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学 位 論 文 要 旨

氏名: **Mingfeng Jiang**

題目: Relationship between Cell Wall Characteristics and Fruit Texture in Japanese Pear Cultivars

（　　ニホンナシ果実の肉質の品種間差異と果肉の細胞壁組成との関係　　）

The Japanese pear fruits are crisp, and their sugar content, organic acid content, and texture differ among cultivars. Studies have shown that the content and quality of cell wall materials influences the texture differences between cultivars, and that the size and density of stone cells in Japanese pear help determine the texture. However, such studies are incomplete. In order to clarify which factors influence texture differences between Japanese pear cultivars, we compared Japanese pear cultivars with different textures. We measured the cell wall component in Japanese pear flesh, conducted a morphological observation of stone cells, and recorded the activity of enzymes. Our primary results are presented below.

1. Cell Wall Composition During Japanese Pear Fruit Growth

In order to clarify the relationship between cell wall composition and fruit texture, we compared the major cultivated Japanese pear cultivars ‘Kosui’, ‘Gold-Nijisseiki’, ‘Chojuro’, ‘Hosui’, ‘Zuisyu’, and ‘Ousyu’ which have different textures. We measured the amounts of ethanol-insoluble soluble (EIS), cellulose, and lignin during Japanese pear fruit growth. Flesh hardness at harvest differed according to cultivar and was higher in the rough cultivars ‘Chojuro’ and ‘Gold-Nijisseiki’ than in the soft cultivars ‘Kosui’ and ‘Hosui’. The EIS content increased form late May to early June and then decreased to harvest in all the tested cultivars. The EIS content in late May and early June was strongly correlated with the content at harvest and influenced flesh hardness; it was higher in the rough cultivars ‘Chojuro’ and ‘Gold-Nijisseiki’ which have harder flesh, and was lower in the soft cultivars ‘Hosui’ and ‘Kosui’ which have softer flesh. Cellulose content, lignin content, and 4% KOH hemicellulose content decreased during the early-middle growth stages. The cellulose content was closely linked to the EIS content during late May to early June; it was higher in the rough cultivars ‘Chojuro’, ‘Gold-Nijisseiki’, and ‘Zuisyu’ which have higher EIS content, and lower in the soft cultivars ‘Hosui’ and ‘Kosui’ which have lower EIS content. Lignin content influenced the EIS content from late May to early June; it was higher in the rough cultivars ‘Chojuro’ and ‘Gold-Nijisseiki’ which have higher EIS content, and lower in the soft cultivars ‘Hosui’ and ‘Kosui’ which have lower EIS content. We inferred that the cellulose and lignin content during late May to early June played an important role in the EIS content and also influenced the flesh hardness, the growth of cells, and the softening of Japanese pear cultivars.

2. Accumulation of Photosynthetic Products in the Japanese Pear

The primary component of cell walls is carbon, and studies have shown that the fruit texture is influenced by cell wall composition. In order to determine the relationship between the accumulation

of photosynthetic products and texture differences in the early growth stages of Japanese pear cultivars, we compared the representative rough cultivar ‘Chojuro’ with the soft cultivar ‘Kosui’. We determined the accumulation of photosynthetic products by using ^{13}Carbon (^{13}C) labeling. The EIS content was higher in the rough cultivar ‘Chojuro’ than in the soft cultivar ‘Kosui’. The ^{13}C content in the core and the residue, after the starch has been removed from EIS were also higher in ‘Chojuro’ cultivar than in ‘Kosui’. We inferred that the accumulation of photosynthetic products during the early growth stages was one of the factors that influenced the differences in EIS content and texture in Japanese pear cultivars.

3. Development of Stone Cells in Japanese Pear

The quantity and density of stone cells are important factors that determine the quality of Japanese pear. In order to clarify the effect of the development of stone cells on EIS content, we compared the Japanese pear cultivars ‘Chojuro’, ‘Zuisyu’, ‘Gold-Nijisseiki’, ‘Kosui’, and ‘Hosui’ which have different textures, and determined the ratio of stone cell cluster numbers to cell numbers per unit area (SCCN), means of stone cell cluster areas (MSCCA), and total stone cell cluster areas per unit area (TSCCA) at 30, 45, and 60 days after full bloom (DAFB). The SCCN decreased from 45 to 60 DAFB in all the tested cultivars; however, the MSCCA increased during these stages. The SCCN and TSCCA were higher in the rough cultivars ‘Chojuro’, ‘Zuisyu’, and ‘Gold-Nijisseiki’ than in the smooth cultivars ‘Kosui’ and ‘Hosui’ at 45 and 60 DAFB. These differences were consistent with the differences in EIS content in these stages; the EIS content was higher in the rough cultivars ‘Chojuro’, ‘Zuisyu’, and ‘Gold-Nijisseiki’ than in the smooth cultivars ‘Kosui’ and ‘Hosui’. In addition, we determined that the flesh cells around the stone cells presented a chrysanthemum appearance during fruit development in the rough ‘Zuisyu’ cultivar. We inferred that that the quantity and the density of stone cells played an important role in the texture differences during the growth of Japanese pear fruit.

4. Enzymatic Analysis in Japanese Pear

In order to clarify the effect of biosynthesis of lignin on the development of stone cells, we compared the Japanese pear cultivars ‘Chojuro’, ‘Zuisyu’, ‘Gold-Nijisseiki’, ‘Kosui’, and ‘Hosui’ which have different textures. We determined phenylalanine ammonia lyase (PAL) and peroxidase (POD) activity at 30, 45, and 60 DAFB. PAL is involved in catalysis of the first step of phenylpropanoid pathway by deaminating L-phenylalanine to cinnamic acid, and its activity decreased from 30 to 60 DAFB. POD is the last major enzyme in lignin synthesis, and its activity increased from 45 to 60 DAFB. In addition, PAL and POD activity were higher in the rough cultivars ‘Chojuro’, ‘Zuisyu’, and ‘Gold-Nijisseiki’ than in the smooth cultivars ‘Kosui’ and ‘Hosui’ at 45 and 60 DAFB. We inferred that the PAL and POD activity were factors that influenced the differences in SCCN and TSCCA in Japanese pear cultivars.