STUDIES ON HIGH PROLIFIC GENES IN TAIHU PIGS*

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SUMMRY

A series of studies were carried out to seek the genes responsible for the high prolificacy in Erhualian (EHL) pigs. The results showed that the high prolificacy in EHL pigs is affected dominantly by the genes of dam of the litter, not those of the litter itself. As for the component traits of prolificacy of dam, an important findings is that EHL pigs have genes to make more follicles maturated and less follicles produced, and have genes to increase ovulation rate, while Large white (LW) pigs possess genes to increase volume of ovaries and reduce the number of embryos. RFLPs of CYP-21 and TCP-1 loci were detedted and differences were found between EHL and LW, and their importance in prolificacy need to be studied further.

INTRODUCTION

The Chinese Taihu pig is amongst the world's most prolific breeds. It has seven strains, and most of them produce higher litter size than European or America pigs by 3-5 piglets. The mechanisms and the genes responsible for the high prolificacy have been sought on Taihu pigs, especialy on Meishan pigs by many research groups, but different ideas and opinions have been put forward on them (Anderson et al. 1992; Haley et al. 1990; Terqui et al. 1990)Here we summarise the results of studies on the high prolific genes, such as dam genes, the components of dam genes and candidate genes in Taihu pig, using Erhualian pigs, large white and their their different types of crossbrdes and give the suggestions for future researches.

MATERIALS AND METHODS

The litter data of Erhualian (EHL) purebreds and Landrace-Erhualian (L-EHL) crossbreds, farrowed from 1983 to 1991 on the Jiangpu Experimontal pig Farm of Nanjing Agricultural University are used to study the dam gene effects on prolificacy when they are mated to different breeds of boars. The prolificacy is defined as litter size total and alive at birth (TLS and LSA). Parities are divided into three groups: first parity, second parity and third and more. Data were analysed with least-square methods.

A crossbreeding experiment using Large White (LW) and Erhualian (EHL) pigs was conducted from 1991-1993 on the Jiangpu Experimental Pig Farm of Nanjing Agricultural University and five groups of animals were produced as purebred EHL, LW, F_1(EHL♂×LW♀ and LW♂×EHL♀), F_2(EHL-LW♂×LW-EHL♀ and LW-EHL♂×EHLLW♀) and backcrossbreds (LW♂×LW-EHL and EHL-LW♂×LW♀). 3~11 gilts of each groupe were sampled and slaughtered on day 28~30 pregnancy in order to measure the volume of ovaries (VO in cm^3), ovulation rate (OR, counts of corpora lutea), visible follicles (VF, ≥2mm), length and volume of uterine horns (LUH and VUH in cm and cm^3), and number of embryos (NE). Based on the components of means proposed by Mather and Jinks (1977), the additive and dominance effects for these traits are estimated by multi-regression analysis methods.

The blood samples were collected from unrelated animals of EHL and LW. Genomic DNA of each sample was extracted and used for RFLPs detection in CYP-21 and TCP-1 loci. After digestion of 10ug of each DNA sample with the restriction enzymes Ban I, Bcl I, Bgl II, EvoR I, Hind III, Msp I, Pst I, Pvu II, Rsa I or Taq I (Biolabs), the DNA fragments were seperated via electrophoresis in 0.8 or 0.9% agarose gels and transferred onto Nylon membrane. The Membranes were hybridized with the digoxigenin-dUTP-labelled CYP21 swine probe or TCP-1 human probe, and hybrids were detected by enzyme immunoassay according to suppliers instructions (Boehringer).

RESULTS

The least-square analysis demonstrated that there are no significant differences in TLS and LSA ($p>0.05$) among the groups of EHL sows when they were mated to EHL, Landrace (L), LW or Duroc (D) boars, although EHL sows mated to D boars have higher TLS than those to L

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boars by 1.38 piglets. Especially in LSA, the differences among groups become more and more smaller(Table 1). The phenomenon is also found in L—EHL sows when they were mated to D or LW boars, giving almost same litter performance(Table 2). Clearly, if a sow possesses the high prolific genes, no matter which boar to mate, it gives high litter size.

Table 1. Least—square means(LSM) of litter performance in EHL purebreds mated to different breeds of boars *

Mating system		TLS		LSA	
Boars	Sows	NF **	LSM	NF	LSM
EHL	EHL	44	13.92a	42	12.88a
L	EHL	27	12.93a	25	12.22a
LW	EHL	110	13.17a	110	12.14a
D	EHL	54	14.31a	53	12.54a

* Values in the column with same letter are no significant different($p > 0.05$) and the same below. ** NF— No. of farrowings

Table 2. LSM of litter performance in L—EHL crossbreds mated to D or LW boars

Mating system		TLS		LSA	
Boars	Sows	NF	LSM	NF	LSM
D	L—EHL	297	13.39a	284	12.69a
LW	L—EHL	174	13.21a	170	12.34a

Table 3. Means of the component traits of litter size in pigs

Generation	n	VO	OR	VF	LUH	VUH	NE
EHL	3	19.69	16.67	34.67	587.00	15047.26	13.67
LW	3	32.88	15.33	47.00	524.00	11544.52	11.67
F1	6	34.88	16.50	36.50	515.43	11987.14	12.33
F2	11	24.61	14.55	33.73	510.45	14730.88	12.91
B	9	28.08	15.22	43.22	547.75	15228.28	12.56

Table 4. Additive(d) and dominance (h) effects in the component traits of prolificacy

Trait	m	d	h	h/d
VO	24.6537	5.8488	6.9737	1.1923
OR	15.6528	0.6388	0.1628	0.2549
VF	40.3008	6.6686	−4.2556	−0.6382
LUH	555.3015	22.6836	−40.2683	−1.7752
VUH	14043.0186	1107.8910	−561.5972	−0.5069
NE	12.7990	0.8257	−0.2210	−0.2677

Means of VO, OR, VF, LUH, VUH and NE in EHL, LW, F_1, F_2 and backcrossbreds (B) are showed in Table 3. Except in VO and VF, EHL pigs are superior to LW in other traits.

Additive and dominance effects for these componnent traits of prolificacy are showed in Table 4. LW pigs show larger VO and more VF than EHL pigs, so the formers seem to have overdominance gene in VO while the latter, near completely—dominance gene in VF. In OR and NE, the mode of gene action seems to be intermediate inheritance. In LUH and VUH, LW pigs show partially dominance or overdominance gene effects. General speaking, LW pigs have genes to increase VO and have genes to reduce LUH, VUH and NE, while EHL pigs have genes to reduce the VF and genes to increase the OR.

Table 5. RFLPs Variants of CYP—21 locus in LW and EHL

(DNA fregment size in Kb)

Breeds	Ban I			Hind III		Kpn I					Pst I			Taq I			
	1.4	1.1	1.0	26	18	24	14.5	13.8	10.4	3.5	1.7	1.4	0.9	3.9	2.0	1.9	1.3
LW	+	+		+		+			+	+	+			+		+	
	+			+	+		+		+	+	+	+			+		+
			+		+			+	+	+		+	+				
								+									
EHL		+		+					+	+		+	+		+	+	

Table 6. RFLPs Variants of TCP—1 locus in LW and EHL

Breed	Bcl I			Bgl II			Msp I					
	20.4	14.1	2.6	11.5	6.3	1.9	4.7	4.4	4.2	2.4	1.7	1.6
LW	+			+				+		+	+	
				+	+	+	+		+		+	
EHL	+	+	+		+	+		+		+		+
	+	+		+	+			+				+

Breed	Pst I		Pvu II							Rsa I		
	4.9	4.4	6.7	4.8	2.4	1.8	1.6	1.4	1.0	1.5	0.9	0.8
LW	+		+	+						+		
	+	+		+	+	+	+	+	+			
		+										
EHL	+			+	+	+	+	+	+	+	+	+
											+	+
										+		+

RFLPs of two candidate genes are detected respectively in LW and EHL. In CYP—21 locus, no variety is found in EHL pigs (n = 12), while with 5 enzymes the RFLPs are produced in LW (Table 5). In TCP — 1 locus, RFLPs patterns are great different between LW and EHL pigs (Table 6).

DISCUSSION

Haley et al (1990) reported that there was no difference between the sows mated to same breed boars or another breed boars. LW females, when they were mated to LW boars and Meishan (MS) boars ,produced 10. 2 and 9. 4 piglets in first parity, and 10. 1 and 9. 6 in second parity respectively, while MS sows, mated to LW boars and MS boars gave 13. 3 and 13. 1 piglets in first parity, and 15. 0 and 15. 1 in second parity respectively. The authors considered that the breed difference in the prolificacy is related mainly to the genes of dam of litter, not those of the litter itself. The results of our studies (Table 1 and Table 2) gave futher evidence for this phenomenom. Therefore, the prolificacy depends mainly on whether dams have the high prolific genes or not.

Ovulation rate and embryo survival were examined as component traits of litter size of Meishan pigs by many research groups ,but the reports on them were contradictory. Some researchers considered that high prolificacy of MS pigs resulted from lower embryonic mortality rather than from an elevated ovulation rate(Bazer et al. ,1988; Terqui et al. , 1990), while other researchers have observed higher ovulation rates in MS females than in LW females(Ashworth et al. , 1990; Haley et al. , 1990). Additive and dominace effects analysis in this study showed that EHL females have genes to increase the ovulation rate, while LW females have gene to reduce the number of embryos, or increase the embryo mortality. The important findings of this study is that EHL animals have genes to make more follicles maturated and less follicles produced. EHL females ovulated 16. 67 eggs and remained 34. 67 visible follicles ,while LW females have 15. 33 eggs ovulated and 47. 00 visible follicles unmaturated in average (Table 3). And the F1 animals showed similar figures as the EHL (16. 50 eggs ovulated and 36. 50 VF remained).

Genes that influence the development and reproduction physiology are potential candidates for the high prolificacy in Taihu pigs. The steriod 21—hydroxylase(CYP— 21) converts the substrates 17 — hydroxy progesteron and progesterone into 11 — deoxycortisol and deoxycorticosterone respectively, leading to cortisol and aldosterone synthesis(Geffrotin et al, 1990). TCP —1(t complex polypeptide 1) is one of a group of polypeptides encoded by genes that map within t complex. All naturally occurring t haplotypes exhibit a series of effect on development, spermatogenesis and meiotic recombination(silver, 1981). RFLPs were detected in theses two loci and there are quite differences between LW and EHL pigs. Therefore, their importance in high prolificacy of Taihu pigs , need to be studied in future.

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