

Molecular characterization of the Cuban Siboney cattle

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REPORT

ABSTRACT

The new genotype of the Cuban Siboney cattle ($5/8H \times 3/8C$) was obtained as part of the genetic improvement strategy to obtain cattle with best fitted behavior under the Cuban climatic conditions and adapted to the tropics. Until 2002, its genetic background had been evaluated based on genetic parameters (progeny and behavior tests, production, and butyric fat yields). The results of the molecular characterization of the Cuban Siboney cattle are presented, from breeds located at the Cuban western regions. The genotypes of cattle six major milk proteins were determined and associative studies to production characters were initiated. RAPD and microsatellite markers were also typified for biodiversity studies. Gene frequencies were obtained for the bovine growth hormone, prolactin and their receptors, and also stearyl-coenzyme A desaturase (SCD) and the diacylglycerol acyltransferase 1 (DAGT1), these two last genes involved in lipids metabolism as candidates for marker-assisted selection. It was demonstrated that the Cuban Siboney cattle has the genetic potential to persist as prominent breed for milk production purposes in the nationwide program of genetic improvement, with high genetic variability and its own molecular characteristics. These results can be used as tools to increase the selection efficiency and to provide greater knowledge on the studied breed. This research won the 2012 Award of the Cuban National Academy of Sciences.

Keywords: Cuban Siboney cattle, molecular markers, marker-assisted selection, microsatellite

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RESUMEN

Caracterización molecular del ganado Siboney de Cuba. La transformación de la ganadería cubana a partir de una población eminentemente cebuana y de pequeños núcleos lecheros aislados, hacia una ganadería cuyos niveles productivos puedan satisfacer las necesidades crecientes de consumo de leche por los humanos, fue uno de los principales objetivos económicos y sociales en Cuba desde inicios de los años 60. En la estrategia de mejoramiento genético se diseñó el nuevo genotipo Siboney de Cuba ($5/8H \times 3/8C$), que expresaba un mejor comportamiento y adaptación a las condiciones medioambientales tropicales. Hasta 2002, este genofondo se había evaluado mediante los parámetros genéticos: pruebas de progenie y comportamiento, producción y rendimiento en grasa butírica. Se exponen los resultados de la caracterización molecular del ganado Siboney de Cuba, en rebaños del occidente cubano. Se identificaron los genotipos de las seis principales proteínas lácteas y se iniciaron estudios de asociaciones con caracteres productivos; se tipificaron marcadores RAPD y microsatélites para estudios de biodiversidad. Se obtuvieron las frecuencias génicas para la hormona del crecimiento, la prolactina y sus receptores, y los genes estearil-coenzima A desaturasa y diacilglicerol aciltransferasa 1, involucrados en el metabolismo lipídico, como genes candidatos para la selección asistida por marcadores. Se demostró que la raza tiene potencial genético para mantenerse como eminentemente lechera en el Programa Nacional de Mejora Genética, con elevada variabilidad genética y características moleculares propias. Estos resultados sirven como herramienta para incrementar la eficiencia de la selección y brindan un mayor conocimiento sobre la raza. Este trabajo mereció el Premio Anual de la Academia de Ciencias de Cuba, 2012.

Palabras clave: ganado Siboney de Cuba, marcadores moleculares, selección asistida por marcador, microsatélite

Introduction

One of the main economic and social challenges in Cuba at the early 1960's comprised transforming Cuban livestock in about 40 years from an eminently zebu cattle population (approximately 96 %) distributed in isolated dairy farms, into a highly structured dairy industry of high production yields, to suffice the increasing demands of milk for human consumption [1]. The strategy was based on increasing the productive potentiality of the existing cattle at that time and simultaneously developing suitable exploitation systems for the livestock imported from other latitudes under tropical conditions.

There were four main points for development: genetic maintenance of breeds adapted to the Cuban tropic, the generation of new breeds, the adaptation of the imported ones and the use of cross-bred stud bulls. These have supported the clustering of animals

identified as breeds resistant to tropical conditions, from which the obtainment of two new genotypes was projected: the Cuban Siboney (stable genetic ratio of $5/8H \times 3/8C$) and the Cuban Mambí (stable genetic ratio of $3/4H \times 1/4C$), both of better behavior under the Cuban climatic conditions and for producing bulls of improved adaptation to the tropics. The Siboney breed, obtained by such a genetic improvement program, has been central to achieve the results expected [2], with a 58 % preponderance on the nationwide program of genetic improvement (NPGI) in 2008, and tending to increase. This genetic background had been previously evaluated just on genetic parameters (mostly on behavior, production and yields of butyric mass).

In this work, the molecular characterization of the Cuban Siboney cattle was addressed. The study used

1. López D. Cruzamientos en Cuba: Experiencias y perspectivas. 1998. Available from: <http://www.alpa.org.ve/PDF/publica/CAP%204.pdf>

2. Suárez MA, Zubizarreta I, Pérez T. Interacción genotipo ambiente en ganado bovino Siboney de Cuba. *Livestock Res Rural Dev.* 2003;21(9):139.

peripheral blood samples from female adult cattle at the genetic dairy farms Los Naranjos and Nazareno, located at the Cuban western region where the Siboney cattle is currently exploited. The respective genotypes of the main six milk proteins were obtained and association studies were initiated for productive characters. Five OPB operons were typified for RAPD characterization, and the 30 microsatellite loci proposed by FAO for biodiversity studies. Moreover, the genetic frequencies of the growth hormone, prolactin and their receptors were determined, and also those of the stearyl-coenzyme A desaturase (SCD) and the diacylglycerol acyltransferase 1 (DAGT1) genes, both involved in lipids metabolism and candidates for marker-assisted selection.

The available statistic software was used to analyze the molecular information while determining genetic indicators and the Hardy-Weinberg equilibrium conditions of the Cuban Siboney population.

Main results

The genetic structure of the Cuban Siboney cattle population was established for the genes encoding the major bovine milk proteins. It was demonstrated that this breed bears the genetic potential of an eminently milk-producing genotype as part of the NPGI [3-5]. There were specific band patterns for each breed on each of the evaluated RAPD markers, showing an increased polymorphism information content (PIC), indicative of an increased genetic variability in Cuban Siboney breeds [6]. Additionally, the population was characterized for microsatellite markers [7], showing evidences of a high genetic variability breed and single identity alleles were identified. There was also established the methodology for typing the bovine growth hormone and prolactin and their receptors, and also the SCD and DGAT1 loci as candidate genes for marker-directed selection [8].

Scientific relevance

It was corroborated the usefulness of the molecular analysis methodologies used to characterize the different cattle breeds, both for commercial and genetic purposes. There was a significant contribution to the knowledge on the genetic properties of the Cuban Siboney cattle, providing valuable information on its genetic variability to reinforce the NPGI and for the introduction of the marker-assisted selection into the country to improve production indicators.

This was the very first time that the genetic profiles of the *loci* associated to lipids metabolism were obtained for the Cuban cattle, as candidate genes and for marker-assisted selection.

Determining the genotypes of the candidate genes will contribute to reduce the intervals between generations, making possible selective breeding among the youngest animals of both sexes. Moreover, costs could be lowered by the efficient use of resources and consumables available at the national dairy industry, for a better maintenance of the animals with potentiality for high yield milk production, and by integrating proper reproductive, sanitary and animal management procedures.

Conclusions

The methodologies used on the study of the Cuban Siboney cattle can be applied to identify and typify candidate genes selected to determine their association to quantitative characters and to understand the effects they cause. These properties can support the use of such methodologies in marker-assisted selection programs. The Cuban Siboney cattle population has a high genetic variability supporting the use of its molecular information to characterize valuable animals, either by productive performance or assuming that they could bear gene arrays in their genomes hard to be reproduced in the population in a near future.

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