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A nonsense mutation in the soybean pectin methylesterase gene leads to softer cooked beans

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Hardness of cooked soybeans [*Glycine max* (L). Merr.] is an important attribute in food processing. Longer cooking time results in softer cooked bean, but results in undesirable qualities such as darker color and unfavorable tastes and flavors. Thus softer beans after shorter cooking are preferable. Quantitative trait locus (QTL) analysis was performed to reveal the genetic factors associated with the hardness of cotyledons after 10-minutes cooking using a soybean recombinant inbred line population developed from a cross between 'Natto-shoryu' and 'Hyoukei-kuro 3'. Two significantly stable QTLs, qHbs3-1 and qHbs6-1, were identified, for which the 'Hyoukei-kuro 3' alleles contribute to decrease the hardness. The contributions to total phenotypic variance of qHbs3-1 were 47.4% and 44.3% for 2010 and 2011, respectively, and those of qHbs6-1 were 15.8% and 11.6% for the two years, respectively. qHbs3-1 was revealed to encode a pectin methylesterase (PME) gene, which is nonsense mutated in 'Hyoukei-kuro 3.' Using 24 cultivars, analysis of the DNA sequence of this PME gene revealed three patterns of mutations, two of which result in truncated proteins lacking amino acids involving in the enzyme activity and one of which results in an amino acid substitution. We classified the 24 cultivars into four groups based on the sequence. The texture analysis indicated that protein truncation resulted in softer cotyledons of cooked soybeans, which was further confirmed by texture analysis performed using F2 populations of a cross between 'Enrei' and 'LD00-3309,' and between 'Satonohohoemi' and 'Sakukei 98.' It has been postulated that during the cooking process, middle lamella pectin of the cell walls is depolymerized by beta-elimination of methyl-esterified polygalacturonic acids, promoting an increase in cell separation, and this softens the tissues. Our results indicated that methyl/demethylesterification of pectin is primary responsible for the hardness of cooked soybeans.