Genetic parameters of rectal temperature in sows in a tropical humid climate and its association with performance during lactation: preliminary results

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GENETIC PARAMETERS OF RECTAL TEMPERATURE IN SOWS IN A TROPICAL HUMID CLIMATE AND ITS ASSOCIATION WITH PERFORMANCE DURING LACTATION: PRELIMINARY RESULTS

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INTRODUCTION

In tropical areas, ambient temperature and humidity are frequently high. Moreover, buildings for animal production systems are usually opened or semi-opened to the outdoor ambient environment. Under these conditions, lactating sows, more than pigs in other physiological stages, often suffer from heat stress because of their high nutrient requirements. In consequence, sow performances are dependent on their ability to tolerate heat (Gourdine et *al.*, 2004).

To establish whether the selection of sows for heat tolerance is feasible, genetic variation of thermoregulation traits and its relationships with production traits must be better understood. In contrast to other species like ruminants (Turner, 1984; Burrow, 2001) or chickens (Obeidah et *al.*, 1974; Taouis et *al.*, 2002), genetic variation for thermoregulation criteria is poorly known in the pig.

Inner temperature of homeothermic animals like pig is the result of the entire thermoregulation process, its measurements by rectal temperature is simple and the material is inexpensive.

The objective of this preliminary study is to evaluate genetic parameters of thermoregulation and its association with performance during lactation in our tropical humid experimental conditions, through rectal temperature measurements of Large White (LW) lactating sows.

MATERIAL AND METHODS

Data. The data used in this study were collected in LW lactating sows between 1999 and 2005 at the INRA experimental farm of Duclos – Petit Bourg, in the French West Indies (Lat. 16°N, Long 61°W). This area is characterized by a tropical humid climate. Two seasons of lactation were determined from means and daily variations in ambient and relative humidity recorded near the experimental farm: a warm season from November to April (ambient temperature: 23.8 ± 0.8°C; relative humidity: 86.0 ± 8.7%) and a hot season from May to October (26.0 ± 0.5°C; 83.3 ± 10.5%). The 94 lactating sows were the progenies of 24 sires and 57 dams; a total of 356 litters were produced. The pedigree of each generation (sires and dams) till foundation generation was available and used in this study (246 animals).

The lactation diet was formulated to meet or exceed requirements for all nutrients and sows were fed *ad libitum* from day 6 *post-partum*. Lactation length was approximately 4 weeks (27.4 ± 2.4 d on average). Sow body weight (BW) was measured on the day after farrowing and at weaning and piglets were individually weighed each week, from birth to weaning. Sow BW loss was expressed as a percentage of BW at farrowing. During the 48-h post farrowing period, litter size was standardized by cross-fostering at 10 or 11 piglets per litter. For all sows, daily feed intake was determined as the difference between the amount of feed offered and the amount of refusals collected on the next morning. Rectal temperature was measured twice daily with a digital thermometer (Microlife Corporation, Paris, France), every Monday and Thursday during the lactation period.

The traits analyzed were rectal temperature during lactation measured at 0700 (RT_7) and at 1200 (RT_{12}), and the difference between RT_{12} and RT_7 (dRT), daily feed intake during *ad libitum* period in lactation (DFI), litter growth rate (LGR) and sow relative body weight loss during lactation (BWL).

Statistical analysis. All traits were normally distributed so that standard mixed linear model procedures were considered adequate to analyze the data. The VCE program (Kovac et *al*., 2002) was used to estimate genetic parameters by Restricted Maximum Likelihood Methodology applied to univariate and multivariate animal models. Two levels of repetition were considered: successive lactations of the same sow and for RT_7, RT_{12}, dRT and DFI repeated measurements during lactation on the same trait. LGR and BWL were single traits. Because of the low number of sows per batch, contemporaneous groups were formed by the combination of consecutive batches within the same season and the same year (20 groups).

For univariate analyses, the model for repeated data included the batch-season-year interaction, the parity (1,2-3 and more than 3) and the stage of lactation as fixed effects, with the direct additive genetic value of each sow, the maternal permanent environment effect, the effect of repeated measurements of the sow within the same lactation and the residual as random effects. The same model, but without the stage of lactation effect was used for LGR and BWL. Metabolic body weight was added as a covariate for DFI and LGR.

For multivariate analysis, mean values of repeated data (RT_7, RT_{12}, dRT and DFI) were considered. The data set was too small to allow a single five-trait REML analysis. Hence, fifteen successive bivariate analyses were performed with the same model as for univariate analyses. The results of these models were combined to get mean estimates of heritabilities.

RESULTS AND DISCUSSION

Means and estimated phenotypic and genetic standard deviations are presented in table 1.
In our experimental tropical humid conditions, the daily feed intake of LW lactating sows during the fed-to-appetite period averaged 4.73 kg/d, litter growth rate was around 1.93 kg/d and sows lost on average 0.072 of their BW at farrowing. Rectal temperature was higher at 1200 (RT_{12}) than at 0700 (RT_{07}) which coincides with the higher values of ambient temperature at 1200 (28.2 and 31.9°C in the warm and the hot seasons, respectively) than at 0700 (21.7 and 24.2°C in the warm and the hot seasons, respectively).

Table 1. Means, phenotypic and additive genetic standard deviation

Traits	N	Mean	Phenotypic S.D	Genetic S.D.
Rectal temperature, °C				
RT_7	2,647	38.53	0.56	0.30
RT_{12}	1,219	39.58	0.68	0.39
dRT	1,219	1.02	0.26	0.18
Lactating traits				
DFI, kg/d	7,082	4.73	1.32	0.13
LGR kg/d	356	1.93	0.39	0.00
BWL	356	0.072	0.034	0.013
Parity	356	3.4	1.9	-
Metabolic body weight[A], $kg^{0.75}$	356	60.31	7.02	-

[A] Metabolic body weight was calculated as $(BWw^{1.75} - BWf^{1.75})/[(1.75\times(BWw - BWf)]$ where BWw = sow BW at weaning and BWf = sow BW at farrowing.

The estimated heritabilities, phenotypic and genetic correlations obtained for the 6 traits analysed are shown in table 2.

Table 2. Estimates of heritability (diagonal), phenotypic (below diagonal) and genetic (above diagonal) correlations between the traits studied

	RT_7	RT_{12}	dRT	DFI	LGR	BWL
RT_7	0.28 ± 0.03	0.91 ± 0.03	0.29 ± 0.15	0.82 ± 0.67	-0.35 ± 0.12	0.16 ± 0.69
RT_{12}	0.78	0.32 ± 0.05	0.70 ± 0.05	0.67 ± 0.23	-0.63 ± 0.13	-0.18 ± 0.04
dRT	-0.06	0.58	0.49 ± 0.14	0.88 ± 0.43	-0.61 ± 0.25	0.87 ± 0.42
DFI	0.05	0.13	0.20	0.01 ± 0.03	-0.96[A]	0.52 ± 0.45
LGR	-0.12	-0.26	-0.63	0.33	0.00 ± 0.00	0.75[B]
BWL	0.15	0.09	0.04	0.18	0.50[B]	0.14 ± 0.1

[A]: no convergence, best point found; [B]: no convergence but variation between iterations tended toward zero

Heritability estimates for RT_7 and RT_{12} were moderate and were close to available estimations of rectal temperature in other species (Obeidah et *al*., 1974; Turner, 1984). These results suggest that selection may change thermoregulation capacity in lactating sows in LW breed. However, inner temperature of homeothermic animals is a constrained trait which tends to return to a basis value (around 38.7°C for sows). Consequently, the possibility to select animals for lower rectal temperature is questionable. It is possible that genetic estimation of thermoregulation parameters made from fluctuation with diurnal or seasonal variation is more interesting (Koga et al., 2004). In the present study, heritability and variability for dRT was higher and it seems to be more useful.

Estimates of heritability for performance during lactation (DFI, LGR and BWL) were lower than usual values reported in the literature (Rydhmer, 2000). As reviewed by Eissen (2000), voluntary feed intake is a heritable trait which can depend on the stage of lactation.

Estimates of phenotypic correlations showed large positive correlations between RT_7 and RT_{12}. Phenotypic correlations between thermoregulation traits (RT_7, RT_{12} and dRT) and both DFI and BWL were low. Low to large negative phenotypic correlations were obtained between thermoregulation traits and LGR. Performance traits during lactation (DFI, LGR and BWL) were positively correlated.

The genetic correlations were estimated with large standard errors so that the associations between thermoregulation and performance traits in lactation have to be interpreted with caution. However, a negative correlation between thermoregulatory parameters and LGR can be observed. In tropical beef cattle, negative genetic correlations were found between rectal temperature and growth performance (Turner, 1984; Mackinnon et al., 1991), suggesting that selection for production traits in tropical environment will be most effective in conjunction with selection for heat tolerance.

CONCLUSION

This preliminary study shows the existence of a genetic variability for thermoregulation in our population of Large White sows, which means that there is space for breeding methods. However, additional studies and observations are required to confirm our results and evaluate the relationship between rectal temperature and production parameters, in order to establish an adequate selection criterion with an optimum between production traits and adaptation traits.

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