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Transgenic Papaya Genome Sequenced

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By a GenomeWeb staff reporter

NEW YORK (GenomeWeb News) – In a paper that made the cover of tomorrow's issue of *Nature*, an international team of researchers report sequencing the first papaya genome.

The sequence — generated from a transgenic papaya — provides insights into the genetic basis of the plant's resistance to some microbial pests and into the properties that separate papaya from other flowering plants. In addition, researchers say, the detailed genetic information may help alleviate the fears of those opposed to transgenic papaya plants.

After pineapple, papaya is Hawaii's second largest fruit crop. In the 1990's, though, a devastating virus called the papaya ringspot virus slashed papaya harvests in that state. Scientists at the US Department of Agriculture, the University of Hawaii, Cornell University, and elsewhere created a genetically modified papaya — resistant to the papaya ringspot virus — by introducing some of the pathogen's genetic information into the papaya.

These genetically modified papaya plants were introduced as crop plants in Hawaii in the mid-1990s and fruit from these plants is currently marketed in the mainland US and Canada. Nevertheless, some countries have resisted the genetically modified papaya citing concerns over the effect the genetic alterations might have.

In an effort to get to the bottom of papaya genetics and the effect of transgenic modifications, the International Papaya Genome Consortium sequenced a red-fleshed transgenic papaya variety called SunUp. The collaboration involved researchers at 22 research institutions in the US and China and was led by Maqsudal Alam, the director of the University of Hawaii's Advanced Studies in Genomics Proteomics and Bioinformatics program.

The team sequenced 75 percent of the entire papaya genome and about 90 percent of its genetically active euchromatin sequence at three times coverage using 2.8 million whole-genome shotgun sequencing reads. When they excluded low-quality reads and sequence that came from organelles, the team was left with 1.6 million high-quality reads, which were assembled into contigs and annotated using the TIGR Eukaryotic Annotation Pipeline. Alam and his colleagues then compared papaya sequences with those of other plants such as *Arabidopsis*, poplar, and grape.

Based on their predictions, the 372 megabase papaya genome contains roughly 23,000 to 25,000 genes. Although it is roughly three times the size of the *Arabidopsis*
genome, the papaya genome has the fewest functional genes of any flowering plant sequenced to date. This may be because — unlike other flowering plants — the papaya genome doesn't seem to have experienced a recent duplication.

Even so, papaya has genetic expansions related to specific functions. For instance, compared to *Arabidopsis*, papaya has more starch-related genes and genes coding for volatile compounds that attract insects and other pollinators. And, consistent with its tree-like characteristics, the papaya genome has more genes related to increased cell expansion and the synthesis of the woody polymer lignin.

Because SunUp is a transgenic papaya variety, the authors noted, sequencing its genome also provides clues about

how transgenic techniques affect genome structure and function. Using Southern blot analysis, they identified three transgenic insertions in the SunUp nuclear genome. These were closely associated with chloroplast DNA sequences and did not appear to disrupt nuclear genes.

Such work provides the basis for future research into compounds of interest in papaya — a plant believed by some to have medicinal properties. And the International Papaya Genome Consortium and others hope that providing detailed genetic information about the SunUp papaya will eventually lead to the introduction of transgenic papayas in new markets.

“Arguably, the sequencing of the genome of SunUp papaya makes it the best-characterized commercial transgenic crop,” the authors wrote. “Because papaya ringspot virus is widespread in nearly all papaya-growing regions, SunUp could serve as a transgenic germplasm source that could be used to breed suitable cultivars resistant to the virus in various parts of the world. The characterization of the precise transgenic modifications in SunUp papaya should also serve to lower regulatory barriers currently in place in some countries.”

The transgenic papaya draft genome sequence has been submitted to GenBank.