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Comparative Cytogenetic Study of Garole and Bonpala Breeds of Sheep

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ABSTRACT

Cytogenetic studies in domestic animals are gaining more importance because of their genetic implications to breeding programmes. The present study describes the chromosome profile and morphometric characteristics of Garole and Bonpala sheep and comparison of chromosomes between males, females and between breeds. The Karyotype revealed diploid chromosome number of 54 (2n) in both breeds and sexes. The first three pairs of autosomes were bi-armed, submetacentric and remaining 23 pairs were acrocentric. The X-chromosome was acrocentric and largest and Y-chromosome was the smallest, biarmed and metacentric. The morphometric analysis showed significant variation in mean relative length of 13th chromosome pair of Garole and Bonpala males and significant variation in the arm ratio of 2nd chromosome pair of females and variation also noticed in almost all the pairs of chromosomes but not up to the level of significance. The mean relative length of autosomes of Garole and Bonpala male ranged from 1.39±0.05 to 11.45±0.15 and 1.48±0.06 to 11.69±0.25 percentage, respectively. The mean relative length of X-chromosome of the males was 5.66±0.15 and 5.83±0.17, respectively while the Y-chromosome length was 1.20±0.02 and 1.27±0.06, respectively. The mean relative length of autosomes of the females ranged from 1.43±0.06 to 10.80±0.20 and 1.42±0.04 to 11.42±0.36, respectively. The mean relative length of X-chromosome of Garole and Bonpala female was 5.51±0.13 and 5.61±0.15, respectively. The mean arm ratio of first 2pairs of autosomes of Garole male was higher than Bonpala male while the 3rd pair was higher in Bonpala males. The mean arm ratio of first 3pairs of autosomes of Garole female was higher than Bonpala female. The present study for the first time compares the cytogenetic profile between Garole and Bonpala sheep breeds.

Key words: Garole, bonpala, sheep, chromosome, karyotype, relative length, morphometry, arm ratio

INTRODUCTION

Domestic sheep (*Ovis aries*) belongs to phylum Chordata, class Mammalia, order Artiodactyla, family Bovidae, genus *Ovis* and species *aries* (Shackleton, 1997). Sheep are the very good economic converter of wastelands, grass, stubbles of cultivated corps, tree topping, farm wastes or weeds into meat, milk and wool (Sahana *et al*., 2001). India has a livestock population of 71.6 million sheep and 140.5 million goats which play a vital role in improving the socio-economic conditions of rural masses (DAHDF., 2012). Though the number of sheep is only about half that of goats, they form the important species of livestock in India.

The Garole (Garole = stupid) sheep is a small-sized native sheep breed found in the coastal saline belt of West Bengal, Sundarbans, swampy delta region (4,226 km^2) of the Ganges river in West Bengal (21-23°N latitude and 87-89°E longitude) and Bangladesh. Garole sheep are popular meat animals in this area, although average live weight of adult ranges between 10-14 kg only (Selvakumar, 2003; Thanikaivel, 2004; Banerjee *et al*., 2010, 2011). However, the breed is best known in the region for its prolificacy with mean litter size of 2.27 (Nimbkar *et al*., 1998). Owing to their high fecundity and ability to thrive on low quality forages and agro byproducts, these animals constitute a major source of income for their owners (Fig. 1).

Bonpala (Bon = forest, Pala = rearing system) is a short stature meat type sheep breed found in the Sikkim, West Bengal, western parts of Bhutan and eastern regions of Nepal (http://www.cswri.res.in/breed_profiles.asp). The breed is popular for excellent reproductive performance with age at puberty occurring around 6 months and first lambing occurring around 11-12 months. Lambing size varies from single to triplets (Tantia and Vij, 2000). Despite its higher reproductive efficiency, the breed is facing the threat of extinction (Fig. 2).

Chromosome study has contributed significantly to understanding of the evolutionary divergence among sheep taxa and different chromosome numbers were found in individual geographic populations (Arslan and Zima, 2011). Due to breed substitution and indiscriminate crossbreeding, the genetic variability of sheep breeds in India is reducing rapidly. The major consequence is the loss of genetic diversity and degradation of many breeds (Kumar *et al*., 2009). The Garole and Bonpala are very important breeds of sheep and their population is declining very

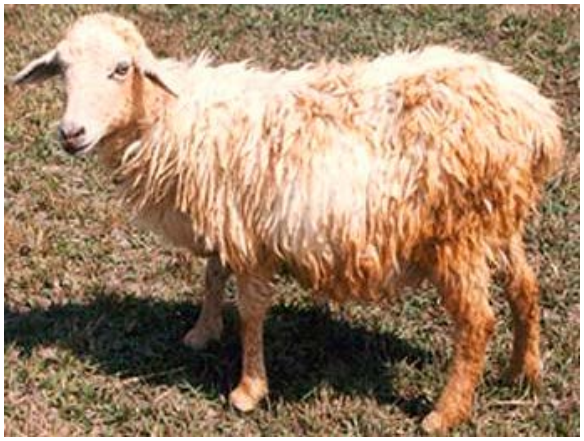

Fig. 1: Garole female sheep. Animals are small-sized, polled, white and fawn in coat colour, coarse wool and medium sized ears

Fig. 2: Bonpala male sheep. Animals are medium in size, horned, leggy, well-built, small ears and coarse wool

fast in their breeding tracts. Hence, there is an urgent need to save these valuable breeds from extinction through a well planned conservation programme (Kumar *et al*., 2006). However, before adoption of such programme, the first step is to evaluate the animals not only at phenotypic level but also at genetic level (Acharya, 2000; Singh, 2000; Dorji *et al*., 2003; Jeremiah, 2005).

Establishment of standard karyotypes for Garole and Bonpala sheep will be of great use for detecting the numerical and structural chromosome anomalies and establishing the cytotaxonomic relation among Caprini species (Dorji *et al*., 2003; Jeremiah, 2005). Although several studies were made on the phenotypic characterization of this breed, the information on the cytogenetic characterization is very scanty. Therefore, the present study was conducted to understand the chromosomal complement of Garole and Bonpala sheep and to compare the chromosomes between males, females and between breeds.

MATERIALS AND METHODS

Experimental animals: Twenty Garole sheep (10 male and 10 female) were selected for karyotypic study from the Livestock Farm, West Bengal University of Animal and Fishery Sciences (WBUAFS) located at Haringhata, Nadia and 20 Bonpala sheep (10 male and 10 female) were selected from the Ram Sahi farm of WBUAFS located at Jalpaiguri district, North Bengal.

Collection of blood: Aseptically 2 mL of blood was collected from each Garole and Bonpala sheep by external jugular vein puncture in a heparinized vials. The blood samples were transported to the laboratory on ice.

Study of somatic metaphase chromosomes: The study of somatic metaphase chromosomes in Garole and Bonpala sheep were carried out by using the whole blood lymphocyte culture technique with some modification following Eldridge (1985).

Preparation of the culture medium: The pH of the medium was adjusted to 7.2-7.4 by adding one or two drops of sodium bicarbonate solution (7.5%) till the medium turned into a light pink

Table 1: Composition of the culture medium:

Ingredients	Quantity
TC-199 (Sigma)	1.51 g
Preautoclaved triple distilled water	100 mL
Poke weed mitogen Lectin (working solution-Sigma)	2 mL (0.25 g)
Benzyl penicillin (working solution)	2 mL (20000 IU)
Streptomycin sulphate (working solution)	2 mL (20 mg)
Ovine autologous serum	30 mL
pH	7.2-7.4

colour (Table 1). The medium was sterilized by filtering through 0.22 μm Millipore filter paper. Sterile ovine autologous serum of 30 mL was added to the medium and mixed by gentle swirling. The culture medium was then distributed in screw cap culture vials of 30 mL capacity in aliquots of 4.5 mL each. The culture vials were stored in deep freeze (-20°C) until use. Generally they were used within 2-3 weeks.

Setting up of culture: The frozen culture vials were thawed to room temperature by kept in a water bath (37°C). Fresh blood (0.5 mL) was added to each culture vial containing 4.5 mL of medium. The contents were then mixed by gentle shaking and the culture was incubated at 37°C for 72 h. The cultures were gently agitated twice a day to increase the number of cells in mitosis.

Harvesting of culture: Colchicine (0.1 mL containing 0.4 μg) was added 1 h before the harvesting of cultures. At the end of 72 h, the culture vials were removed from the incubator and the contents were transferred to 15 mL centrifuge tubes and centrifuged at 1000 rpm for 10 min. The supernatant was discarded leaving 0.5 mL of the medium above the cell pellet. The cell pellet was then mixed with 7 mL of pre warmed 0.075 M hypotonic potassium chloride (KCl) solution for 12 min at 37°C. The hypotonic treatment was terminated by adding 2 mL of freshly prepared chilled methanol: Acetic acid (3:1) Cornoy's fixative. The contents were again centrifuged for 10 min at 2000 rpm, supernatant discarded and the pellet was re-suspended in 5 mL of chilled fixative and kept at 4°C for 20 min. Then the contents were centrifuged at 1000 rpm for 10 min. This procedure was repeated 3-4 times to ensure the removal of traces of cell debris and water. After final centrifugation, the cell button was re-suspended in 0.5 mL of freshly prepared chilled fixative.

Preparation and screening of slides for metaphase chromosomes: Two to three drops of cell suspension was placed on clean glass slides for chromosome preparations and the smears were heat fixed. The slides were mounted with DPX and air dried. The slides were screened for non-overlapping metaphase spreads by using Leitz microscope fitted with camera under oil immersion. A minimum of 25 metaphase spreads from each slide were examined to ascertain number, morphology and chromosomal abnormalities. Three metaphase chromosome spreads from each coded slide were selected at random for microphotography.

Preparation of karyotypes and morphometric measurements: The microphotographs were properly magnified and photographed for preparing karyotypes and assessing morphometric characteristics. Each chromosome from photo print was cutout separately and leaving sufficient space around, so that the complete outline of an entire photo print chromosome was visible. Then

the chromosomes were matched in homologous pairs and arranged according to the decreasing size and keeping the centromere upwards. The sex chromosomes were placed at the last. The length of each chromosome was measured from tip to tip directly from the magnified print by using a dial type digital caliper with an accuracy of 0.05 mm.

Measurement of relative length: The relative length of each chromosome in relation to the total genomic length was calculated, using the following formula as described by Bhatia and Shanker (1999):

$$\text{Relative length} = \frac{\text{Length of individual chromosome}}{\text{Total length of the genome including X-chromosome}} \times 100$$

Relative lengths of chromosome were calculated based on the contribution of particular chromosome to the total haploid genome length. The relative length of X-chromosome was calculated taking the denominator as total length of autosomes plus X-chromosome. In males, the length of single X-chromosome was taken, whereas in females the average of 2X chromosome was taken. The relative length of Y-chromosome was calculated by taking the denominator as total length of autosomes+X+Y chromosomes. The chromosomal lengths thus obtained in magnified values were converted to absolute values in micron (μ).

Arm ratio: The arm ratio was calculated for the biarmed chromosomes using the following formula as described by Bhatia and Shanker (1999).

$$\text{Arm ratio} = \frac{\text{Length of long arm (q)}}{\text{Length of short arm (p)}}$$

Statistical analysis: The estimates of mean relative length and standard error for each pair of autosomes and sex chromosomes as well as t-test of significance to study the difference of mean relative lengths between males, between females and between breeds of Garole and Bonpala have been estimated (Snedecor and Cochran, 1989) and results are significant at $p<0.05$.

RESULTS AND DISCUSSION

For improving production potential of the animal it is important to improve the genetic worth of the animal. Chromosome number and chromosome morphology are the basic requirement for the thorough understanding of the genetics of a species (Dorji *et al*., 2003; Banerjee *et al*., 2010). The complete set of chromosomes of an organism is called karyotype and is usually presented as a picture of metaphase chromosomes lined up in descending order of their size. The karyotyping in sheep getting immense importance since its genetic implications to selection and further breeding programmes. Cytogenetics is the hybrid science which attempts to correlate cellular events with genetic phenomena (Acharya, 2000; Jeremiah, 2005). The cytogenetic investigations in domestic animals constitute a matter of both biological and practical importance because of their genetic implications to enhance more economical production of animal products for human consumption. Sheep is having fewer number and smaller size of the chromosomes when compared with cattle and goat (Singh, 2000; Jeremiah, 2005).

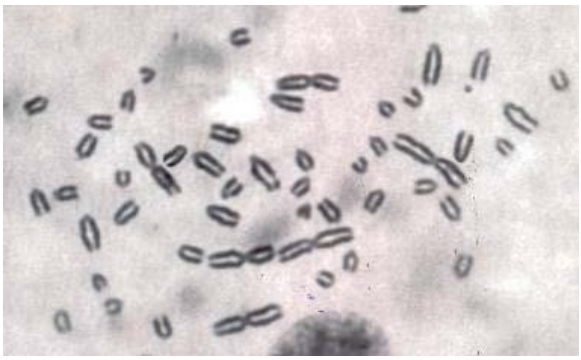

Fig. 3: Metaphase chromosome spread of Garole female sheep

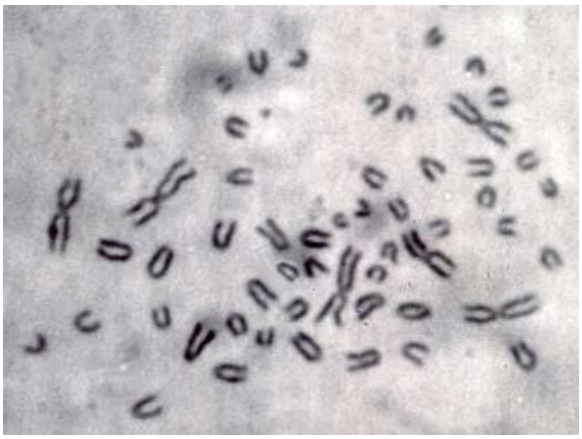

Fig. 4: Metaphase chromosome spread of Bonpala female sheep

Modal chromosome number: In the present study, the modal chromosome number of Garole and Bonpala sheep was found to be 54 (2n), comprising of 52 autosomes and 2 sex chromosomes. These findings were in agreement with the reports made in other Indian sheep breeds viz. Nali (Bhatia and Shanker, 1989), Mandya (Langhe *et al*., 1993; Kumar *et al*., 2009). Munjal (Bhatia and Shanker, 1994), Malpura (Gupta and Gupta, 1995), Pattanwadi (Bhatia and Shanker, 1999), Garole (Selvakumar, 2003; Thanikaivel, 2004), Mecheri (Karunanithi *et al*., 2005), Nellore (Amareswar *et al*., 2005), Coimbatore (Devendran *et al*., 2009), Marwari, Mandya, Madras Red and Muzaffarnagari (Kumar *et al*., 2009).

Chromosome morphology: In the present study, based on the position of centromere, the first 3 pairs of autosomes were submetacentric and biarmed in nature. Out of 3 pairs submetacentrics, first pair was the largest followed by 2nd and 3rd pair. The remaining 23 pairs of autosomes were acrocentric and one pair of sex chromosome being homomorphic in females and heteromorphic in males (Fig. 3 and 4). The submetacentric nature of the first three autosomes were in agreement with the reports made in other Indian sheep breeds viz. Mandya (Umrikar and Narayankhedkar, 1997), Lohi (Ali *et al*., 1999), Nellore (Amareswar *et al*., 2005), Deccani (Prakash *et al*., 2008; Arora *et al*., 2010) and Vizianagaram Sheep (Kumar *et al*., 2014).

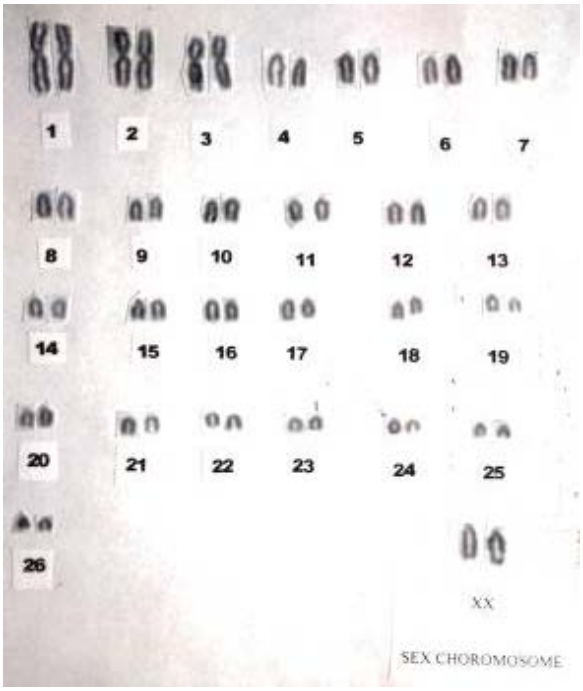

Fig. 5: Karyotype of chromosomes of Garole female sheep

However, these findings were in disagreement with metacentric nature of the first three autosomes reported in other Indian sheep breeds viz. Nali (Bhatia and Shanker, 1989), Munjal (Bhatia and Shanker, 1994), Malpura (Gupta and Gupta, 1995), Pattanwadi (Bhatia and Shanker, 1999), Mecheri (Karunanithi *et al*., 2005) and Coimbatore sheep (Devendran *et al*., 2009). Furthermore, Rcheulishvili and Dzhokhadze (1985) reported that the first two autosomes were submetacentric and the third autosome was metacentric in the exotic sheep, Imeritian. The variation in the shape of biarmed chromosomes among the different sheep breeds might possibly be attributed to shift or reciprocal translocation in the arms of chromosomes during the process of evolution (Devendran *et al*., 2009).

In the present study, X-chromosome of female was found to be acrocentric and largest (Fig. 5). The Y-chromosome of male was metacentric, biarmed, very small in size and its morphology was not clear in the prepared sections (Fig. 6). These findings were similar with the reports made in other Indian sheep breeds viz. Malpura (Gupta and Gupta, 1995), Mecheri (Karunanithi *et al*., 2005), Deccani (Prakash *et al*., 2008) and Coimbatore sheep (Devendran *et al*., 2009). However, these findings were in disagreement with Di Meo *et al*. (2005) who observed that the comparative Fluorescent *in situ* Hybridization (FISH) mapping is suitable for better understanding of the morphology of Y-chromosome and reported Y-chromosome was a small submetacentric structure in sheep.

Morphometric measurements: In the present study, the morphometric analysis showed that significant variation in mean relative length of 13th pair of chromosome of Garole and Bonpala males and significant variation noticed in the arm ratio of 2nd pair of chromosome of Garole and Bonpala females and variation also noticed in almost all the pairs of chromosomes but not up to the level of significance.

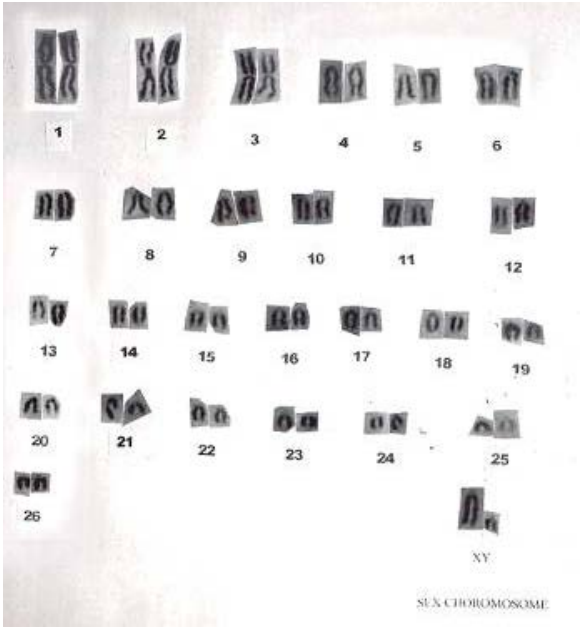

Fig. 6: Karyotype of chromosomes of Bonpala male sheep

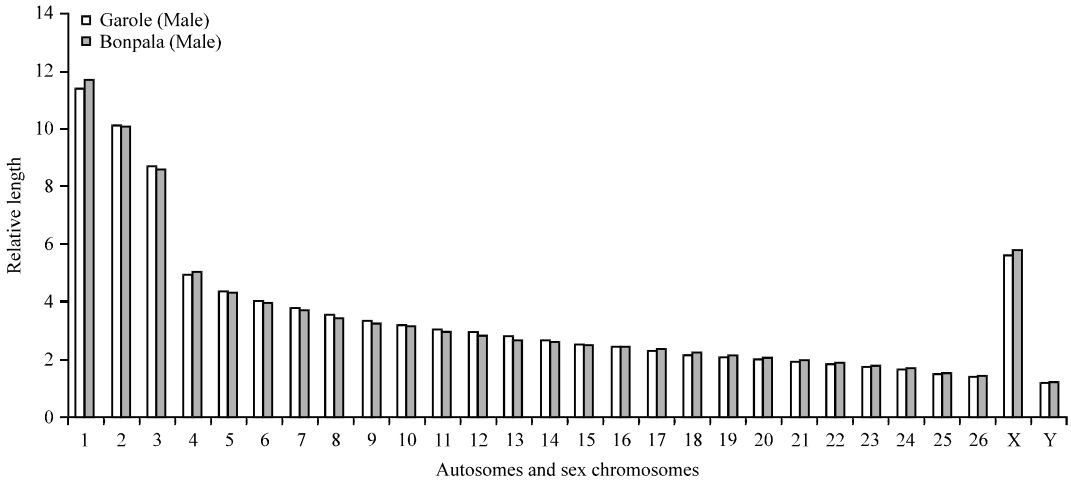

Fig. 7: Comparative idiogram for chromosomes of Garole and Bonpala males

The mean relative length of first 26 pairs of autosomes and one pair of sex chromosome (X and Y) of Garole and Bonpala males were presented in Table 2 and Fig. 7. For Garole male the mean relative length of autosomes ranged from 1.39±0.05 to 11.45±0.15 whereas, in Bonpala male the mean relative length of autosomes ranged from 1.48±0.06 to 11.69±0.25. These findings were in disagreement with Thanikaivel (2004) who reported that lower relative length of autosomes. In the present study, the mean relative length of X-chromosome of Garole male was estimated to be 5.66±0.15 and that of Bonpala it was 5.83±0.17. The Y-chromosome length was 1.20±0.02 in Garole and 1.27±0.06 in Bonpala males.

Table 2: Relative length (expressed in percentage) of chromosomes of Garole and Bonpala male sheep (Mean±SEM)

	Males	
Chromosome pair	Garole	Bonpala
1	11.45±0.15	11.69±0.25
2	10.12±0.15	10.08±0.25
3	8.73±0.26	8.57±0.29
4	4.96±0.13	5.04±0.09
5	4.38±0.07	4.32±0.08
6	4.05±0.09	3.96±0.07
7	3.81±0.09	3.72±0.06
8	3.57±0.07	3.46±0.07
9	3.36±0.08	3.28±0.06
10	3.20±0.07	3.17±0.05
11	3.07±0.06	3.03±0.05
12	2.97±0.05	2.87±0.06
13	2.84±0.04[a]	2.71±0.05[b]
14	2.71±0.04	2.66±0.05
15	2.57±0.05	2.55±0.05
16	2.45±0.04	2.47±0.04
17	2.34±0.05	2.36±0.05
18	2.19±0.05	2.28±0.05
19	2.12±0.05	2.18±0.05
20	2.04±0.06	2.10±0.05
21	1.94±0.04	2.01±0.05
22	1.85±0.04	1.93±0.05
23	1.76±0.04	1.82±0.04
24	1.67±0.03	1.74±0.04
25	1.54±0.04	1.61±0.06
26	1.39±0.05	1.48±0.06
Sex chromosome		
X	5.66±0.15	5.83±0.17
Y	1.20±0.02	1.27±0.06

The mean of a row having different superscript differ significantly ($p \leq 0.05$)

The mean relative length of first 26 pairs of autosomes and one pair of sex chromosome (X and X) of Garole and Bonpala females were presented in Table 3 and Fig. 8. For Garole female the mean relative length of autosomes ranged from 1.43±0.06 to 10.80±0.20 and in Bonpala female it ranged from 1.42±0.04 to 11.42±0.36. The mean relative length of X chromosome of Garole female was 5.51±0.13 and that of Bonpala female it was 5.61±0.15. These findings were in agreement with Selvakumar (2003) and Thanikaivel (2004).

The mean relative length of autosomes and sex chromosome (X and Y) of Garole and Bonpala breeds were presented in Table 4 and Fig. 9. The mean relative length of autosomes of Garole breed was ranged from 1.41±0.04 to 11.12±0.14 and that of Bonpala breed it ranged from 1.45±0.04 to 11.55±0.22. The mean relative length of X-chromosome of Garole breed was estimated to be 5.59±0.10 and Bonpala breed it was 5.72±0.11. The relative length of Y-chromosome of Garole was found to be 1.20±0.18 and that of Bonpala it was 1.27±0.06.

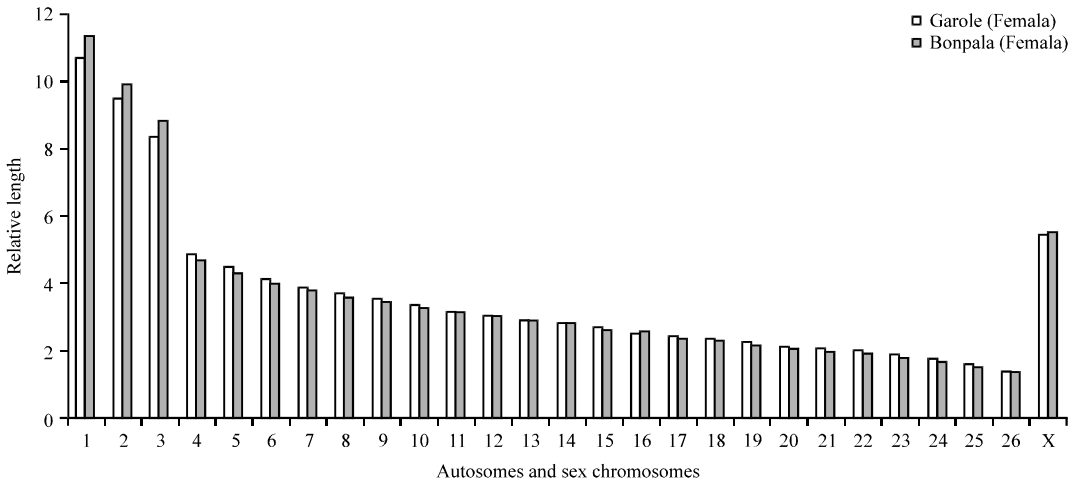

Fig. 8: Comparative idiogram for chromosomes of Garole and Bonpala females

Table 3: Relative length (expressed in percentage) of chromosomes of Garole and Bonpala female sheep (Mean±SEM)

	Females	
Chromosome pair	Garole	Bonpala
1	10.80±0.20	11.42±0.36
2	9.54±0.1461	9.95±0.32
3	8.43±0.25	8.93±0.29
4	4.90±0.20	4.75±0.10
5	4.53±0.17	4.35±0.09
6	4.19±0.14	4.07±0.07
7	3.95±0.11	3.90±0.07
8	3.78±0.10	3.65±0.05
9	3.61±0.09	3.51±0.05
10	3.43±0.09	3.34±0.04
11	3.22±0.06	3.24±0.03
12	3.09±0.05	3.09±0.03
13	2.99±0.05	2.98±0.04
14	2.86±0.05	2.86±0.05
15	2.77±0.04	2.72±0.07
16	2.60±0.05	2.62±0.06
17	2.48±0.05	2.46±0.07
18	2.41±0.05	2.43±0.09
19	2.32±0.05	2.21±0.09
20	2.21±0.07	2.16±0.09
21	2.15±0.06	2.03±0.09
22	2.06±0.07	1.94±0.08
23	1.97±0.08	1.84±0.08
24	1.81±0.10	1.73±0.06
25	1.65±0.05	1.58±0.05
26	1.43±0.06	1.42±0.04
Sex chromosome		
X	5.51±0.13	5.61±0.15

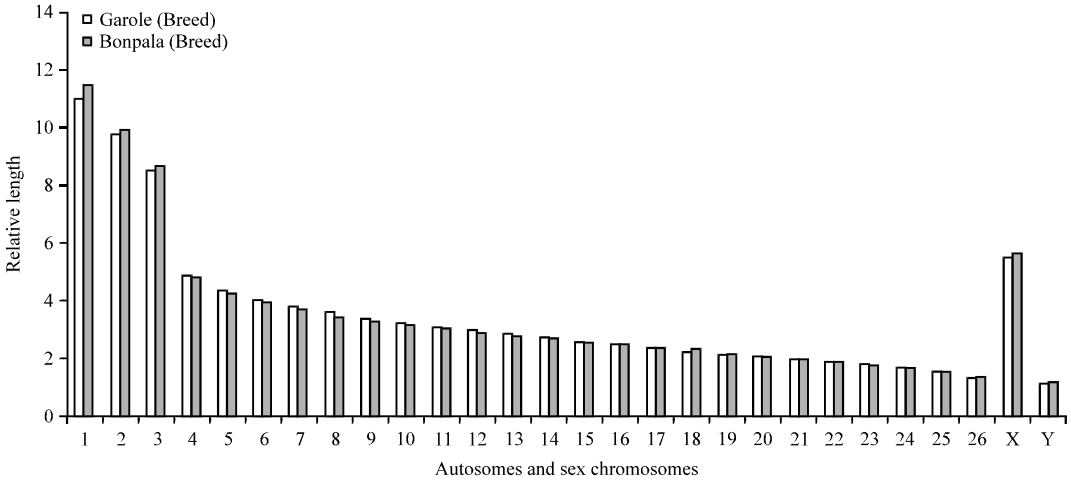

Fig. 9: Comparative idiogram for chromosomes of Garole and Bonpala breeds

Table 4: Relative length (expressed in percentage) of chromosomes of Garole and Bonpala sheep breeds (Mean±SEM)

	Breeds	
Chromosome pair	Garole	Bonpala
1	11.12±0.14	11.55±0.22
2	9.83±0.12	10.02±0.20
3	8.58±0.18	8.75±0.20
4	4.93±0.12	4.89±0.08
5	4.45±0.09	4.34±0.06
6	4.12±0.08	4.01±0.05
7	3.88±0.07	3.81±0.05
8	3.68±0.06	3.55±0.05
9	3.48±0.06	3.40±0.04
10	3.32±0.06	3.25±0.04
11	3.14±0.04	3.13±0.04
12	3.03±0.04	2.98±0.04
13	2.91±0.03	2.84±0.04
14	2.79±0.03	2.76±0.04
15	2.64±0.04	2.63±0.05
16	2.53±0.04	2.55±0.04
17	2.41±0.04	2.41±0.04
18	2.30±0.04	2.36±0.05
19	2.22±0.04	2.20±0.05
20	2.12±0.05	2.13±0.05
21	2.04±0.04	2.02±0.05
22	1.95±0.05	1.94±0.05
23	1.86±0.05	1.83±0.04
24	1.74±0.05	1.73±0.04
25	1.59±0.04	1.60±0.04
26	1.41±0.04	1.45±0.04
Sex chromosome		
X	5.59±0.10	5.72±0.11
Y	1.20±0.18	1.27±0.06

Table 5: Mean arm ratio (expressed in percentage) of chromosomes of Garole and Bonpala males (Mean±SEM)

	Males	
Chromosome pair	Garole	Bonpala
1	1.26±0.04	1.19±0.04
2	1.25±0.06	1.21±0.05
3	1.20±0.04	1.24±0.04

Table 6: Mean arm ratio (expressed in percentage) of chromosomes of Garole and Bonpala females (Mean±SEM)

	Males	
Chromosome pair	Garole	Bonpala
1	1.29±0.04	1.22±0.03
2	1.27±0.04[a]	1.14±0.03[b]
3	1.27±0.05	1.24±0.06

The mean of a row having different superscript differ significantly ($p \leq 0.05$)

These results were almost similar to the observations of Langhe *et al.* (1993) reported that higher values of relative length in Bannur sheep for long chromosomes. However, lower mean relative length of autosomes were reported in Muzzafarnagari (Benjamin and Bhat, 1978), Munjal, Magra and Pattanwadi (Bhatia and Shanker, 1994, 1996, 1999), Nellore (Amareswar *et al.*, 2005), Mecheri (Karunanithi *et al.*, 2005), Deccani (Prakash *et al.*, 2008) and Coimbatore sheep (Devendran *et al.*, 2009).

Mean arm ratio: The mean arm ratio of first 3 pairs of autosomes of Garole and Bonpala male sheep were presented in Table 5. The mean arm ratio of 1st and 2nd pairs of autosomes of Garole male was higher than Bonpala male and the mean arm ratio of 3rd pair of autosomes of Bonpala male was higher than Garole male; however these mean arm ratio values were not statistically significant ($p \leq 0.05$).

The mean arm ratio of first 3 submetacentric chromosome pairs of autosomes of Garole and Bonpala female sheep are presented in Table 6. The mean arm ratio of first 3 pairs of autosomes of Garole female was higher than Bonpala female. The values of 1st and 2nd pairs of autosomes were not statistically significant ($p \leq 0.05$) but the values of 3rd pair of autosome were significantly different.

In the present study, the mean arm ratio values of first 3 pairs of autosomes of Garole breed was 1.28±0.03, 1.26±0.03 and 1.24±0.03, respectively. In Bonpala the corresponding values were 1.21±0.03, 1.18±0.03 and 1.24±0.03, respectively. The values are not significantly different between Garole and Bonpala breeds. In the present study, the arm ratio decreased from first to third autosomes in Garole breed. These findings were in agreement with the reports made in other Indian sheep breeds viz. Munjal (Bhatia and Shanker, 1994), Malpura (Gupta and Gupta, 1995), Pattanwadi (Bhatia and Shanker, 1999), Nellore (Amareswar *et al.*, 2005) and Deccani (Prakash *et al.*, 2008) sheep. However, Langhe *et al.* (1993) reported higher values in Bannur sheep and Karunanithi *et al.* (2005) reported lower values in Mecheri sheep.

CONCLUSION

The present study of cytogenetic evaluation showed that the diploid chromosome number of Garole and Bonpala breeds of sheep was 2n = 54, comprising of 26 pairs of autosomes and a pair of sex chromosome. The metaphase chromosome spread and karyotypic pattern was more or less

similar to those reported in descript breeds of sheep in India. The chromosome number, morphology and morphometric measurements of the autosomes and sex chromosomes showed that both the Garole and Bonpala breeds of sheep are genetically very close. They might have originated from the same source. Morphologically, both the breeds are very alike except some difference in behaviour and fecundity. Cytogenetic characterization of Garole and Bonpala breeds of sheep performed in the present study forms the basis for molecular genetic characterization and physical gene mapping like FISH (Fluorescent *in-situ* Hybridization). Routine cytogenetic screening enables early detection and culling of animals with chromosomal abnormalities and reduces economic loss. Further, the chromosome organization information revealed by karyotyping may aid in thorough understanding of evolution gene expression and characterization which in turn may result in the conservation of these sheep breeds.

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