Cytogenetic Study of “Saavedreño” Creole Cattle

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Summary The “Saavedreño” Creole cattle was established at the Saavedra Experimental Station (Santa Cruz de la Sierra, Bolivia) in the seventies’ aiming to obtain a dairy breed adapted to humid tropical environments. The relationship between the occurrence of the 1/29 translocation and subfertility or infertility is well known. On the other hand, the analysis of the Y chromosome morphology is useful to determine the possible introgression with *Bos indicus*. As the incidence of 1/29 translocation and Y-chromosome morphology has not been previously studied in the “Saavedreño” Creole cattle, cytogenetic studies were performed in 40 bulls from different origin and 47 dams. Results obtained demonstrated a low frequency of 1/29 translocation (1.15%) in the animals and the presence of an acrocentric and submetacentric Y chromosome morphology.

Key words Y chromosome, Saavedreño Creole cattle, 1/29 translocation.

The Saavedra Experimental Station (Santa Cruz de la Sierra, Bolivia) was established in the seventies’, aiming milk production improvement through selection of different Creole cattle breeds well adapted to humid tropical environments. The founder group was made up with “Yacumeño” Creole cattle (Beni, Bolivia), “Chaqueño” Creole breed (Bolivian Chaco), Dairy Caracu breed (Mina Gerais, Brazil), Nicaraguan Dairy Creole cattle, and Cuban Dairy Creole cattle. Nowadays, the population goes up to about 300 animals.

“Saavedreño” Creole cattle is a humpless breed, with uniform coat colour and long horns (characteristic of American Creole breeds). Males and females have an average weight of 730 and 426 kg. respectively. In addition, this breed shows a high degree of fertility and can produce more than 1,000 litters of milk in the first lactation in humid tropical environments.

Up to now, no cytogenetics studies have been carried out in the “Saavedreño” breed. Thus, the incidence of chromosomal abnormalities and Y-chromosome morphology in this breed are unknown.

The existence of Y chromosome polymorphism in bovine was described by Kieffer and Cartwrigth (1968). While Zebu (*Bos indicus*) breeds from Asia and Africa have an acrocentric Y chromosome, in European breeds (*Bos taurus*) the Y chromosome is submetacentric. However, there are evidences that some humpback breeds, like Afrikaner and some humpless breeds, like N’Dama (South Africa), exhibited both types of Y chromosome in the population (Halnan 1976, Meyer *et al.* 1980, Teale *et al.* 1995). Phylogenetically, is probably that a pericentric inversion occurred in the acrocentric Y chromosome of Zebu breeds. Therefore, the terminal portion of the long arm of the Y chromosome of Zebu shows adjacent bright and dark bands by R and C-banding techniques. The same banding pattern is observed in the distal region of the short arm of the Y chromosome of European cattle. These evidences were used to explain the evolution of Y chromosome polymorphism in bovine (Eldbridge and Balzak 1977).

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In cattle, the 1/29 Robertsonian translocation is one of the most widely studied chromosomal rearrangements (Gustavsson 1969). It was first described in Swedish Red and White cattle (Gustavsson and Rockborn 1964). Heterozygote and homozygote animals show 59 and 58 chromosomes, respectively. A world-wide distribution of this translocation has been reported in more than 50 breeds, including Spanish and American breeds (Tambasco *et al.* 1985, Arruga and Zaragosa 1987, Muñoz *et al.* 1994, Postiglioni *et al.* 1996), and has a very old origin (probably before cattle was domesticated). This abnormality reduces fertility in the carrier animals by increasing early embryonic mortality (Gustavsson 1969, Dryendahl and Gustavsson 1979).

This work was focused on the analysis of the incidence of 1/29 translocation in "Saavedreño" Creole cattle, as well as the morphology of the Y chromosome in bulls of this breed.

Materials and methods

Cytogenetic analysis was carried out on 40 phenotypically normal "Saavedreño" Creole bulls and 47 dams. The bulls belonged to 4 different paternal origin (Table 1). This fact allowed for the determination of Y chromosome morphology in the distinct bulls lineage in this breed.

Heparinized peripheral blood samples were obtained from the jugular vein. Lymphocyte cultures were performed by adding 1 ml of blood to 9 ml of Ham's F12 culture medium, supplemented with pockweed (Gibco BRL, at concentration recommended by suppliers), penicillin (60 IU) and streptomycin (50 µg/ml). Cultures were incubated for 72 h at 37°C. One h before harvesting, cultures were added with colchicine (1 µg/ml). After centrifugation lymphocytes were resuspended in 7 ml of 0.075 N potassium chloride and incubated at 37°C for 40 min. Fixation was carried out with methanol-acetic acid (3:1) at room temperature. Chromosomal preparations were made by dropping the cell suspension onto cold slides that were stained with 5% Giemsa solution. Thirty metaphases per bull were scored to analyse the incidence of 1/29 translocation and Y chromosome morphology.

Results

The 1/29 translocation was detected in only one of the 47 dams studied (Fig. 1A, B). In this case a chromosome complement $2n=59$, XX was observed, while in the other animals a chromosome complement $2n=60$, was found. Results obtained in relation with the Y chromosome are shown in Table 1. Whereas in the 22 bulls from Beni, Nicaragua and Bolivian Chaco as well as in 10 "Caracu" bulls the Y chromosome was submetacentric (Fig. 1C, D), 8 animals from Brazilian lineage ("Caracu") exhibited an acrocentric Y chromosome. These results indicate that Zebu introgression into "Saavedreño" bulls came from the Brazilian breeds (Fig. 1E, F).

Discussion

Our results showed that all analysed bulls belonging to "Chaqueño", "Yacumeño" and Nicaraguan lineage exhibited a submetacentric Y chromosome. These results are in concordance with those obtained in other breeds originated from animals brought by Spanish conquerors, like Venezuelan Creole cattle (Muñoz *et al.* 1994), Uruguayan Creole cattle (Postiglioni *et al.* 1996) and Argentine Creole cattle (De Luca *et al.* 1997). On the other hand, acrocentric and submetacentric Y chromosome morphology were detected in the group of "Saavedreño" Creole cattle bulls belonging to "Caracu" lineage.

Cytogenetic studies carried out in 4 Brazilian Creole breed ("Caracu, Mocho Nacional", Curraleiro" and Crioulo Lageano") demonstrated the existence of Y chromosome polymorphism. For example, 90% of bulls from "Caracu" and "Mocho nacional" breeds as well as 43% of "Crioulo

Fig. 1. Metaphases of cow a and two bulls. A, B) Metaphase and karyotype of a heterozygous cow for 1/29 translocation. C, D) Metaphase and karyotype of a bull with a submetacentric Y chromosome. D, E) Metaphase and karyotype of a bull with an acrocentric Y chromosome.

Lageano" bulls carried acrocentric Y chromosome (Tambasco *et al.* 1985). Our data confirm Zebu introgression in the "Caracu" breed.

Zebu introgression into Brazilian Creole cattle breeds could be originated first, from animals introduced to Brazil by Portuguese since 1534. These animals came from Portugal, as well as from Africa and Asian colonies. In the last cases, crosses with *Bos indicus* could be produced before introduction in America. In addition, Zebu was introduced in Brazil during XVIII and XIX centuries in

Table 1. Incidence of the two types of Y chromosome morphology in the "saavedreño" Creole cattle according to the different origin.

Origin	Animals studied	Y chromosome morphology	
		Submetacentric	Acrocentric
Beni ("Yacumeño")	9	9	0
Nicaragua (Nicaraguan Dairy Creole)	8	8	0
Bolivian Chaco ("Chaqueño")	5	5	0
Brazil (Dairy "Caracu" breed)	18	10	8

order to improve native breeds in tropical regions. This fact points out a strong difference with American Creole Breeds originated from animals introduced by Spanish conquerors because cattle were transported directly from Spain, where there were not Zebu at all.

Since "Saavedra" Creole cattle and Zebu breeds have overlapping distribution in Bolivia, cytogenetic analysis for the scoring Y chromosome morphology is a useful method for the maintenance of purity of this Creole cattle. A previously study (Kemp and Teale 1994, Teale *et al.* 1995) has reported on the resistance/susceptibility in N'Dama cattle herds to trypanosomiasis depending introgression with *Bos indicus* cattle. The practical consequence of Y chromosome polymorphism seems to be negative in the Zebu×European crosses. F₂ generation from crosses between Zebu breeds with acrocentric Y chromosome and European breeds with submetacentric Y chromosome, shows calving rate significantly reduced compared to both parental breeds (Rao 1982, Rendel 1980). After four centuries of natural selection American Creole cattle show a high degree of fitness to tropical environments. Genetic dilution by introgression of genes from other breeds such as the Zebu could reduce their distinctiveness and value.

The low frequency (1.15%) of 1/29 translocations in the animals studied, could be one of many causes for the high fertility rate observed in the "Saavedra" Creole cattle. Similar results were reported in Argentine Creole cattle (De Luca *et al.* 1997), and Uruguayan Creole cattle (Postiglioni *et al.* 1996). By contrast, it was found that 21.6% of Venezuelan Creole bulls were heterozygous for the 1/29 translocation, and the rate of fertility in this breed was correspondingly low (45%) (Muñoz *et al.* 1994).

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