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Correlação genética e fenotípica entre características relacionadas à produção de oócitos e embriões em doadoras da raça Guzerá.

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Resumo: O objetivo desse estudo foi estimar herdabilidade e correlação genética para características relacionadas à produção de oócitos e embriões em fêmeas da raça Guzerá. As características avaliadas foram: número de oócitos viáveis aspirados (N_{OV}), número de embriões clivados (N_{CLV}), número de embriões viáveis produzidos (N_{EMB}), percentuais de: oócitos grau I aspirados (P_{GI}), embriões clivados (P_{CLV}) e embriões produzidos (P_{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 análises univariadas e bivariadas sob modelo animal. Herdabilidades estimadas para N_{OV}; N_{CLV}; $N_{EMB;}$ P_{OV}; P_{GI}; P_{CLV} e P_{EMB} foram respectivamente; 0,23; 0,17; 0,15; 0,05; 0,03; 0,02 e 0,07. Os resultados encontrados nesse estudo sugerem que existe importante variação genética aditiva para as características estudadas na população. A seleção para N_{OV} parece ser potencialmente mais adequada para inclusão em programas de melhoramento por sua correlação favorável (0,63) com N_{EMB} e por demandar tempo e custo reduzidos para aquisição dos dados, quando comparada com a seleção direta para N_{EMB}.

Palavras–chave: análise bivariada, fertilização *in vitro*, parâmetros genéticos, zebu

Genetic and phenotypic correlations between 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. Analyzed traits were: number of viable oocytes (N_{OV}), number of cleaved embryos (N_{CLV}) and number of viable embryos produced (N_{EMB}), percentages of viable oocytes (P_{OV}), grade I oocytes (P_{GI}), cleaved embryos (P_{CLV}) and viable embryos (P_{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 one and two-trait animal models. Heritabilities estimated for N_{OV}; N_{CLV}; $N_{EMB;}$ P_{OV}; P_{GI}; P_{CLV} e P_{EMB} were, respectively, 0.23; 0.17; 0.15; 0.05; 0.03; 0.02 e 0.07. The results found in this study suggest that there is genetic variation among the population. Selection for N_{OV} seems to be, potentially, more adequate for inclusion in breeding programs due to its favorable genetic correlation (0.63) with N_{EMB} and for demanding reduced cost and time for data acquisition when compared to direct selection for N_{EMB}.

Keywords: bivariate analysis, genetic parameters, *in-vitro* fertilization, zebu cattle

Introduction

Animal reproductive technologies have been successfully applied worldwide, enhancing the importance of female selection in bovine populations (Guerreiro et al., 2014). In zebu breed cattle, ovary puncture (OPU) followed by *in vitro* embryo production (IVP) biotechnology have assumed the position of main procedure for multiplication of individuals of interest. Especially in the Guzerá breed, reproductive biotechnologies have assumed an important role for its development, since 1994, when a selection nucleus based on an embryo transfer program (MOET nucleus) was implemented. Both multiple ovulation and embryo transfer (MOET), and more recently, OPU followed by IVP technologies have been used inside the nucleus in order to accelerate the identification of genetically superior individuals.

Reproductive traits are complex biological events and the same can be expected for reproductive biotechnologies related traits, as both processes must share a similar biological background. Genetic components have been shown to influence OPU/IVP results (Machado et al., 2006; Merton et al., 2009). However, efforts in

science have aimed to explain, mainly, physiological, environmental and technological factors that affect bovine embryo production results.

The genetic correlation consists of a central parameter of quantitative genetics and its estimation is a powerful tool when designing breeding programs. The identification of favorable (and unfavorable) genetic associations between traits of interest can reduce costs, speed up genetic gains and prevent undesirable impacts on correlated traits.

Little 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. In order to analyze genetic associations between traits related to *in vitro* embryo production, the objective of this study was to estimate heritabilities and genetic correlations for numerical and percentage embryo production traits 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 2005 and July 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: number of viable oocytes (N_{OV}), number of cleaved embryos (N_{CLV}) and number of viable embryos produced (N_{EMB}), percentages of viable oocytes (P_{OV}), grade I oocytes (P_{GI}), cleaved embryos (P_{CLV}) and viable embryos (P_{EMB}). Percentage traits (P_{GI}, P_{CLV} and P_{EMB}) were calculated as proportions of N_{OV}, except for P_{OV}, which was calculated as a proportion of the total number o oocytes. 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), utilizing animal models. Estimates of variance components were obtained by univariate analyses and covariances by bivariate analyses. Values of heritability obtained in univariate analysis did not differ significantly from bivariate analyses.

For the ovarian puncture related traits (N_{OV}; P_{OV}; P_{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}; $N_{EMB;}$ P_{CLV}; P_{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. Merton et al., (2009) reported, in *Bos taurus*, means of 7.8; 4.4 and 1.8, respectively, for the number of viable oocytes, number of cleaved embryos and number of produced embryos; and 26.6 %; 53.6 % and 22.4 %, respectively, for mean percentages of grade I oocytes, cleaved embryos and embryos produced (as proportions of the number of viable oocytes).

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_{OV}	4852	11.00	15.09	12.79	84.75	0 – 94
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
P_{OV}	4852	55.00%	58.94%	14.66%	24.87	0-100%
P_{GI}	4852	24.37%	22.69%	18.93%	83.42	0-100%
P_{CLV}	4852	68.50%	65.43%	19.53%	29.84	0-100%
P_{EMB}	4852	30.57%	34.84%	20.26%	58.15	0-100%

N_{OV} = number of viable oocytes; N_{CLV} = number of cleaved embryos; N_{EMB}= number of transferable embryos; P_{OV} = percentage of viable oocytes; P_{GI} = percentage of grade I oocytes; P_{CLV} = percentage of cleaved embryos; P_{EMB} = percentage of viable embryos

The present study indicates that Guzerá breed's oocyte and embryo production traits seem to behave differently from *Bos taurus* breeds, especially when considering absolute numbers (count) traits (N_{OV}; $N_{CLV;}$ N_{EMB}).

In table 2, it is shown the estimates of heritability (on the diagonal, in bold), genetic correlations (under diagonal) and phenotypic correlations (above diagonal). Heritabilities found for oocyte production traits varied from 0.15 (N_{EMB}) to 0.23 (N_{OV}). However, heritabilities for percentage traits were found to be low, varying from 0.02 (P_{CLV}) to 0.07(P_{EMB}). Selection for higher percentages of oocyte and/or embryos may not be as successful as selecting for the total number of structures. Higher impacts on percentage traits may be acquired when applying environmental and/or technological improvements.

Table2. Estimates of heritability (diagonal); genetic correlation (under) and phenotypic correlations (above) of the variables analyzed in this study and it`s associated standard error (in parenthesis).

Trait	N_{OV}	N_{CLV}	N_{EMB}	P_{OV}	P_{GI}	P_{CLIV}	P_{EMB}
N_{OV}	**0.23(0.06)**	0.72(0.01)	0.72(0.01)	0.35(0.01)	-0.40(0.02)	-0.09(0.01)	-0.22(0.01)
N_{CLV}	0.88(0.07)	**0.17(0.05)**	0.79(0.01)	0.27(0.01)	-0.33(0.01)	0.30(0.01)	-0.02(0.02)
N_{EMB}	0.63(0.05)	0.87(0.05)	**0.15(0.05)**	0.24(0.01)	-0.22(0.01)	-0.21(0.01)	0.54(0.01)
P_{OV}	0.41(0.21)	0.38(0.22)	0.34(0.22)	**0.05(0.02)**	-0.10(0.01)	0.03(0.01)	0.03(0.01)
P_{GI}	-0.18(0.22)	-0.55(0.25)	-0.33(0.19)	-0.49(0.27)	**0.03(0.01)**	0.06(0.01)	0.14(0.01)
P_{CLV}	-0.56(0.25)	-0.46(0.23)	-0.47(0.23)	0.11(0.21)	0.50(0.27)	**0.02(0.01)**	0.45(0.01)
P_{EMB}	-0.37(0.19)	-0.34(0.20)	0.21(0.17)	0.16(0.23)	0.13(0.23)	0.34(0.20)	**0.07(0.03)**

N_{OV} = number of viable oocytes; N_{CLV} = number of cleaved embryos; N_{EMB}= number of transferable embryos; P_{OV} = percentage of viable oocytes; P_{GI} = percentage of grade I oocytes; P_{CLV} = percentage of cleaved embryos; P_{EMB} = percentage of viable embryos

Genetic correlation between N_{OV} and N_{EMB} was moderate to high (0.63). However, negative association was detected between N_{OV} and all percentage traits ($P_{GI;}$ $P_{CLV;}$ P_{EMB}) but P_{OV}. This suggests that selection for N_{OV} may increase the total number of embryos produced, but will decrease the percentage of viable embryos (as a proportion of viable oocytes cultured). Both phenotypic and genetic correlations for P_{GI} were negative, excepted for P_{CLIV} and P_{EMB}, which indicates an important association between oocyte quality and the success in IVP.

Conclusions

Results found in this study suggest that selection for *in vitro* production efficiency can be applied in Guzerá breed cows due to the genetic variation present in the traits analyzed. Selection for N_{OV}, due to its moderate heritability and positive association with N_{EMB} seems to respond well to selection, indirectly increasing the number of total embryos produced. Direct selection to N_{EMB} can also be applied, but would require more time for data availability, which consequently implies in higher costs.

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