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Novel SNPs in the exon region of bovine *DKK4* gene and their association with body measurement traits in Qinchuan cattle

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ABSTRACT. The aim of this study was to determine whether single nucleotide polymorphisms (SNPs) of bovine Dickkopf homolog 4 (*DKK4*) are associated with body measurement traits in Qinchuan cattle. By using PCR-SSCP technology and DNA sequencing, we discovered 5 *DKK4* SNPs in Qingchuan cattle, including -65G>A and -77G>T in the 5'-untranslated region, 1532C>G and 1533T>C in exon 2, and 2088C>T in exon 3. The sequencing map showed that 1532C>G and 1533T>C were in close linkage disequilibrium and were treated as 1532C>G-1533T>C in this study. Allele frequencies were calculated and analyzed by the chi-square test, which showed that -65G>A and 1532C>G-1533T>C were in Hardy-Weinberg equilibrium ($P > 0.05$), whereas -77G>T and 2088C>T were not in all 633 tested Qinchuan cattle individuals ($P < 0.01$). Gene heterozygosity (H_E), effective allele number (N_E), and polymorphism information content (PIC) were 0.407, 1.686, and 0.324 at -65G>A; 0.472, 1.894, and 0.361 at -77G>T; 0.476, 1.908, and 0.363 at 1532C>G-1533T>C; and

0.218, 1.279, and 0.195 at 2088C>T. We also evaluated the potential association of these SNPs with body measurement traits in all 633 individuals; the results suggest that several SNPs in Qinchuan cattle *DKK4* were significantly associated with body length, hip height, rump length, hip width, heart girth, and pin bone width ($P < 0.05$ and $P < 0.01$). These results suggest that bovine *DKK4* could be used as candidate gene for Qinchuan cattle breeding.

Key words: *DKK4* gene; Qingchuan cattle; SNPs; PCR-SSCP; Body measurement traits

