Genome Mapping: the Key to Fortifying Arabica

by Diana Jendoubi
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Assistant Professor Jarkko Salojarvi, from NTU Singapore's School of Biological Sciences, co-led an international research team that mapped out the genomes of the Arabica plant (pictured) and two related coffee plants. *Photo credit: NTU Singapore.*

A major breakthrough has been made in the race to save Arabica coffee plants from potential global decimation. Using complex genome mapping, scientists have identified a new combination of genes present in three types of coffee plants resistant to the deadly leaf rust fungus. By identifying other

important traits, such as drought resistance, this vital genome data helps breed a stronger Arabica for the future.

Arabica accounts for 60% of worldwide coffee production. In the 2022/2023 Market Year (MY), about 87.3 million 60kg bags of Arabica were produced, and this number is expected to increase to over 97 million bags in 2024. Coffee enthusiasts love Arabica's unique aromatic qualities and sweet taste. However, such delicate flavors come with a high price.

Due to Arabica's lack of genetic variety, it is highly susceptible to pests, diseases, temperature fluctuations, and drought. For these reasons, Arabica only thrives at high elevations with lots of shade and temperate climatic conditions. The plant's vulnerability is a major liability.

The coffee leaf rust fungus has destroyed entire coffee industries, and many producers live in constant fear of its return. The US Agency for International Development estimated that an outbreak of coffee leaf rust cost Latin America about $1 billion in economic damages between 2012 and 2014.

Assistant Professor Jarkko Salojarvi from NTU's School of Biological Sciences in Singapore, who co-led the international research team, said: "The high-quality genome sequences of the three plant species, together with the candidate genetic sequences for coffee leaf rust resistance, form the cornerstone for breeding new varieties of Arabica plants that are more adaptable to change and more resistant to diseases caused by pathogens like fungi."

Such a massive undertaking involved the combined efforts of researchers from the NTU School of Biological Sciences, the University at Buffalo in New York, the Université de Montpellier in France, and representatives from Nestlé. Coffee breeders from around the world were also consulted.

The study, published in Nature Genetics, was conducted using highly sophisticated and complex DNA sequencing technology to create extremely accurate chromosome conformation. Because Arabica has a very shallow gene pool, scientists also had to map more diverse plants, such as Robusta and *C. eugenioides,* to understand how varieties like the Timor Hybrid became stronger and more resistant.

"The low genetic diversity of both cultivated and wild modern Arabica plants is an obstacle to its breeding using the wild varieties of the plants. But close similarities found between Arabica, Robusta, and *C. eugenioides* plants are likely to facilitate the introduction of interesting traits from the latter two into Arabica," said Assistant Prof Salojarvi.

Finding the perfect balance between Robusta's resistant traits and Arabica's exceptional flavor and aroma is the key to coffee's survival in a world facing climate change, diseases, and pests. Identifying these genetic markers allows breeders to predict coffee seedlings' future performance, saving producers years of waiting and countless expenses. According to the International Coffee Organisation, 125 million people worldwide earn their living from the coffee industry.

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