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Profiling of Chromosomal Complement in Nandidurga Goats of Karnataka

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ABSTRACT

Background: To characterize the chromosomal complement of Nandidurga goats.

Methods: Blood samples for short term lymphocyte culture were collected from 5 bucks and 5 does from its breeding tract and then mitotic chromosomal spreads were accomplished.

Result: The diploid chromosome number was found to be 60, consisting of 58 acrocentric autosomes and 2 sex chromosomes (X and Y). The X chromosome was found to be the longest acrocentric and Y chromosome was found to be sub metacentric. The mean mitotic drive was 64.5±2.01 and 63.15±1.30 percent in bucks and does, respectively. The mean relative length of autosomes varied from 2.08±0.24 to 4.81±0.12 in does and 2.09±0.09 to 4.70±0.11in bucks. The relative length of X chromosome in does was 5.14±0.17 and that in bucks was 4.92±0.21, whereas Y chromosome had a relative length of 1.99±0.20. The mean Arms Ratio, Centromeric Index and Morphological Index were 2.47, 31.62 and 396.14, respectively. This cytogenetic analysis indicates the normal chromosomal complement in the studied Nandidurga goats.

Key words: Chromosome, Cytogenetic, Karyotype, Nandidurga goat.

INTRODUCTION

Goat was the first animal to be domesticated at the dawn of Neolithic period around 10,000 years ago. Goat farming offers much needed income generation to millions of marginal and landless laborers. The Indian goat population was about 47 million in 1952 and has expanded to 148.88 millions in 2019 (Anonymous 2019). India is bestowed with 34 registered goat breeds and many non-descript goats which have high production potentialities and are yet to be characterized (Phenotypic, Cytogenetic and Molecular). In Karnataka, the goat population has continuously increased over the years from 3.7 million in 1972 to 6.17 million in 2019 (Anonymous., 2019). Karnataka is ranked tenth in the country with regard to goat population and has increased by almost 28.63 per cent compared to the population status in 2012.

Cytogenetic characterization is crucial in identifying the breed and forms the basis for molecular genetic characterization (Ekambaram *et al*., 2011). Cytogenetics provides a simple and easier approach for characterizing a breed and helps in conservation of indigenous breeds. It enables the correct identification of individual chromosomes and establishes standard karyotype which is essential for characterization of any breed (Stranzinger and Fechheimer, 1989). Also, cytogenetic studies help in selection of animals free from chromosome abnormalities (abnormal body conformation, lower fertility or sterility). The chromosomal profiling will ultimately aids in evaluating reproductive health and fertility status of breeding animals at an earlier age (Basumatary, 2003). Keeping this in view, the technique of short term lymphocyte culture for Nandidurga goats was standardized and various morphometric measurements of chromosomes and idiogram were established.

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MATERIALS AND METHODS

Present study was conducted on Nandidurga goats maintained by farmers in their breeding tract. This research was conducted at Department of Animal Genetics and Breeding, Veterinary College, Bengaluru (KVAFSU) during the year 2019-2020. Total of 10 goats (5 bucks and 5 does) were identified randomly from the breeding population. About 2 ml blood was collected from the jugular vein using heparinised vacutainers and was carried to laboratory in

ice cold chamber. Samples were cultured by short term lymphocyte culture technique within 24 hours as given by Moorehead *et al.* (1960). At least 10 good quality metaphase spreads were considered to minimize sampling errors. The individual chromosomes were identified and classified as per the International System for the Cytogenetic Nomenclature of Domestic Animals (ISCNDA, 1990). The homologous pairs of chromosomes were identified and karyotyped based on their size and structure using IKARYOS software. Karyotypes established from the photographs taken from several good metaphase spreads were used for measuring the length of chromosomes.

The mitotic drive was estimated as the percentage of number of cells in metaphase and number of lymphoblasts to the total number of lymphocytes proliferated, whereas the mitotic index was calculated as the percent number of cells in metaphase to the total lymphocytes proliferated. The relative length (RL) of the individual chromosome was the ratio of length of the chromosome to the total length of genome including X chromosome and multiplied by 100. The Arms Ratio was calculated as ratio of length of long arm (q) to the length of short arm (p), Centromeric Index was calculated as the ratio of length of short arm (p) to the total length of chromosome (p+q) and multiplied by 100 and the Morphological Index was calculated by dividing the total length of chromosome (p+q) by the arms ratio and multiplied by 100. Idiogram was constructed by taking the chromosome number on X-axis and mean relative lengths of individual pairs of chromosomes on the Y- axis (Fig 3).

RESULTS AND DISCUSSION

Mitotic drive and mitotic index

The mean mitotic drive in this study was found to be 64.5±2.01 per cent in bucks and 63.15±1.30 per cent in does of Nandidurga goats. Similar results (64.96%) were observed in local goats of Karnataka by Jayshree *et al.* (2014) and Kasabe *et al*. (2009) reported mean mitotic drive of 51.22±0.65 per cent in Berari does and 47.94±0.94 per cent in Berari bucks. The mitotic index in this study was found to be 13.25±1.00 in Nandidurga bucks and 12.7±1.08 per cent in Nandidurga does. Similar result (10.62%) was observed in local goats of Karnataka by Jayshree *et al.* (2014) and Kasabe *et al*. (2009) reported mean mitotic index was 6.59±0.58 per cent in Berari does and 5.29±0.85 per cent Berari bucks.

Number and morphology of chromosomes

The examination of all the metaphase spreads revealed a diploid number (2n) of 60 chromosomes with 58 autosomes and 2 sex chromosomes (XY in males and XX in females) (Fig 1 and Fig 2). All the autosomes were found to be acrocentric, X-chromosome was observed to be the longest acrocentric and the Y-chromosome was sub metacentric, which was confirmed by various indices (Arms Ratio, Centromeric Index and Morphological Index). Similar findings with regard to number and morphology of autosomes were reported in many Indian goat breeds like Kanniadu (Saravanan *et al*., 2006), Berari (Kasabe *et al*., 2009), Mahabubnagar (Ekambaram *et al*., 2011), Karnataka local goats (Jayashree, 2014), Sangamneri (Bhagat *et al*., 2014), Osmanabadi and Boer bucks (Kokani *et al*., 2018) and in native Black Bengal goats (Banani *et al*., 2018). In contradiction to the present findings, the autosomes were reported as telocentric in Tehran goats (Khavary, 1973), Korean local goats (Yeo, 1984) and in Ganjam and Black Bengal goats (Pattnayak and Patro, 1986).

The acrocentric nature of X-chromosome in the present study was in agreement with the reports for Korean native goats (Yeo, 1984), Berari (Kasabe *et al*., 2009), Mahabubnagar (Umadevi *et al*., 2011), Karnataka local goats (Jayashree, 2014), Sangamneri (Bhagat *et al*., 2014), Osmanabadi and Boer bucks (Kokani *et al*., 2018) and Native Black Bengal goats (Banani *et al*., 2018). In contradiction to the present

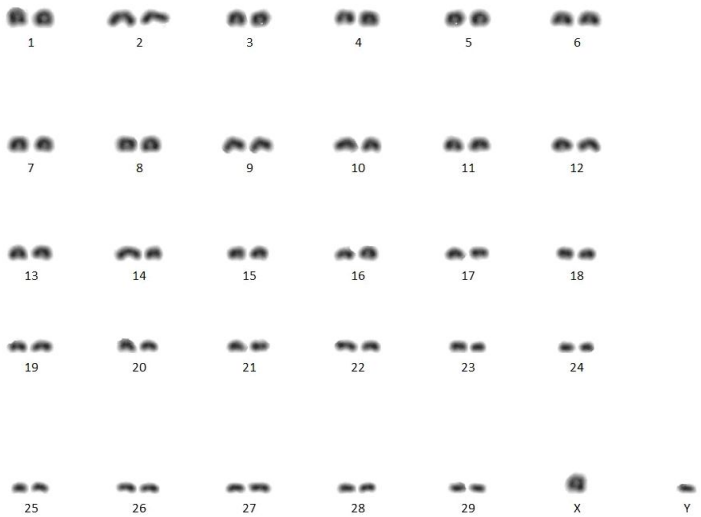

Fig 1: Mitotic-metaphase spread of Nandidurga buck

finding, X-chromosome was reported to be telocentric in Tehran goats (Khavary, 1973). In the present study, Y-chromosome was found to be sub metacentric, however it was metacentric in morphology and smallest in the complement as reported by Khavary (1973), Ford *et al*. (1980), Jayashree (2014) in Karnataka local goats and Bhagat *et al*. (2014) in Sangamneri goats. Umadevi *et al*. (2011) reported that the Y chromosome appears to be smallest and dot like in Mahabubnagar local and in Black Bengal goats, respectively. Likewise, in Osmanabadi and Boer bucks, Y chromosome was the smallest dot like in majority of the metaphase examined and in few metaphases it was found to be sub metacentric in morphology (Kokani *et al*., 2018). In Black Bengal goats, Y-chromosome was found to be smallest, dot like structure and suspected to be sub-metacentric (Banani *et al*., 2018).

Relative length

In the present study, the mean relative length of autosomes varied from 2.08±0.24 to 4.81±0.12per cent in does and 2.09±0.09 to4.70±0.11 per cent to in bucks (Table 1). Analysis of relative length data revealed a non significant difference in the mean relative length of the chromosomes between the sexes. The mean relative lengths of autosomes ranged from 1.61 to 5.49 per cent in Kanniadu goats (Saravanan *et al*., 2006). The least square means for relative length of autosomes in unicolored, bicolored and multicolored Mahabubnagar goats ranged from 1.997 to

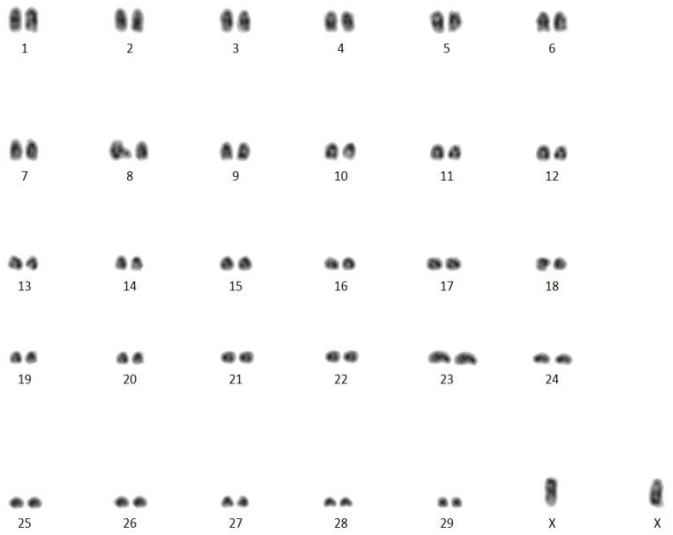

Fig 2: Mitotic-metaphase spread of Nandidurga Doe.

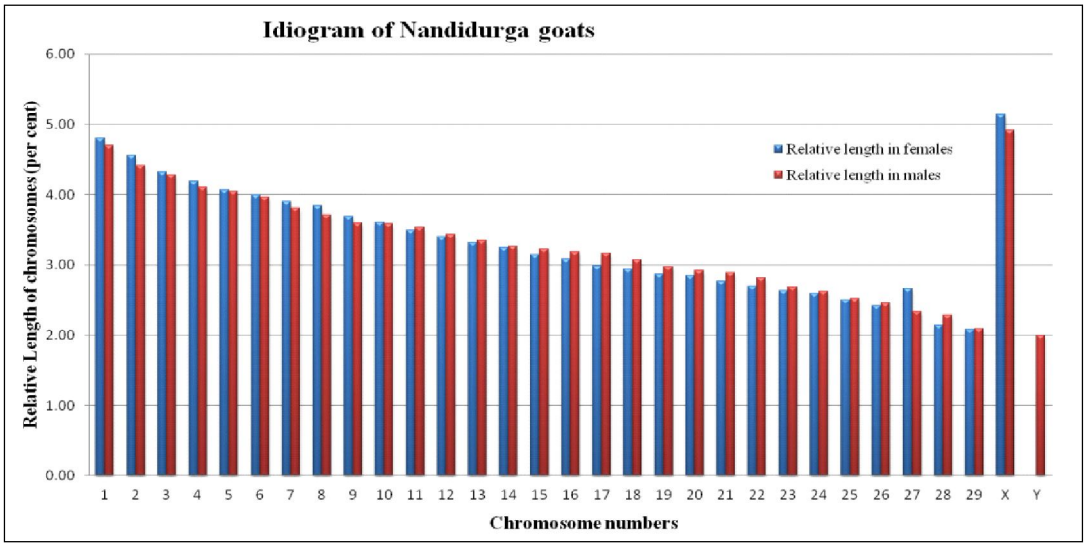

Fig 3: Idiogram based on relative length of chromosomes of Nandidurga goats.

4.742, 2.050 to 5.065 and 2.041 to 4.672 per cent, respectively with no significant difference between them (Umadevi *et al*., 2011). The mean relative length (%) of autosomes varied from 1.65±0.11 to 5.69±0.18 in males and 1.68±0.13 to 5.26±0.16 in females and significant differences in relative length was observed between the sexes in 1st, 16th, 17th, 19th, 20th, 21st , 23rd , 24th and 25th pair of autosomes (Jayashree, 2014). The relative length of autosomes varied from 1.79 to 5.19 per cent in females and in males from 1.78 to 5.25 per cent in Black Bengal goats (Banani *et al.,* 2018).

In this study, the relative length of X- chromosome in Nandidurga does was 5.14±0.17 per cent and that in bucks was 4.92±0.21 per cent. It was reported as 5.1 to 5.8 per cent in Ganjam goats (Pattnanayak and Patre, 1986), 5.86±0.08 per cent (Ekambaram *et al*., 2011) and 5.16 per cent (Umadevi *et al*., 2011) in Mahbubnagar goats, 6.05±0.15 per cent in does and 6.28±0.31 per cent in bucks of local goats of Karnataka (Jayashree, 2014), 5.95±0.05 per cent in bucks and 5.57±0.05 per cent in does of Black Bengal goats (Banani *et al*., 2018). In the present study, Y- chromosome had a relative length of 1.99±0.20 per cent. The relative length Y chromosome was 1.36±0.05 per cent in Mehabubnagar goats (Ekambaram *et al*., 2011), 1.42±0.13 percent in local goats of Karnataka (Jayashree, 2014) and 1.47±0.03 percent in Black Bengal goats (Banani *et al*., 2018). Umadevi *et al*. (2011) reported as 1.96 per cent in Mahbubnagar goats.

Table 1: Least squares means of relative length (%) of autosomes and sex chromosomes.

Chromosome number	Female	Male
1	4.81 ± 0.12	4.70 ± 0.11
2	4.56 ± 0.11	4.41 ± 0.07
3	4.32 ± 0.10	4.28 ± 0.05
4	4.19 ± 0.08	4.11 ± 0.06
5	4.07 ± 0.07	4.05 ± 0.04
6	3.99 ± 0.06	3.96 ± 0.05
7	3.90 ± 0.07	3.81 ± 0.04
8	3.85 ± 0.05	3.71 ± 0.05
9	3.69 ± 0.03	3.60 ± 0.04
10	3.61 ± 0.03	3.59 ± 0.04
11	3.50 ± 0.03	3.53 ± 0.04
12	3.40 ± 0.05	3.43 ± 0.03
13	3.32 ± 0.05	3.35 ± 0.03
14	3.25 ± 0.05	3.30 ± 0.03
15	3.15 ± 0.04	3.23 ± 0.03
16	3.08 ± 0.04	3.18 ± 0.02
17	2.98 ± 0.03	3.17 ± 0.02
18	2.94 ± 0.03	3.07 ± 0.03
19	2.87 ± 0.04	2.97 ± 0.04
20	2.85 ± 0.04	2.92 ± 0.03
21	2.77 ± 0.04	2.89 ± 0.03
22	2.69 ± 0.04	2.81 ± 0.03
23	2.63 ± 0.03	2.69 ± 0.03
24	2.59 ± 0.04	2.63 ± 0.02
25	2.50 ± 0.04	2.52 ± 0.04
26	2.41 ± 0.05	2.46 ± 0.03
27	2.66 ± 0.28	2.33 ± 0.06
28	2.14 ± 0.06	2.29 ± 0.05
29	2.08 ± 0.24	2.09 ± 0.09
X	5.14 ± 0.17	4.92 ± 0.21
Y	-	1.99 ± 0.20

The mean arms ratio of Nandidurga goats in the present investigation was 2.47 and arms ratio of all Y-chromosomes was found to be more than 1 and lesser than 7, mean centromeric index was 31.62 and centromeric index of all Y chromosomes was found to be more than 12.5 and lesser than 50.0 and average morphological index of Y-chromosome was 396.14 which was lesser than themean genome length of 812.4. All these indices confirm the sub metacentric nature of Y chromosome in the studied goats. However, Umadevi *et al*. (2011) reported arms ratio as 1.68 per cent (1.08 to 4.19), centromeric index as 39.22 percent, morphological index as 214.00 and genome length as 321.75 mm in Mahabubnagar goats. Idiogram was constructed by taking the chromosome number on X-axis and mean relative lengths of individual pairs of chromosomes on the Y- axis (Fig 3).

CONCLUSION

The present cytogenetic profiling of Nandidurga goats revealed chromosomal compliment which evinces the absence of any chromosomal abnormalities. This normal chromosome compliment reveals the status of Nandidurga goats for reproductive health and fertility, will benefit in enhancing production potentialities.

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