Phenotypic and genetic trends in the MOET nucleus selection scheme for milk production in Guzerá cattle

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Summary

The objective of this study was to evaluate inbreeding and phenotypic and genetic trends in the MOET nucleus selection scheme for milk production traits in the Guzerá breed. Information was obtained from the database of the National Program for the Improvement of the Guzerá Dual Purpose (PNMGuD). The data consisted of 305-days milk and solids yield, individual estimates of PTA for both traits, as well as of individual inbreeding coefficients. Annual averages were calculated from 1994 to 2013. To access trends, the means were regressed on the birth year of animals. The trend for inbreeding revealed an annual increase of 0.05%, which is considered low and can be attributed to both mating planning and inclusion of genetically distant families in the nucleus. Positive trends of the phenotypic (+22 kg/year) and genetic (+12 kg/year) means were attributed to the genetic gain promoted by the selection scheme in the nucleus. In conclusion, the MOET nucleus scheme was effective in contributing to the genetic progress of the Guzerá cattle for milk traits, without significant impact on the average inbreeding coefficient.

Keywords: Breeding value, Inbreeding, Milk Production, Selection, Zebu cattle

Introduction

The National Program for the Improvement of Guzerá Dual Purpose (PNMGuD) cattle is based on the integration of several animal breeding tools, with the aim of speed and reliability of selection. From the progeny test and the MOET nucleus scheme, the program generates information used in genetic evaluations for traits of importance to milk production (Bruneli et al., 2017). The MOET nucleus mates the animals with the greatest production and genetic potential by multiple ovulation followed by embryo transfer (MOET) or, recently, by *in vitro* embryo production (IVEP). Proposed by Nicholas & Smith (1983), the MOET nucleus scheme allows early survey and identification of genetically superior animals and high selection intensity (Nicholas & Smith, 1996). The main advantage of this scheme is to increase the rate of genetic progress due to the decrease in the generation interval. However, there is a risk of an increase in the inbreeding coefficient, since the nucleus, despite being open, comprises a small sample of the population of animals that are to a lesser or greater extent genetically related, and the scheme favors the selection of families (Weigel, 2001). Considering the benefits of MOET schemes, the MOET nucleus of Guzerá cattle has been conducted since 1994 in Brazil, together with a progeny test for milk production traits (Penna et al., 1998). The hierarchical mating strategy in which one sire per dam and more than one dam per sire are mated has been chosen to obtain the full-sib families (Leitch et al., 1994).

After almost 25 years of implementation of the MOET nucleus of Guzerá cattle, the present study aimed at evaluating the effectiveness of the MOET nucleus selection scheme in improving milk production traits without substantially increasing the level of inbreeding.

Material and methods

Data came from 174 families with 967 siblings generated by MOET or IVEP from 1994 to 2013 in the MOET nucleus scheme of the Guzerá cattle. Full-siblings were composed of 503 males and 464 females, of which 373 had their first lactation recorded in standardized and realistic conditions, i.e., in a low-input and pasture-based production system. The mean number of full-sibs per family was 6 ± 3 (2-18). Only families with at least one male and one female had their information included in dataset. The inbreeding coefficients were calculated using the ENDOG program (Gutierrez et al., 2005). The annual means of milk and solids yields and the inbreeding coefficients for MOET animals by birth year?, were calculated using the procedures available in the SAS® (SAS, 2012). Similarly, the mean DEPs for milk and solids yields that were estimated using the annual genetic evaluations of the National Improvement Program of the Guzerá Dual Purpose (Bruneli et al., 2017) were calculated. Data for genetic evaluations consisted of 305-days lactation records from first to fifth lactation. These data came from 114 purebred, including the MOET Nucleus, and crossbred herds, participants of the progeny test and of the Genetic Improvement Program of Zebu /Brazilian Association of Zebu Breeders (PMGZ/ABCZ. Estimated breeding values were obtained from the solution of the mixed model equations that included the relationship matrix, using the uni- and multi-trait derivative-free restricted maximum likelihood method available in the MTDFREML algorithms (Boldman et al., 1995). Estimates of phenotypic and genetic trends were generated by regression of the mean values on year of birth of the animals, using the Microsoft Excel package.

Results and discussion

The average inbreeding coefficient for the MOET Nucleus animals in the period studied was 0.006 ± 0.015, which is less than that (0.009) observed by Peixoto et al. (2010) in a shorter period for the same herd?. It reveals acceptable values for this parameter, as well as the efficiency of endogamy control in this scheme, that has been, therefore, had little detrimental effects on the animals' performance until now (Weigel, 2001). The contribution of occasionally using animals from genetically distant lineages to mate in the nucleus must also be highlighted, even in the absence of knowledge about their genetic potential. The means for 305-days milk and solids yields were2359 ± 754 (382-5133) and 208 ± 161 (32-557), respectively. These means for the complete PNMGuD database in the same period were 2276 ± 1163 kg and 243 ± 111 kg, respectively (Bruneli et al., 2017). These differences, although small, especially for milk yield, were significant ($P < 0.05$) and are due to particular environmental and genetic aspects of the MOET nucleus compared to other herds. The higher average milk yield in the nucleus can be attributed mostly to the high selection pressure, since genetically top animals are usually selected as sires and dams of families in this scheme. The lower mean for solids in the nucleus in relation to the entire population can be attributed to selection with a focus only on milk production, in addition to environmental conditions, especially with respect to diet. Correlated response in solids yield in the nucleus, therefore, did not occur at the same intensity.

The trend of annual increase (0.05%) in the average inbreeding coefficient (Figure 1) was considered low, but it requires continuous monitoring because of the lack of information

about inbreeding before the animal's arrival in the country and incompleteness of the pedigree. The observed annual fluctuation in the average inbreeding coefficient reveals that some inbreeding is actually occurring in the Nucleus herd, despite the effort of mating planning to minimize inbreeding. According to Weigel (2001), inbreeding is a function of selection intensity, thus it is difficult to avoid inbreeding since selection intensity in the nucleus is high, being based on the selecting few individuals and families. On the other hand, the observed low level of inbreeding (Figure 1) suggests that immediately after the inbreeding coefficients increases it is sought to avoid endogamy, mainly by including animals from different origin in the Nucleus, even if their productive or genetic potential for traits of interest is unknown. This strategy contributes to the maintenance of genetic variability and avoids the consequences of inbreeding depression.

Averages for milk and solids yields also fluctuated year by year. The phenotypic trend for milk production was + 22 kg/ year and, practically null for solids, -0.8 kg/year (Figure 2). The changes in average milk yield may result mainly from genetic factors, since the program seeks to hold standardized environment conditions in the Nucleus and management changes are discrete. This may have allowed greater accuracy in the estimation of milk yield genetic merit of the Nucleus full-sib families and consequently a higher genetic progress. The mean PTA for milk and solids yields also varied from year to year (Figure 3). However, there was a positive genetic trend for DEP of these traits, being 12 kg milk/year (0.6% of the average) and 1.2 kg solids/year (0.4% of the average), although the solids yield is not targeted. However, phenotypic trend for solids yield was practically null, which is attributed to limitations of the environmental conditions. In an initial study with the MOET nucleus dataset, Peixoto et al. (2006) found a genetic trend of 36.5 kg/year, which is higher than that found in this study. The results of these authors, however, cover a shorter period and include the initial genetic lift, which was the period of greatest selection pressure, i.e. choosing the top animals to be the parents of bulls at the beginning of the nucleus program. The annual genetic gains found in this study are below that of 30% above of a conventional progeny-testing scheme (Nicholas and Smith, 1993). Among the reasons, the lack of knowledge about the genetic value of some individuals and the selection for other purposes than milk yield, e.g. beef traits, in the herds where the individuals that are chosen to be parents of full-siblings come from may contribute to the lower rate achieved.

Conclusions

The rate of genetic progress for milk production accounts for a large proportion of the phenotypic trend for milk production in the MOET nucleus. The MOET nucleus scheme has contributed to the genetic progress of the Guzerá cattle for milk traits, increasing, phenotypically, the milk yield, while minimizing increased in inbreeding.

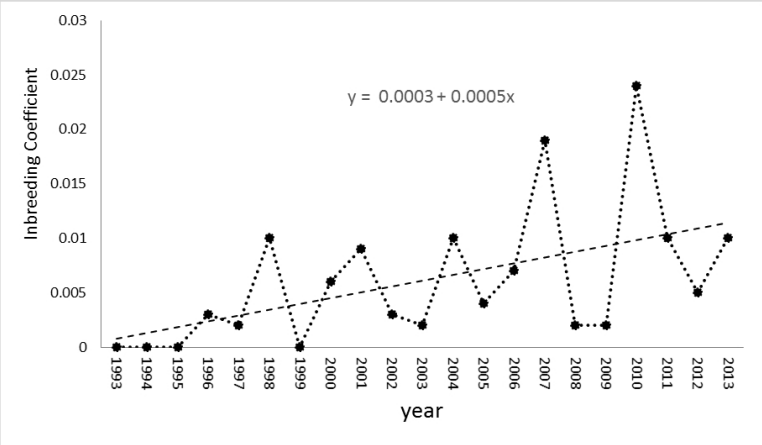

Figure 1 – Evolution of the average inbreeding coefficients of animals born in the MOET Nucleus Selection Scheme of the Brazilian Guzerá Cattle.

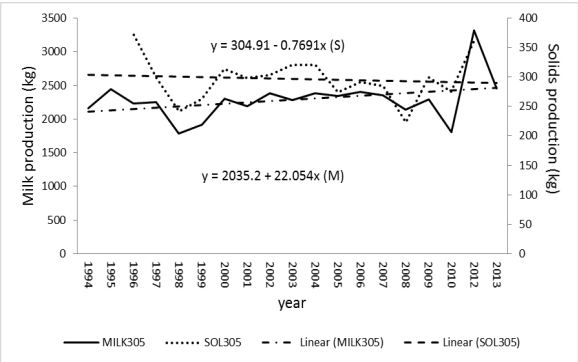

Figure 2 – Phenotypic trends of the average milk (M) and solids (S) production of animals born in the MOET Nucleus Selection Scheme of Guzerá Cattle.

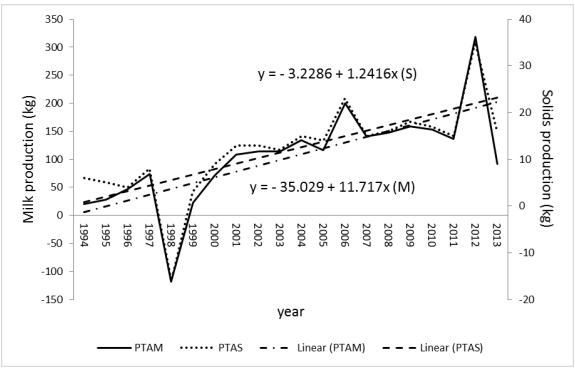

Figure 3 – Genetic trends of the average PTAs for milk (M) and solids (S) production of animals born in the MOET Nucleus Selection Scheme of Guzerá Cattle.

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