Crow 1964), and heterozygosities (Levene 1949 and Nei 1973). Poly information content (PIC) values were estimated (Botstein *et al.* 1980). Allelic richness was calculated with FSTAT (Goudet 1995).

RESULTS AND DISCUSSION

Breeding tract: The semi-arid region of Maharashtra comprising Nasik, Ahmednagar and Pune districts forms the habitat for this goat breed. The geographical coordinates of its native place, i.e. Sangamner are 19° 34'0½ North, 74° 13'0½ East. Although the place of origin of Sangamneri breed is Sangamner tehsil of Ahmednagar district but it has also spreaded over the adjoining places like Sinar tehsil from Nasik district, Junar from Pune district and Rahuri, Shrirampur, Ahmednagar, Parner of Ahmednagar district of Maharashtra.

Morphological characteristics: Sangamneri goats are small- to-medium sized animals. The coat is complete white. Animals with admixture of black and brown were also seen. About 40% of the goats had long hair at the thigh. 10% of animals (male and females) had beard. Only 2% animals showed wattles. Head is proportionate to the body. Face is triangular and convex type. Eye lids are pinkish white. Muzzle is black but pinkish white in pure white animals. Hoof and horns are grey. Horns are thin and small orienting upward and backward. Ears are long and drooping. The face



Fig 2. Morphological features of Sangamneri goat

characteristics of a Sangamneri goat are shown in Fig. 2. The distribution of phenotypic variability in different traits was studied by Deokar *et al.* (2007). Majority of the animals showed white coat (66%), brown skin (94%), white muzzle (81%), white eyelids (82%), convex forehead (88%), white hooves (69%), backwardly curved horns (69%) and pendulous ears (82%).

Body measurements and weights: The average measurements for the different phenotypic parameters in the animals of different age groups have been presented in Table 1. The averages for height at wither, body length, chest girth, paunch girth, face length, horn length, ear length, tail length (cm) and body weight (kg) are as 55.16±1.02, 50.79±0.79, 55.74±0.63, 57.21±1.00, 13.74±0.27, 3.47±0.21, 14.63±0.52, 11.53±0.36, 14.47±0.57 in 3 months; 60.32±0.73, 57.63±1.07, 60.89±1.13, 66.95±1.10, 14.68±0.28, 4.21±0.65, 14.84±0.42, 14.16±0.33, 20.26±0.83 in 6 months; and 69.31±0.43, 68.90±0.45, 73.13±0.65, 77.81±0.86, 17.07±0.17, 12.12±0.50, 17.29±0.19, 16.31±0.16, 33.14±0.67 in adult animals of the age more than 15 months. The birth weight of male and female kid is

Table 1. Body measurements of different age group animals of Sangamneri goats

Age groups	Sex (No)	Height at wither	Body length	Chest girth	Paunch girth	Face length	Horn length	Ear length	Tail length	Body weight
3 months	F (15)	56.00±1.01	51.47±0.76	56.33±0.71	57.33±1.15	13.93±0.32	3.47±0.26	15.00±0.59	11.60±0.43	14.60±0.69
	M (4)	52.00±2.48	48.25±2.06	53.50±0.65	55.25±1.93	13.00±0.41	3.50±0.29	13.25±0.85	11.25±0.63	14.00±0.91
	Overall (19)	55.16±1.02	50.79±0.79	55.74±0.63	57.21±1.00	13.74±0.27	3.47±0.21	14.63±0.52	11.53±0.36	14.47±0.57
6 months	F (12)	59.67±0.70	57.50±1.47	59.57±1.80	66.50±1.49	14.42±0.42	3.75±0.78	14.83±0.52	13.83±0.44	20.14±1.16
	M (7)	61.43±1.57	57.86±1.56	61.67±1.47	67.71±1.67	15.14±0.14	5.83±0.88	14.86±0.77	14.71±0.42	20.33±1.16
	Overall (19)	60.32±0.73	57.63±1.07	60.89±1.13	66.95±1.10	14.68±0.28	4.21±0.65	14.84±0.42	14.16±0.33	20.26±0.83
Adult (>15)	F (158)	68.92±0.42	68.56±0.44	73.10±0.67	77.83±0.89	17.00±0.18	11.90±0.50	17.19±0.20	15.18±0.16	32.62±0.64
	M (20)	74.60±1.92	73.40±2.07	73.50±2.74	77.60±3.38	18.00±0.75	15.10±2.67	18.60±0.48	17.10±0.64	39.10±3.70
	Overall (178)	69.31±0.43	68.90±0.45	73.13±0.65	77.81±0.86	17.07±0.17	12.12±0.50	17.29±0.19	16.31±0.16	33.14±0.67

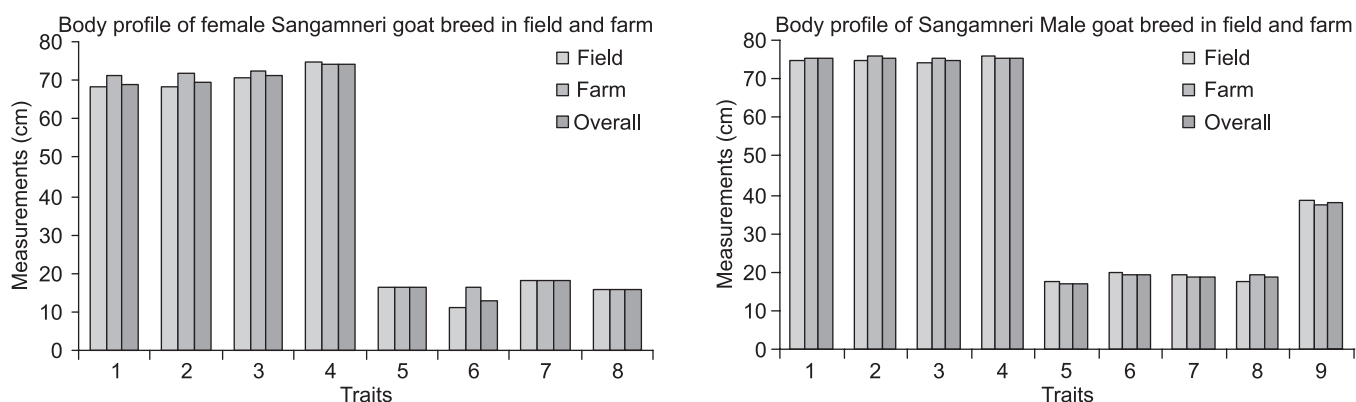


Fig 2. Comparative profile of Sangamneri goats reared under field and farm conditions.

about 1.90 kg as reported by Deokar *et al.* (2007). The male kids at an early age showed comparatively less body weight than the female kids of the same age group. However, the adult males were heavier than their female counterparts. Bhoite *et al.* (1994) and Deokar *et al.* (2007) observed higher body weights in male animals of any age group than the female. An attempt was also made to compare the biometry of the Sangamneri goats maintained under field conditions with those maintained under farm conditions (Fig. 3). The growth of animals under these different systems of management was not significantly different.

Management: Animals under field conditions are kept on semi-intensive management. Flock size varies from 2 to 25. Number of males in a flock varied from 1 to 2. The animals are kept in open houses (Fig. 3) as well as in close housings. The close houses are made up of thatched roof and *kutchra* floor without any proper arrangement of electricity and water supply. Animals are generally driven out for pasture grazing. When kept on stall feeding they are fed with brown pea (locally called as *matki*) and local grass. The kids are allowed to suckle from their mothers. Pregnant animals are fed with the concentrate and mineral mixture.

Performance: Sangamneri goats attain early maturity and

conceive first time at the age of 10 to 12 months. The overall age at puberty, oestrus cycle duration, oestrus duration, age at first conception, age at first kidding, service period, kidding interval and gestation period recorded in Sangamneri goats under field conditions are as 9.94 months, 29.14 days, 47.96 h, 10.40 months, 15.52 months, 73.55 days, 218.48 days and 148.26 days respectively (Deokar *et al.* 2007) The litter size is mostly single however, 15–20% goats showed twinning whereas triplets are rare. Although these goats are reared mainly for meat purpose but some animals show good milch potential. They have well developed bowl/round shape udder. The teats are either conical, cylindrical or pear-shaped. The data recorded on farm animals indicated the average daily milk yield of 0.860 liters, lactation yield of 77.40 liters in about 160 days of lactation (AICRP Report 2007). Some goats produced 3.0 liters of milk per day under farm as well as field conditions.

Breeding: Pure breed bucks are prepared at MPKV, Rahuri farm (Fig. 4) and are distributed to the farmers for breeding purpose. The males are selected on the basis of dam's performance. The bucks are rotated to avoid the inbreeding and the performance of progeny of these bucks is monitored.

Population: Maharashtra has more than 80 lakh of goat



Fig 3. Animals kept under open housing system



Fig 4. A Sangamneri breeding buck at MPKV, Rahuri farm

population. The goat population in Sangamneri distribution area is about 6.0 lakh (17th Livestock Census, 2003, Maharashtra state). Major part of this population is comprised of Osmanabadi goats. In absence of breed-wise census it is difficult to find the number of Sangamneri goats but depending upon the small size of flocks observed in the breeding tract, it can be assumed that population size of Sangamneri goats may be ranging between 15 000 to 20 000.

Genetic characterization

Suitability of microsatellite markers for genetic diversity
Analysis of Sangamneri breed: A battery of 25 selected micro-satellite markers used by us for other goat breeds that is Marwari (Kumar *et al.* 2005, Dixit *et al.* 2007), Mehsana (Aggarwal *et al.* 2007), Sirohi (Verma *et al.* 2007a), Jakhrana (Kumar *et al.* 2005, Verma *et al.* 2007b), Gohilwadi (Verma *et al.* 2007c), Kutchi (Dixit *et al.* 2008) and Malabari (Verma *et al.* 2009), was also used to study the genetic variability in Sangamneri breed. The estimates for allele number and heterozygosities are given in Table 2. The number of alleles observed varied from 3 (ILSTS 022) to 21 (OarFCB304) with an overall mean of 9.0. The observed number of alleles across the loci was more than the effective number of alleles (1.0 to 9.0) as per expectations. All the studied micro-satellite loci exhibited polymorphism which indicated that the genetic

markers used were suitable for genetic studies of Sangamneri goats. The Shannon information index, poly-information contents (PIC) and inbreeding estimates (F_{is}) are given in Table 3. Shannon's Information Index which measure the level of biodiversity (Lewontin 1972), was also sufficiently high in Sangamneri goat population with over all mean of 1.61. Most of the studied loci showed the polymorphic information content value greater than 0.5 except ILST008, OarJMP29, ILSTS005 and ILSTS029 locus. The PIC values varied from 0.271 (OarJMP29) to 0.878 (ILSTS 082) across loci with a mean value of 0.711 (Table 3).

All the parameters (observed number of alleles, effective number of alleles, Shannon's information index and PIC values) estimated to know the genetic variation showed that most of the micro-satellite markers used were highly informative. Suitability of these markers was further strengthened as the number of alleles at different loci were greater than recommended number of alleles /locus which is at least 4 alleles/ locus (Barker 1994).

Genetic variation within population: Mean number of alleles observed over a range of loci in different population is considered to be a reasonable indicator of genetic variation within the population (MacHugh *et al.* 1997). All the studied loci in this breed of goat showed low effective number of alleles (even lower than half) than the observed number of

Table 2. Measures of genetic variation in Sangamneri breed of goat

Locus	Sample size	Observed no. of alleles	Effective no. of alleles	Heterozygosity		Nei's expected heterozygosity
				observed	expected	
ILST008	30	8	2	0.3667	0.4938	0.4856
ILSTS059	27	13	8	0.6296	0.8847	0.8683
ETH225	23	5	3	0.0435	0.6966	0.6815
ILSTS044	30	9	3	0.4000	0.7164	0.7044
ILSTS002	28	10	5	0.8571	0.8253	0.8106
OarFCB304	47	21	6	0.7447	0.8428	0.8339
OarFCB48	16	9	5	0.8125	0.8044	0.7793
OarHH64	21	10	5	0.6190	0.7979	0.7789
OarJMP29	23	7	1	0.1304	0.2831	0.2769
ILSTS005	10	4	2	0.2000	0.5526	0.5250
ILSTS019	43	9	5	0.8372	0.8211	0.8115
OMHC1	16	13	6	0.5000	0.8448	0.8184
ILSTS087	26	7	4	0.3208	0.7640	0.7493
ILSTS30	16	8	5	0.5000	0.8266	0.8008
ILSTS34	47	11	3	0.5319	0.6648	0.6578
ILSTS033	47	15	6	0.7021	0.8545	0.8454
ILSTS049	46	8	4	0.7174	0.7432	0.7351
ILSTS065	32	6	3	0.5000	0.6944	0.6836
ILSTS058	43	12	3	1.0000	0.6969	0.6888
ILSTS029	14	6	2	0.4286	0.3862	0.3724
RM088	20	5	2	0.3500	0.3949	0.3850
ILSTS022	26	3	3	0.0000	0.6546	0.6420
OarAE129	26	11	5	0.7692	0.8190	0.8033
ILSTS082	43	15	9	0.8140	0.8985	0.8880
RM4	43	9	5	0.8140	0.8079	0.7985
Mean	30	9.0±0.8	4.0±0.4	0.5399±0.05	0.7108±0.03	0.6970±0.03

alleles. This is due to the low frequency of about half of the alleles expressed by the locus. Only the alleles having high frequency might have contributed more to the overall allelic frequency. Nevertheless, the loci revealed high level of allelic diversity among them. The mean number of alleles per locus in Sangamneri breed of goat was comparable to mean number of alleles in Gohilwadi, Jharkhand black, Black Bengal and Ganjam breeds studied by Kumar (2007). For the markers to be useful for measuring genetic variation, average heterozygosity/ gene diversity should be between 0.3 and 0.8 in the population (Takezaki and Nei1996). The average expected heterozygosity value of 0.6970 was within this range of average expected heterozygosity in Sangamneri breed of goat which supports the suitability of selected micro-satellite markers.

A more appropriate measure of genetic variation within a population is gene diversity/average expected heterozygosity (Nei 1987). The average observed heterozygosity was lesser than the expected (Table 3). The average expected gene diversity within the population ranged from 0.2769 (OarJMP 29) to 0.8880 (ILSTS 082) with an overall mean of 0.6970 ± 0.033 , whereas observed heterozygosity ranged from 0.0435 (ETH 225) to 0.8571 (ILSTS 002) with

an average of 0.5399 ± 0.0549 (Table 2). The mean gene diversity (0.6970) observed in Sangamneri was higher than the values reported in Swiss goat breeds (Saitbekova *et al.* 1999) and South-East Asian goats (Barker *et al.* 2001) but is slightly lower than those reported in Chinese goat breeds (Yang *et al.* 1999) and Indian Ganjam and Jarkhand Black goats (Kumar 2007). The Sangamneri goats had higher mean observed heterozygosity than what was observed in Marwari (Kumar *et al.* 2005), Attapaddy (Aggarwal *et al.* 2006) and many other Asian goats (Barker *et al.* 2001) but lower to Chegu breed of a goat (Behl *et al.* 2003). Genetic variation observed in this breed may be due to their large effective population size, immigration of new gene due to intermixing of different populations and low selection pressure.

Significant heterozygote deficiency (positive F_{is} value) was observed in 16 out of 25 studied loci. The significant positive values of the F_{is} ranged from 0.118 (OarFCB304) to 1.0 (ILSTS0225) with an overall mean of 0.245 (Table 3). The heterozygote deficiency observed at these loci may be due to one or more of reasons like population sub-division owing to genetic drift, null alleles, selection against heterozygotes or inbreeding. However, pin-pointing the reason is generally difficult (Christiansen 1974). Null alleles are most unlikely to be segregating at all the loci. The fairly high value of F_{is} indicated that some of the loci in this breed of goat were homozygous presumably resulting from the mating between relatives and consequent genetic drift. Significant heterozygote deficiencies have also been reported in Asian goats (Barker 2001) and Indian goat populations, viz. Marwari (Kumar *et al.* 2005, Dixit *et al.* 2007), Mehsana (Aggarwal *et al.* 2007), Sirohi breeds of goat (Verma *et al.* 2007a), Jakhara (Kumar *et al.* 2005, Verma *et al.* 2007b), Gohilwadi (Verma *et al.* 2007c) Kutchi (Dixit *et al.* 2008) and Malabari (Verma *et al.* 2009). The genetic analysis based on the selected microsatellites clearly pin-pointed the need for suitable genetic management so as to retain the founder alleles to the extent possible in the population.

In view of low population of Sangamneri goats, emphasis should be given to increase the population of these animals and maintaining the purity of the breed through open nucleus breeding scheme. Since the breed is having good milk potential, improvement programme can be taken up to increase the milk potential further. Supply of good quality bucks to the farmers in the breeding tract and the neighboring area may improve production and reproduction of this breed. To maintain the genetic variability within the breed, inbreeding in the population need to be controlled by avoiding the indiscriminate and uncontrolled matings.

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Table 3. Polymorphism and F_{is} values in Sangamneri breed of goat

Loci	Sample size	Shannon's Information index	PIC	F_{is}	P values for F_{is}
ILST008	30	1.0852	0.461	0.261	0.0340
ILSTS059	27	2.2376	0.855	0.292	0.0020
ETH225	23	1.2706	0.624	0.939	0.0020
ILSTS044	30	1.5136	0.658	0.446	0.0020
ILSTS002	28	1.8717	0.785	-0.039	0.7580
OarFCB304	47	2.3683	0.824	0.118	0.0280
OarFCB48	16	1.7732	0.752	-0.010	0.6540
OarHH64	21	1.8645	0.758	0.228	0.0180
OarJMP29	23	0.6924	0.271	0.545	0.0020
ILSTS005	10	0.9819	0.480	0.650	0.0040
ILSTS019	43	1.8680	0.787	-0.020	0.6740
OMHC1	16	2.1383	0.805	0.416	0.0020
ILSTS087	26	1.5709	0.712	0.702	0.0020
ILSTS30	16	1.7949	0.774	0.403	0.0040
ILSTS34	47	1.5697	0.635	0.202	0.0100
ILSTS033	47	2.2683	0.834	0.180	0.0040
ILSTS049	46	1.5915	0.698	0.035	0.3800
ILSTS065	32	1.3968	0.647	0.283	0.0080
ILSTS058	43	1.5315	0.638	-0.442	1.0000
ILSTS029	14	0.8540	0.360	-0.114	1.0000
RM088	20	0.8281	0.368	0.116	0.3160
ILSTS022	26	1.0634	0.570	1.000	0.0020
OarAE129	26	1.9974	0.787	0.062	0.2960
ILSTS082	43	2.3649	0.878	0.095	0.0640
RM4	43	1.7895	0.771	-0.008	0.6140
Mean	30	1.6114	0.711	0.245	0.0020

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