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生物技术在猪育种应用中几个问题的讨论

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報告內容

一、影响猪繁殖性状的基因

二、影响猪生长性状的基因

三、影响猪肉质性状的基因

四、影响猪对疾病抗性的基因

五、问题的讨论

1、分子育种对质量性状的作用

2、分子育种对数量性状的作用



一、影响猪繁殖性状的基因



1、已发表的部分论文

基因名称		功能	参考文献
MHC	主要组织相容性复合体	雄性：影响雄激素水平 雌性：影响产仔数	Rothschild, M. F; et al. (1996)
ESR	雌激素受体	影响产仔数	Rothschild, M. F; et al. (1996)
FSH β	促卵泡素 β 亚基	影响产仔数	李宁, 等. (1998)
SLC22A18	溶质载体基因 家族22, 成员8	影响产仔数	Onteru, S. K; et al. (2012)
PL5CR4/5	磷脂爬行酶4/5	影响产仔数	Onteru, S. K; et al. (2011)
EGR2	早期生长应答因子2	影响产仔数	Kwon, S. G; et al. (2016)
LIPG	内皮脂肪酶	影响产仔数	Kwon, S. G; et al. (2016)





2、举例

(1) ESR基因

Rothschild等，通过基因分型，BB型母猪的产仔数比AA型平均要多1.5头。

Proc. Natl. Acad. Sci. USA
Vol. 93, pp. 201–205, January 1996
Genetics

The estrogen receptor locus is associated with a major gene influencing litter size in pigs

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摘要

Identification of individual major genes affecting quantitative traits in livestock species has been limited to date. By using a candidate gene approach and a divergent breed cross involving the Chinese Meishan pig, we have shown that a specific allele of the estrogen receptor (ER) locus is associated with increased litter size. Female pigs from synthetic lines with a 50% Meishan background that were homozygous for this beneficial allele produced 2.3 more pigs in first parities and 1.5 more pigs averaged over all parities than females from the same synthetic lines and homozygous for the undesirable allele. This beneficial ER allele was also found in pigs with Large White breed ancestry. Analysis of females with Large White breed background showed an advantage for females homozygous for the beneficial allele as compared to females homozygous for the other allele of more than 1 total pig born. Analyses of growth performance test records detected no significant unfavorable associations of the beneficial allele with growth and developmental traits. Mapping of the ER gene demonstrated that the closest known genes or markers were 3 centimorgans from ER. To our knowledge, one these, superoxide dismutase gene (SOD2), was mapped for the first time in the pig. Analysis of ER and these linked markers indicated that ER is the best predictor of litter size differences. Introgression of the beneficial allele into commercial pig breeding lines, in which the allele was not present, and marker-assisted selection for the beneficial allele in lines with Meishan and Large White background have begun.





(2) FSH β 基因

李宁、赵要风等，通过基因分型，BB型母猪的产仔数比AA型平均要多1.5头



FSH β 座位与控制猪产仔数的主效基因连锁

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摘要：定位控制畜禽数量性状的主效基因具有重要的科学理论意义和经济利用价值。通过候选基因鉴定,本研究确定了促卵泡素 β 亚基(FSH β)座位与控制猪产仔数的主效基因连锁。在大约克、杜洛克、长白和二花脸猪合成系中,FSH β 优良等位座位均存在。FSH β 座位影响猪产仔数的效应达到了极显著水准($P < 0.01$)。对于初胎产仔数,FSH β 优良座位纯合子(BB)母猪与另一个座位纯合子(AA)母猪相比,总产仔数平均每胎可多出2.53头,而活产仔数平均每胎则多出2.12头。对于二胎、三胎和四胎产仔数,尽管优良基因的效应在下降,但始终存在,并且BB基因型母猪每胎平均要比AA基因型母猪高出1.5头以上。由于优良等位座位控制猪产仔数的效应明显,因此可以在猪育种上利用标记辅助选择技术来改良产仔数性状。



二、影响猪生长性状的基因



1、已发表的部分论文

基因名称		功能	参考文献
GH	生长激素基因	促进生长	Vize, et al. (1987)
IGF2	胰岛素样生长因子	促进肌肉生长	Anne-Sophie, V. L. (2003)
GHR	生长激素受体	影响生长	Yue, M. et al. (2016)
BMP2	骨形态发生蛋白2	影响胴体长度	Blaj, I. et al. (2018)
MAP3K5	有丝分裂原活化蛋白激酶5	影响日增重和饲料效率	Pu, L. et al. (2016)
MSTN	肌生成抑制蛋白基因	双肌性状	Ren, H. et al. (2020)
MEF2C	肌生成转录因子2C	双肌性状	Ren, H. et al. (2020)
SCD5	硬脂酰辅酶A去饱和酶	双肌性状	Ren, H. et al. (2020)





2、举例

(1) 转GH基因

陈永福、李国豪等。表现为促进生长，易得病。

(2) 敲除MSTN基因

李宁等，表现为促进生长，易得病。





2、举例

(3) ZBED6作为肌肉发育模型

据介绍，能提高瘦肉率，降低脂肪，而且不影响成年后的产仔数。能否在商品猪种中应用有待进一步研究



三、影响猪肉质性状的基因



1、已发表的部分论文

基因名称		功能	参考文献
HAL	氟烷基因	导致PSS，出现PSE肉	Sellier, P. et al. (1994)
RN	酸肉基因	影响肉PH值	Sellier, P. et al. (1994)
RYR	兰尼定受体基因	控制Ca ⁺⁺ 通道，影响猪对氟烷基因的敏感性	Sellier, P. et al. (1994)
PLINI	脂素1	和脂肪代谢有关	Li, B. et al. (2018)
CAPN1	钙蛋白酶1	与肉的嫩度有关	Yang, X. et al. (2007)
CAPN3	钙蛋白酶3	与肉剪切力有关	Yang, X. et al. (2012)
PGC-1 α	过氧化物酶增殖激活受体 γ 共激活因子1 α	与肉剪切力有关	Yang, X. et al. (2012)





2、举例

(1) 氟烷敏感基因（隐性）

① 氟烷检测

阳性: nn

阴性: NN, Nn

② 分子检测，可区分三种基因型: NN、Nn、nn

不利方面: 应激敏感综合征, PSE肉

有利方面: 肌肉丰满, 瘦肉率高





(2) 酸肉基因（显性）

第15号染色体上PRKAG3是RN基因的候选基因。

RN基因携带者肌肉中糖原含量较高，酵解后产生的乳酸量多，导致PH下降。

不利方面：系水力差，造成烹调和加工损失。

有利方面：剪切力较小，风味较好，瘦肉率高，腿臀比例大。



四、影响猪疾病抗性的基因



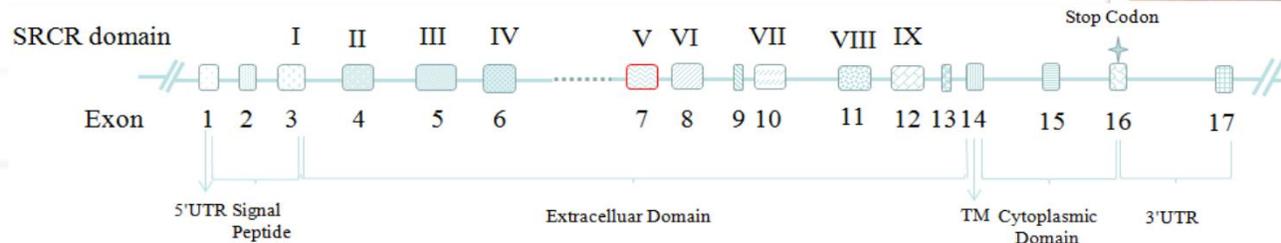
1、已发表的部分论文

基因名称		功能	参考文献
NRAMP1	自然抗性相关巨噬细胞蛋白1	与细胞内病原体的免疫应答有关	Ding, X. et al. (2014)
BPI	杀菌通透性增强蛋白	与猪对沙门氏菌感染的抗性有关	Miguel, M. A. et al. (2019)
TLR4	Toll样受体4	与免疫应答有关	Wang, J. et al. (2013)
FUT1	α - (1, 2)岩藻糖基转移酶	与猪呼吸生殖综合征病毒和副猪嗜血杆菌感染的抗性有关	Wang, S, J. et al. (2011)
HDAC6	组蛋白脱乙酰基酶	增强对PRRSV感染的抗性	Lu, T. et al. (2017)
PBD-2	重组猪 β 防御素2	PBD-2过表达能增强对胸膜肺炎支原体的抵抗力	Yang, X. et al. (2015)



2、举例

(1) CD163: 介导PRRSV入侵的重要受体基因，已用于抗蓝耳病（呼吸生殖综合征）抗性的育种



Int. J. Biol. Sci. 2019, Vol. 15 481
 IVYSPRING INTERNATIONAL PUBLISHER
 International Journal of Biological Sciences
 2019; 15(2): 481-492. doi: 10.7150/ijbs.25862

Research Paper
Generation of Pigs Resistant to Highly Pathogenic-Porcine Reproductive and Respiratory Syndrome Virus through Gene Editing of CD163

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 International Journal of Biological Sciences
 2019; 15(9): 1993-2005. doi: 10.7150/ijbs.34269

Research Paper
Deletion of CD163 Exon 7 Confers Resistance to Highly Pathogenic Porcine Reproductive and Respiratory Viruses on Pigs

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2020年1月8日，CD163E7D基因编辑大白猪批准进入环境释放



2、举例

(2) 仔猪病毒性腹泻

某些中国地方猪种的抗性强，据分析是缺乏该种病毒的受体基因



五、分析与讨论



1、对单基因决定的质量性状

生物技术应用已取得明显效果

2、对多基因决定的数量性状

生物技术应用还没有足够说服力

(1) 相关反应

(2) 后续观察





中國農業大學
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谢谢!

