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Original Research Article

Chromosomal Study of Black Bengal Goats of Jharkhand, India

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A B S T R A C T

Cytogenetic studies in domestic animals are gaining importance because of their genetic implications in breeding programmes. The present study describes the chromosomal profile of Black Bengal goats from Instructional Farm Small ruminants, Birsa agricultural university Ranchi Jharkhand. Blood samples were taken from 20 goats, after applying short term lymphocyte culture technique mitotic metaphase preparation was accomplished. The diploid chromosome number in Black Bengal goat irrespective of sex was found to be 60 in all the metaphases examined. Each metaphase consisted of 58 (29 pairs) autosomes and 2 (1pair) sex chromosome or allosome. As regard of morphology all the 58 autosomes and X chromosome were found to be acrocentric in nature. The X chromosome was found to be largest acrocentric chromosome in the complement. The Y chromosome was very minute dot like structure. In the present study it seemed to be sub-metacentric in appearance. The mean relative length of autosome ranged from 5.19±0.03 to 1.79±0.02 in male, 5.25±0.04 to 1.78±0.03 in female and 5.22±0.03 to 1.78±0.02 percent in pooled over sex black Bengal goat. Comparison of relative lengths of chromosomes between sexes revealed that the relative length of chromosome pair 3, 19, 23, 27, 28 and X were significantly ($p<0.01$) higher in male than female goat of Black Bengal breed while relative length of chromosome pair 5, 6, 8, 9, 10, 11, 12, 13 and 16 were significantly ($p<0.01$) lower in male than that of female Black Bengal goat. Relative length of X and Y chromosomes were found to be 5.76±0.05 and 1.47±0.03 percent respectively.

Keywords

Goat, Black Bengal goat, Cytogenetic, Karyotype, Chromosome number

Introduction

Goat is an important livestock species in India. Around 80% of the global goat population is in developing countries. India ranks second in goat population with 135 million goats. At present 28 breeds of goats documented in India out of which Black Bengal is one of the most important meat producing breed. This breed is commonly found in West Bengal, Bihar, Jharkhand, Orissa and north eastern parts of India. Body colour is predominantly black although brown, grey and white colours also found.

The size of goat is usually small and body structure is very tight. Legs are short and horns are small in size. Adult male goat weigh about 25-30kg whereas female goat weigh about 20-25 kg. This breed is very popular due to high kidding rate and multiple birth (i.e. twins or triplets) and low demand for food. The goats attains maturity at fast rate and have high degree of disease resistance and easily adaptable to any kind of environment. The meat and skin quality is excellent and have high demand in

international market. Cytogenetics applied to domestic animals is a useful biotechnology to be applied in genetic improvement of livestock. It can be used to select reproducers free from chromosomal aberration responsible for abnormal body conformation (aneuploidy), lowered fertility (balanced chromosome abnormalities) or sterility (sex chromosome abnormalities). Chromosomal study may also be used to applied to assess environmental pollution by studying animals living in hazardous areas and using them as biological indicators.

Chromosome also represent optimum biological structures for the study of evolution among related (bovids) and unrelated (bovid-humans) species usually using comparative FISH mapping which is one of the most important powerful tool to establish the correct order of loci among chromosome (Iannuzzi, L., 2007).

In India breedable goats are carrier for major structural cytogenetic defects are not been identified by karyotyping and allowed for breeding through natural service, artificial insemination or embryo transfer. So the chances of spreading defects such as Reciprocal or Robertsonian translocation in the population and causing reduced fertility, early embryonic mortility, abortion, decreased litter size etc. has been increased.

Identification of chromosomal defect is possible by studying chromosomal profile which inciude making standardized karyotype and Idiogram. Based on the above facts it become necessary to screen the breeding animals for finding chromosomal abnormalities and ultimately preventing possible economic losses to farmers. Although several studies made on the phenotypic characterization of black Bengal goat the information on cytogenetic characterization is very scanty. Therefore the present study was conducted to understand the chromosomal complement of Black Bengal breed and to compare chromosome of male and female Black Bengal goats.

Materials and Methods

Selection of animals

The present study was undertaken on Black Bengal goats maintained in Instructional Farm Small Ruminants, Ranchi Veterinary College, Birsa agricultural University, Ranchi. Out of the total animals present in this farm, 20 goats (10 Males and 10 females) were taken randomly from the breeding population for karyological study.

Collection of Blood

2 ml of blood was taken from each goat aseptically from jugular vein puncture in a 5 ml disposable syringe containing 40 IU of sodium heparin. The samples were carried to the laboratory packed in ice. Care was taken to prevent direct contact of the sample and ice. On arrival to the laboratory the blood samples were kept in the refrigerator at 40^0C till the culture was set up.

The study of somatic metaphase chromosome in goats were carried out by whole blood short-term lymphocyte culture method as given by Moorehead *et al.*, (1960) was followed with slight modifications.

Parameters taken for study

Length

The chromosomes in the karyotypes was measured in millimetre with an accuracy of 0.01 mm, using the Software IKRYOS Karyotyping system V5.15.

Relative length

Relative length was represented as the ratio of the length of a chromosome to the total length of haploid set of chromosome containing the X- chromosome and the ratio was expressed in percentage.

$$\text{Relative length (\%)} = \frac{\text{Length of a chromosome}}{\text{Total length of haploid genome including X-chromosome}} \times 100$$

The idiogram was drawn by taking the chromosome number on X-axis and the relative length (%) on the Y- axis.

Results and Discussion

In the present study the diploid chromosome number of Black Bengal goat was found to be 60. Among the total of 60 chromosomes, 58 were autosome and 2 were sex chromosomes.

Our findings are in agreement with the observation of Nes *et al.*, (1963), Buttle and Hancock (1966), Gracia Monge (1968), Datta (1970), Evans *et al.*, (1973), Hansen (1973), Khavery (1973), Schnedl and Czaker (1974), Bunch *et al.*, (1977), Ford *et al.*, (1980), Hasanbasic *et al.*, (1984), Cribiu and Matejka (1986, 1987), Das (1990), Bhatia and Shankar (1993, 1994) and Nicodemo *et al.*, (2008).

All the 29 pairs of autosome of Black Bengal goat were found to be acrocentric in nature in all the metaphase examined in the present investigation. These finding are in agreement with the findings of Nes *et al.*, (1963) who was the first to describe the autosome in goat as acrocentric. Buttle and Hancock (1966), Evans *et al.*, (1973), Hasanbasic *et al.*, (1984), Berardino *et al.*, (1987), Das (1990), Bhatia and Shankar (1993, 1994) and Kasabe *et al.*, (2009) also reported the acrocentric nature of autosome in different breeds of goat. Pattnanayak and Patre (1986) reported the acrocentric nature of autosome in Ganjam, Black Bengal goat and its crosses. In contrast telocentric autosome has been reported by Khavary (1973). Some of the pioneer scientists like Scaccini (1956), Lopez-Saez and Giamenz-Martin (1963) also reported the autosome in goat as telocentric.

In this study X chromosome was found to be acrocentric and longest one which is in agreement with the observations found by Nes *et al.*, (1963), Buttle and Hancock (1966), Hancock and Jacobs (1966), and Kasabe *et al.*, (2009), though some of the workers posed different views for length of the chromosome.

Hauschteck-jungen and Meili (1967) reported the X chromosome to be second longest. Henderson and Bruere (1979) identified X chromosome as third longest and Bhatia and Shankar (1992) as fourth longest chromosome. Bhatia and Shankar (1992) observed the X- chromosome in White Bengal goat as acrocentric as well as biarmed (Polymorphism in X-chromosome).

In this investigation Y-chromosome in Black Bengal goat was found to be smallest, dot like structure and suspected to be submetacentric. This finding is similar to the finding of Bhatia and Shankar (1992) in Marwari goat.

This finding also agreed with the observation of Henderson and Bruce (1979), Hasanbasic *et al.*, (1984) and Berardino *et al.*, (1987). However Makino *et al.*, (1967), Datta (1970), Ford *et al.*, (1980), Hasanbasic *et al.*, (1984), Bhatia and Shankar (1992, 1993, 1994), Kasabe (2009) identified the Y-chromosome as minute metacentric.

Table.1 Mean ± SE of the relative length (%) of the chromosomes in male and female Black Bengal goat

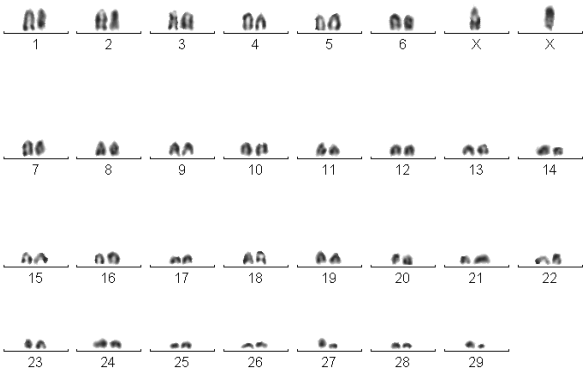
Chr. Pair number	Mean ± SE	Mean ± SE
1	5.19±0.03$^{z''}$	5.25±0.04^{z}
2	5.00±0.02$^{z'}$	4.96±0.03^{y}
3	4.78±0.03^{z}	4.70±0.03^{w}
4	4.52±0.02^{y}	4.55±0.03^{x}
5	4.28±0.02^{x}	4.44±0.03^{v}
6	4.13±0.01^{w}	4.26±0.03^{u}
7	4.02±0.01^{v}	4.05±0.03^{t}
8	3.87±0.01^{u}	3.95±0.01^{s}
9	3.74±0.01^{t}	3.79±0.01^{r}
10	3.62±0.01^{s}	3.74±0.02^{r}
11	3.52±0.01^{r}	3.60±0.01^{q}
12	3.37±0.01^{q}	3.44±0.01^{p}
13	3.31±0.01^{p}	3.35±0.01^{o}
14	3.24±0.01^{o}	3.23±0.01^{n}
15	3.09±0.01^{n}	3.16±0.01^{m}
16	2.99±0.01^{m}	3.06±0.01^{l}
17	2.93±0.01^{l}	2.94±0.02^{k}
18	2.87±0.01^{k}	2.87±0.01^{j}
19	2.81±0.01^{j}	2.75±0.01^{i}
20	2.65±0.02^{i}	2.63±0.01^{h}
21	2.57±0.01^{h}	2.59±0.01^{h}
22	2.51±0.01^{h}	2.47±0.02^{g}
23	2.42±0.02^{g}	2.36±0.02^{f}
24	2.32±0.02^{f}	2.32±0.02^{f}
25	2.26±0.02^{f}	2.26±0.02^{e}
26	2.15±0.02^{e}	2.14±0.03^{d}
27	2.09±0.02^{d}	1.94±0.03^{c}
28	1.98±0.02^{c}	1.86±0.03^{b}
29	1.79±0.02^{b}	1.78±0.03^{a}
X	5.95±0.05$^{z'''}$	5.57±0.05$^{z'}$
Y	1.47±0.03^{a}	

**P≤0.01, Value having same superscript in column did not differ significantly; N=100

Table.2 Effect of sex on length of chromosomes in Black Bengal Goat

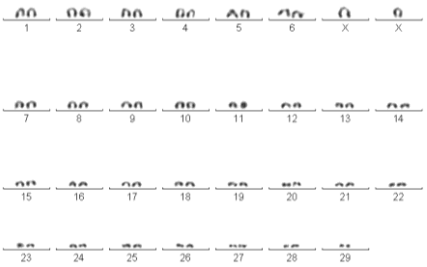
Chr. Pair Number	Male	Female	t-value
1	2.78±0.04	2.86±0.06	1.091^{NS}
2	2.68±0.04	2.70±0.06	0.322 ^{NS}
3	2.56±0.04	2.55±0.06	0.145^{NS}
4	2.43±0.04	2.49±0.06	0.849^{NS}
5	2.30±0.03	2.41±0.05	1.812^{NS}
6	2.21±0.03	2.33±0.06	0.1779^{NS}
7	2.16±0.03	2.21±0.05	0.904^{NS}
8	2.08±0.03	2.16±0.05	1.423^{NS}
9	2.01±0.03	2.08±0.05	1.269 ^{NS}
10	1.95±0.03	2.05±0.05	1.817 ^{NS}
11	1.89±0.03	1.97±0.05	1.560 ^{NS}
12	1.81±0.03	1.89±0.04	1.376 ^{NS}
13	1.77±0.03	1.84±0.05	1.293 ^{NS}
14	1.74±0.03	1.77±0.04	0.662 ^{NS}
15	1.66±0.03	1.73±0.04	1.451 ^{NS}
16	1.60±0.02	1.68±0.04	1.670 ^{NS}
17	1.57±0.02	1.61±0.04	0.972 ^{NS}
18	1.54±0.02	1.57±0.03	0.821 ^{NS}
19	1.51±0.02	1.50±0.03	0.169 ^{NS}
20	1.42±0.02	1.44±0.03	0.425 ^{NS}
21	1.38±0.02	1.42±0.03	0.930 ^{NS}
22	1.35±0.02^{i}	1.35±0.03	0.097 ^{NS}
23	1.30±0.02	1.29±0.03	0.239 ^{NS}
24	1.25±0.02	1.27±0.03	0.609 ^{NS}
25	1.21±0.02	1.23±0.03	0.760 ^{NS}
26	1.15±0.02	1.16±0.02	0.317 ^{NS}
27	1.12±0.02	1.06±0.02	2.057*
28	1.06±0.01	1.00±0.02	2.386*
29	0.96±0.01	0.96±0.02	0.022 ^{NS}
X	3.19±0.05	3.03±0.06	1.953*
Y	0.79±0.02		

a. Mitotic-metaphase spread



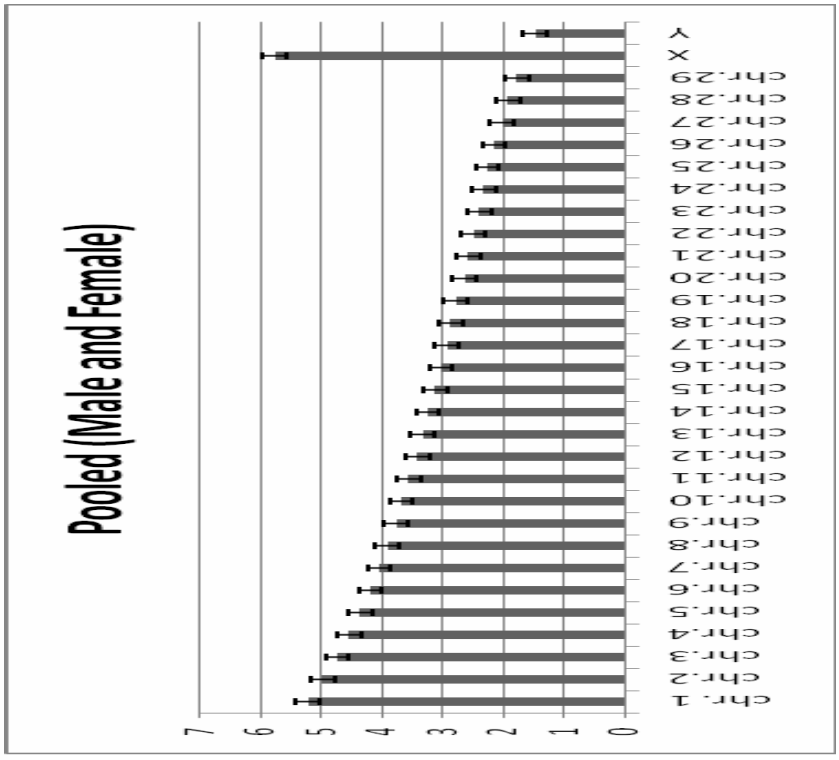
b. Karyotype of Black Bengal buck

c. Mitotic-metaphase spread



d. Karyotype of Black Bengal doe

Idiogram of Black Bengal goat based on relative length of Chromosome data pooled over sex



Estimation of relative lengths of corresponding chromosomes of each sex of Black Bengal goats revealed that the longest autosome contributed 5.19%, 5.25% and 5.22% of haploid genome in female, male and pooled over sex, respectively. The relative length of autosome were almost similar to those of Gaddi, White Bengal, Ganjam and Ganjam X Black Bengal goats reported earlier by Pattnanayak and Patro (1986), Bhatia and Shankar (1991) and Bhatia and Shankar (1992) respectively. The relative lengths of longest autosomes in Black Bengal goat was found to be longer than that of observed by Bhatia and Shankar (1993) as 4.87% in male and 5.04% in female Marwari goats and by Bhatia and Shankar (1992) as overall 4.99% in White Bengal goat. Das (1990) reported that the contribution of largest autosome in male and female of Assam local goat were 5.50% and 5.53% respectively, which were higher than that of observed in our condition. Nicodemo *et al.,* (2008) found higher contribution i.e. 6.18% of longest autosomes to total haploid genome in Angora goat.

The relative length of smallest autosome contributed 1.79%, 1.78% and 1.78% of haploid genome in female, male and data pooled over sex in Black Bengal goat respectively. This finding was slightly higher than that of observed by Hansen (1973) in domestic goat as 1.7% and Das (1990) as 1.57% and 1.61% in male and female respectively in Assam local goat. Bhatia and Shankar (1993) also reported the contribution of smallest autosome to be 1.95% and 1.83% of haploid genome in female and male Marwari goats. The longest acrocentric chromosome was found to be X chromosome in this study. This finding was in agreement with the findings of Bunch *et al.,* (1977), Berardino *et al.,* (1987) and Bhatia and Shankar (1992). The relative length of X chromosome was found to be 5.95±0.05% in male, 5.57±0.05% in female and 5.76±0.05 % in data pooled over sex in the present study. These findings were higher than that of the findings of Bhatia and Shankar, 1992 (5% in White Bengal goat), Bhatia and Shankar, 1993 (5.21% in Marwari goats), Bhatia and Shankar, 1994 (5.33% in Beetal goat), and Nicodemo *et al.*, 2008 (5.30% in Angora goat) but in agreement with the findings of Pattnanyak and Patre (1986) who observed that the relative length of X chromosome varied from 5.1 to 5.8 percent in Ganjam, Black Bengal and Ganjam X Black Bengal goat.

The relative length of Y chromosome was found to be 1.47±0.03% in Black Bengal goat. This finding is almost similar to the findings of Pattnanyak and Patre (1986) in Ganjam, and Ganjam X Black Bengal, Bhatia and Shankar (1993 and 1994) in Marwari and Beetal goat respectively. Hansen (1973), Das (1990) and Nicodemo *et al.*,(2008) reported the relative length of Y chromosome were 1%, 0.73% and 1.08%, respectively which are lower than that of our findings. However Bhatia and Shankar (1992) reported Y chromosome contributed 1.62% in total genome of White Bengal goat which is higher than that of our findings.

Comparison of relative lengths of chromosomes between sexes revealed that the relative length of chromosome pair 3, 19, 23, 27, 28 and X were significantly ($p<0.01$) higher in male than female goat of Black Bengal breed while relative length of chromosome pair 5, 6, 8, 9, 10, 11, 12, 13 and 16 were significantly ($p<0.01$) lower in male than that of female Black Bengal goat. These findings are in agreement with the findings of Bhatia and Shankar (1992) who observed the significant ($p<0.05$) difference between the relative length of longer chromosome (chromosome pair 2 to 4) and X chromosome between the sexes but

contrary to our observation Bhatia and Shankar observed non-significant differences between the relative length of middle and shorter chromosomes in both the sexes. Pattnanyak *et al.*, (1986) also reported no significant differences in relative length of chromosome between sexes of Ganjam and Ganjam X Black Bengal goats.

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