Rapid communication: Mapping of the pro-opiomelanocortin (POMC) gene to pig chromosome by linkage analysis using a PCR-RFLP

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Marker Name. Pro-opiomelanocortin (POMC).

Genus and Species. Sus scrofa.

Source and Description of Primers. Primers were designed to amplify pig genomic DNA from exon 2 to exon 3 using porcine POMC cDNA sequence (Genbank accession no. X03561), based on exon/intron boundary and intron size information of bovine (Genbank J00019) and human (Genbank J00291, J00292) POMC sequences.

Primer Sequences. Forward primer: 5′TGCCTGAA-GATGCCGAGAT3′. Reverse primer: 5′AAGTGGCC-CATGACGTACTT3′.

Method of Detection. PCR amplification was performed in a 10-µL reaction volume using 50 ng of genomic DNA, 0.5 units Taq polymerase (Sigma-Aldrich, St. Louis, MO) with the supplied MgCl2-free buffer, 0.8 mM MgCl2, 200 µM each dNTP, 150 nM each primer, and 1× RediLoad (Research Genetics, Huntsville, AL). “Touchdown” thermal cycling consisted of 10 cycles with annealing temperature starting at 65°C and decreasing 1°C per cycle, followed by 30 cycles with 55°C annealing temperature.

Description of Polymorphism. The ~2,600-bp PCR product was digested with HaeIII to reveal a polymorphism with two alleles (Figure 1), with major bands at 1,100, 460, and 230 bp (allele A) or 670, 460, 380, and 230 bp (allele B). Smaller polymorphic bands were observed, but due to poor resolution they were not used for linkage analysis. Sequencing of the purified PCR product yielded a 128-bp conserved region of exon 2 with homologies of 100% to known pig POMC sequence (Genbank S73519), 95% to known human, macaca, and bovine POMC sequences (Genbank XM_002485, M19658 and V00107, respectively), and 85% to known mouse POMC sequence (Genbank NM_008895).

Inheritance Pattern. A Mendelian pattern of inheritance of POMC was observed in three full-sib families (45 offspring).

Chromosomal Location. In a sex-averaged analysis using the three-generation PiGMaP reference families (Archibald et al., 1995), POMC was linked to several microsatellite marker loci on chromosome 3 (SSC3), including S0002, S0216, S0352, S0372, and S0397, with recombination frequencies of 0.10, 0.11, 0.13, 0.13, and 0.21 and LOD scores of 5.43, 6.09, 4.33, 5.23, and 3.41, respectively.

Frequency. Frequency of the A allele was 0.40 in the Large White (n = 10) PiGMaP grandparents. The A

Figure 1. HaeIII restriction fragment length polymorphism in porcine POMC PCR products electrophoresed in a 4% agarose gel stained with ethidium bromide. Lanes (left to right): pGEM molecular weight marker (Promega, Madison, WI); ~2,600-bp uncut product; AA genotype; AB genotype; BB genotype.
allele was not observed in any of the Meishan grandparents (n = 8). The Wild Boar grandparent was a heterozygote.

Comments. The Pro-opiomelanocortin (POMC) gene encodes for several biologically active peptides, including corticotropin (ACTH), β-lipotropin (β-LPH), α-, β-, and γ-melanocyte stimulating hormone (α-, β-, γ-MSH) and β-endorphin, which affect pigmentation; the immune, central, and peripheral nervous systems; adrenocortical function; and energy regulation (Yaswen et al., 1999). The POMC gene was mapped by FISH to human chromosome 2p23.3 (Zabel et al., 1983; Satoh and Mori, 1997). Recently, a QTL for leptin serum levels and fat mass was localized to HSA2q21 (Comuzzie et al., 1997), making POMC a strong positional candidate gene for human obesity studies. Additional studies have shown that mice lacking POMC-derived peptides are obese and have affected adrenal development and pigmentation, much like humans with POMC deficiency. POMC-deficient mice treated with α-MSH lost 40% of their excess weight after just 2 wk of treatment (Yaswen et al., 1999).

Recent ZOO-FISH experiments have shown conserved synteny between HSA2 and SSC3 (Rettenberger et al., 1995; Goureau et al., 1996). Other HSA2 genes that map to SSC3 include FSHR, LHCGR, APOB, and MDH1. Mapping POMC to SSC3 adds another Type I locus to the established synteny in this region.

Literature Cited


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