

Iowa State University now makes available three pig gene markers for genetic improvement in the pig

MC4R

The melanocortin-4 receptor (MC4R) is expressed in virtually all brain regions of mammals and plays an important role in energy homeostasis. MC4R has been described in several studies as a functional gene controlling several growth and performance traits in pigs. Allele frequencies of a polymorphism (Asp298Asn) were quite different among commercial pig breeds where divergent selection has been practiced intensively. In general, Asn298 allele is associated with higher average daily gain and backfat thickness. Conversely, the Asp298 allele is associated with lean growth with high feed conversion rate. The MC4R 298Asn allele will be a useful marker to increase growth in the relatively slowing breed such as Berkshire and Landrace and used for even faster growth for Duroc breed. On other hand, where high feed cost is concerned and fat reduction preferred, the Asp298 allele is useful for selecting animals with high feed conversion rate and lean growth.

Breed information:

Hampshire breed is nearly fixed with 298Asn MC4R allele.

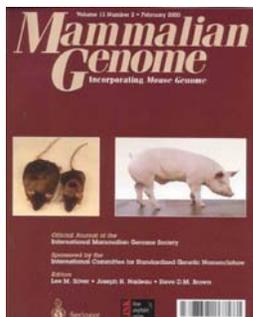
In Duroc breed, the 298Asn allele is 0.56 (Danish Duroc) and 0.73 (Korea)

In Landrace, the 289 Asn allele is 0.29 (Polish), 0.28 (USA), 0.32 (Korea)

In Yorkshire the 289 Asn allele is 0.76 (Polish), 0.57 (USA), 0.75 (Korea)

In Berkshire, the 289 Asn allele is 0.24 (Korea)

See scientific article Kim et al. 2000.



PRKAG3

PRKAG3 is a regulatory subunit of AMP - activated protein kinase, which is involved in the regulation of energy homeostasis in eukaryotes. *PRKAG3* gene was well known for one of its alleles called RN⁻ (200Q), present only in Hampshire pigs. This mutation affects glycogen content in muscle and in general meat quality traits of pigs that include ultimate pH and color measures which are correlated with other characteristics like drip loss, water holding capacity, tenderness, and cooking loss. Another mutation, I199V, which is nearby and causative as well, affects also glycogen content, ultimate pH and color but this mutation is present in all breeds. The favorable allele is 199I and is associated with lower glycogen, higher ultimate pH and favorable color. The differences between homozygotes account for .1 ultimate pH between I/I and V/V animals with the heterozygotes being intermediate. In addition, the I/I animals are significantly better for lower glycolytic potential, better color and Minolta reflectance scores.

Breed frequencies:

Landrace	I 14%	V 86%
Large White	I 22%	V 78%
Berkshire	I 84%	V 16%
Duroc	I 39%	V 61%

In all breeds considerable improvement can be made by selecting the 199I allele. In Berkshire the V allele can be considered a deleterious allele and quickly removed with testing.

CAST

Calpastatin (CAST) is a specific inhibitor of μ - and m-calpain proteases. There is evidence indicating that in different species including the pig, calpastatin activity post mortem is highly related to meat tenderness. We identified two missense mutations (CAST *Hpy188I* or *Arg249Lys* and CAST *PvuII* or *Arg638Ser*) which used in tandem are significantly associated with firmness, juiciness, Instron force, chewiness, and tenderness scores. Both mutations can be genotyped and used individually. For the first mutation the CAST *249Arg* is the favorable allele and is associated with higher tenderness, lower cooking loss and Instron force.

Table 1. Association results between genotypes of *CAST Arg249Lys* and meat quality traits in BxY F₂ animals^{a, b}.

Traits	Genotype			p
	Lys/Lys	Lys/Arg	Arg/Arg	
Firmness	3.21 ^{e,c}	3.44 ^f	3.43 ^d	0.001
Juiciness	6.23 ^a	6.05	5.76 ^b	0.05
Tenderness	8.01 ^a	7.74 ^b	7.75	0.11
Chew score	2.32	2.51	2.54	0.11
Instron force (kg)	4.39 ^a	4.45 ^a	4.63 ^b	0.05

^a n=136 (11), 228-233 (12), and 129-130 (22).

^b Significant differences: a-b, p<.05; c-d, p<.005; e-f, p<.0005.

Table 2. Association results between genotypes of *CAST Arg249Lys* and meat quality traits in commercial animals^{a, b}

Traits	Genotype			p
	Lys/Lys	Lys/Arg	Arg/Arg	
Cooking loss_%	22.29 a,m	23.83 b,i	26.55 n,j	0.0004
Subjective Tenderness	7.68 e,a	7.09 f	7.21 b	0.07

Significant differences: a-b p<.3; c-d p<.1; e-f p<.05; g-h p<.01; i-j p<.005; m-n p<.0005

Similar effects were observed with the second *CAST* mutation: *CAST Arg638Ser*. This mutation was also found to be a significant source of variation for cured ham moisture content. The allele *CAST 638Arg* is associated with higher moisture in the cured ham than *CAST 638Ser*. Both mutations can be used together as a haplotype maximizing the accuracy of selection for tenderness, cooking loss and related traits. Haplotype *249Lys/Arg638* is the favorable haplotype. In all breeds considerable improvement can be made by selecting both *CAST* markers for *249Lys* allele and/or for *638Arg* allele.

Breed frequencies:

CAST Arg249Lys

Landrace	Lys 45%	Arg 55%
Large White	Lys 38%	Arg 62%
Berkshire	Lys 95%	Arg 5%
Duroc	Lys 75%	Arg 25%

Breed frequencies:

CAST Arg638Ser

Large White	Arg 60%	Ser 40%
Berkshire	Arg 95%	Ser 5%
Duroc	Arg 83%	Ser 17%