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Parâmetros genéticos para características relacionadas à produção de oócitos e embriões em doadoras da raça Guzerá.

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Resumo: O objetivo desse estudo foi estimar componentes de variância para características relacionadas à produção de oócitos e embriões em fêmeas da raça Guzerá. As características avaliadas foram: número total de oócitos aspirados (N_{OC}), número de oócitos viáveis aspirados (N_{OV}), número de oócitos inviáveis (N_{UNV}), número de oócitos grau I aspirados (N_{GI}), número de embriões clivados (N_{CLV}) e número de embriões viáveis produzidos (N_{EMB}). Os dados foram obtidos de 4852 registros de aspiração folicular (seguida de fertilização *in vitro* - FIV), em 1013 doadoras da raça Guzerá de diversas idades. Os componentes de variância foram estimados através do método de máxima verossimilhança restrita (REML), em análise univariada sob modelo animal. Herdabilidades estimadas para N_{OC}; N_{OV}; N_{UNV}; N_{GI}; N_{CLV}; N_{EMB} foram, respectivamente, 0,24; 0,23; 0,18; 0,08; 0,17 e 0,15. O efeito de touro utilizado na FIV (pai dos embriões) correspondeu a 2,1% e 6,7% do total da variação encontrada para N_{CLV} e N_{EMB}, respectivamente. Os resultados encontrados nesse estudo sugerem que existe variação genética aditiva para as características estudadas na população.

Palavras–chave: componentes de variância, fertilização *in vitro*, zebu

Genetic parameters for oocyte and embryo production related traits in the Guzerá breed female donors.

Abstract: The objective of this study was to estimate variance components for oocyte and embryo production related traits in Guzerá breed female donors. Traits analyzed were: total number of oocytes punctured (N_{OC}), number of viable oocytes (N_{OV}), number of unviable oocytes (N_{UNV}), number of grade I oocytes (N_{GI}), number of cleaved embryos (N_{CLV}) and number of viable embryos produced (N_{EMB}). Data were obtained from 4852 ovary puncture (OPU) (followed by *in vitro* fertilization - IVF) sessions, from 1013 Guzerá female donors in different ages. Variance components were estimated by restricted maximum likelihood, using a one-trait animal model. Heritabilities estimated for N_{OC}; N_{OV}; N_{UNV}; N_{GI}; N_{CLV}; N_{EMB} were, respectively, 0.24; 0.23; 0.18; 0.08; 0.17; 0.15. The effect of the bull mated with the donor (father of the embryos) attended for 2.1% and 6.7% of the total variance found in N_{CLV} and N_{EMB}, respectively. The results found in this study suggest that there is genetic variation among the population.

Keywords: *in-vitro* fertilization, variance components, zebu cattle

Introduction

Zebu breed cattle depend, increasingly, on the success on reproductive biotechnologies to assure multiplication and/or dissemination of high valued animals, as well as to increase the annual genetic gains (Viana & Camargo, 2007). In the Guzerá breed, reproductive biotechnologies have assumed an important role for it's development, since 1994, when a selection nucleus based on a embryo transfer program (MOET nucleus) was implemented using superovulation methods. Recently, ovary puncture (OPU) followed by *in vitro* embryo production (IVP) biotechnologies have assumed the position of main procedure for multiplication of high genetic merit individuals in zebu cattle breeds.

Reproductive traits are complex biological events, affected by numerous factors. The same can be expected for reproductive biotechnologies related traits, as both processes must share a similar biological background. The success in an embryo transfer program is strongly dependent on the donor cow`s ability to produce oocytes that are viable to *in vitro* embryo production processes. Countless studies have aimed to explain the factors that affect bovine embryo production results, focusing primarily, on environment and technologies involved in the process.

In the only one study found in the literature accounting for the additive genetic variation for OPU/IVP related traits, Merton et al., (2009), using a sire model, reported heritabilities of 0.07 to 0.25 in Holstein cattle. The authors also emphasized the importance of embryo production in genomics era. Considering that, in the future,

genomic selection could be applied at embryo stages; a higher number of produced embryos per donor would allow, consequently, a higher and anticipated selection pressure.

No enough attention have been given to genetic components involved in oocyte and embryo production from zebu breed female donors submitted to ovarian puncture and *in vitro* fertilization. The objective of this study was to estimate, for the first time, variance components and genetic parameters for traits related to follicular aspiration and *in vitro* embryo production in Guzerá breed cows.

Material and Methods

It was analyzed a total of 4852 aspirations, in 1013 Guzerá breed female donors. The sessions occurred between March of 2005 and July of 2013, in 16 herds. The procedures were accomplished by an embryo production central located in Minas Gerais state, Brazil. Animals were 1 to 20 years old at the OPU moment. The genealogic file to determine relations between the 1013 donors included five previous generations. The structures were obtained by transvaginal ovarian puncture guided by ultrasound, followed by *in vitro* fertilization one day after aspiration. The number of sessions varied from 1 to 62 per donor and the intervals between OPU sessions of the same donor varied from 7 to 120 days.

Traits analyzed were: total number of oocytes (N_{OC}), number of viable oocytes/cumulus-oocyte complexes (N_{OV}), number of unviable oocytes (N_{UNV}), number of grade I oocytes (N_{GI}), number of cleaved embryos (N_{CLV}) and number of viable embryos produced (N_{EMB}). Logarithmic transformation was applied to all variables, in order to improve normality, attend for the analysis assumptions and allowing estimation of variance components. The variance components were estimated by restricted maximum likelihood method (REML) using ASREML software (Gilmour et al., 2002), in univariate analyses utilizing animal models.

For the ovarian puncture related traits (N_{OC}; N_{OV}; N_{UNV}; N_{GI}), the model included the herd-year of OPU session; donor's herd of birth; interval between OPU sessions; veterinary responsible for the OPU and season as fixed effects. For embryo production related traits (N_{CLV} e N_{EMB}), in addition to the mentioned fixed effects, the sire whose semen were used for *in vitro* fertilization was included as a non-correlated random effect. The age of the donor (in months) at the OPU moment was included as a covariate for both models (linear and quadratic effects).

Results and Discussion

In table 1, it is shown the descriptive statistics of data (not transformed) utilized for the analyses in this study. Pontes et al., (2010, 2011) reported 23.4 ± 0.7; 12.1 ± 3.9 and 8.0 ± 2.7 viable oocytes obtained per session in Nelore, Gir and Holstein cattle breeds, respectively. The higher means found for Nelore and Guzerá cattle could be associated to selection for reproductive traits applied in these zebu cattle breeds with beef production aptitude. In case of genetic association existence between both reproductive processes (*natural* and *artificial*), selection for better reproductive performance can be, indirectly, selecting animals for higher oocyte and embryo production potential.

Table1. Number of observations (N), median, mean, standard deviation (SD), variation coefficient (CV) and variable ranges found for the traits analyzed (variable not transformed).

Trait	N	Median	Mean	SD	CV(%)	Range
N_{OC}	4852	20.00	25.82	20.84	80.71	0 – 156
N_{OV}	4852	11.00	15.09	12.79	84.75	0 – 94
N_{UNV}	4852	8.00	10.73	9.50	88.53	0 – 87
N_{GI}	4852	2.00	3.30	3.62	109.69	0 – 40
N_{CLV}	4852	8.00	11.19	10.11	90.34	0 – 71
N_{EMB}	4852	4.00	5.81	5.91	101.72	0 – 48

N_{OC} = total number of oocytes; N_{OV} = number of viable oocytes; N_{UNV} = number of unviable oocytes; N_{GI} = number of Grade I oocytes; N_{CLV} = number of cleaved embryos; N_{EMB}= number of transferable embryos.

In table 2, it is shown the variance components, heritability, percentage of the total variance corresponding to the sire (used in IVF) effect and repeatability for the variables studied. Heritabilities found in this study varied from 0.08 (N_{GI}) to 0.24 (N_{OC}). This suggests the existence of important additive genetic variation for oocyte and embryo production related traits in Guzerá cattle, indicating that selection for the number of oocytes could be feasible. Merton et al., (2009) reported genetic correlation of 0.52 between the number of viable oocytes and the number o embryos produced per session. More studies addressing the genetic association among these traits would help to design breeding strategies on selection for the number of oocytes and embryo production traits in Guzerá cattle.

Table2. Estimates of additive genetic variance ($\hat{\sigma}_a^2$); environmental variance ($\hat{\sigma}_e^2$); phenotypic variance ($\hat{\sigma}_p^2$); permanent environment variance ($\hat{\sigma}_{pe}^2$); sire (semen used in IVF) effect variance ($\hat{\sigma}_b^2$); proportion of the total variance coming from de $\hat{\sigma}_b^2$ ($\hat{b}^2$); heritability ($\hat{h}^2$) and repeatability (t), for the transformed variables.

Trait	$\hat{\sigma}_a^2$	$\hat{\sigma}_e^2$	$\hat{\sigma}_p^2$	$\hat{\sigma}_{pe}^2$	$\hat{\sigma}_b^2$	$\hat{b}^2$	$\hat{h}^2$	t
N_{OC}	0.122	0.241	0.510	0.147	-	-	0.24(0.06)	0.53
N_{OV}	0.129	0.263	0.557	0.165	-	-	0.23(0.06)	0.53
N_{UNV}	0.094	0.302	0.500	0.103	-	-	0.18(0.05)	0.39
N_{GI}	0.046	0.465	0.587	0.075	-	-	0.08(0.03)	0.21
N_{CLV}	0.100	0.337	0.575	0.126	0.012	0.021	0.17(0.05)	0.39
N_{EMB}	0.104	0.451	0.701	0.098	0.047	0.067	0.15(0.05)	0.29

N_{OC} = total number of oocytes; N_{OV} = number of viable oocytes; N_{UNV}= number of unviable oocytes; N_{GI} = number of grade I oocytes; N_{CLV} = number of cleaved embryos; N_{EMB}= number of transferable embryos.

Merton et al., (2009) reported heritabilities of 0.25; 0.19 and 0.21, respectively, for the number of viable oocytes, number of cleaved embryos and total number of embryos produced in Holstein female donors, using univariate analysis following a sire model. Heritabilities for N_{OV} and N_{EMB}, which are variables strongly related to direct success on IVP, were low to moderate (0.23 and 0.15). The additive genetic variation found for N_{GI} suggests that the oocyte quality improvement involves, primarily, environmental, handling and technological improvements. The proportion of the total variation reported for the sire (used in IVF) effect ($\hat{b}^2$) in N_{EMB} reinforces the importance of male fertility for IVP success as a reproductive technology in cattle.

Conclusions

Results found in this study suggest existence of enough additive genetic variation to allow selection for the traits analyzed in Guzerá breed cows. The improvement of the number of progenies per donor can decrease the costs in embryo production programs and accelerate animal genetic merit assessment in breeding programs. Finally, the proportion of the total variation coming from the sire (utilized in IVF) effect alerts for the importance of male fertility for *in vitro* embryo production results in Guzerá cattle. Studies on genetic association between embryo production related traits, productive (milk, meat…) and (*natural*) reproductive traits would help to assess possible impacts expected when selecting for traits studied in this paper.

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