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First fully open-access *Coffea arabica* genome sequence released

Partnership led by illycaffè and Lavazza fully release today new genome sequence for coffee; it will assist coffee industry to prepare for climate change and improving quality

Today, a partnership led by **illycaffè** and **Lavazza**, together with **Istituto di Genomica Applicata**, **IGA Technology Services**, **DNA Analytica**, and the **Universities of Trieste, Udine, Padova, and Verona**, released the results of the ***Coffea arabica* Genome Sequencing Project**. This unique achievement in genome research will accelerate scientific efforts to ensure the future of coffee agriculture, which is threatened by climate change. World Coffee Research (global coffee industry R&D nonprofit organization) is making the genome sequence available via its website today (worldcoffeeresearch.org/genome). **This is the first genome sequence for *Coffea arabica* fully available to the public.**

The study was initially coordinated by professor Giorgio Graziosi of DNA Analytica Srl. The partnership of Italian researchers, along with world coffee market leaders illycaffè and Lavazza, is an important example of collaboration between the private and public sectors.

Coffee is worth about \$160 billion annually and employs more than 25 million families of farmers globally, according to the International Coffee Organization.

Public-private collaboration to address threats of climate change

*“The genome research is not only a brilliant example of public-private sector collaboration,” says **Andrea Illy, Chairman of illycaffè**, “but is also an important step to support coffee growers around the world, who are already facing the damages of climate change. As indicated by another common research project, also developed with the colleagues from Lavazza together with Earth Institute of Columbia University led by Jeffrey Sachs in 2015, the suitable land for Arabica coffee may be reduced by as much as half by 2050*

due to climate change, at the same time as global demand is expected to nearly double. Research and innovation is one of the most important ways to fight this threat. Making the research results available to everyone is the right thing to do and will maximize the impact of the global effort to make coffee more sustainable”.

Better coffee on the horizon

*“We are proud of having contributed to the unveil of the Arabica DNA, an incredibly important initiative for the coffee sector conducted by a multi-functional team of researchers. The results of this project highlight the importance of working in a pre-competitive approach, which in turn will help improve the entire coffee production supply chain,” comments **Giuseppe Lavazza, Lavazza Vice Chairman**. “The sequencing of the coffee genome gives us the ability to ‘read’ the plant and precisely identify its origins as well as determine, for example, the genes that give it a certain resistance to diseases or infections. This could result in a superior quality coffee end product based on objective criteria. Indeed, excellent quality is the ultimate goal our company has always pursued, and which is the focus of our ongoing research projects”.*

Coffea arabica is one of two species in the Coffea genus consumed globally. It is renowned for its high quality and represents over 60% of coffee production in the world.

For the benefit of coffee producers

*“We are thrilled to be able to convey this Arabica genome to the global coffee and research community freely and openly,” says **Tim Schilling, CEO and founder of World Coffee Research**. “Advanced genetics research is essential to coffee’s future as a sustainable crop, and to exploring the thrilling diversity of flavors found in coffee. Having access to a whole sequenced genome is an essential precursor to unlocking the potential of genetics research to transform coffee production. Utilizing advancements in DNA science for the benefit of coffee producers around the world is the very reason that a collaborative industry research nonprofit like World Coffee Research exists. Our scientists are looking forward to working with other organizations, countries and governments to make use of the treasures within this genome to make coffee more profitable to farmers and better tasting for consumers”.*

In many tropical countries where coffee is grown, coffee production is an essential contributor to the national economy, as well as being one of the world’s most important agricultural commodities. Improvements in coffee production due to advanced applied genetics will have an important positive economic impact globally.

Advancing sustainable coffee production

According to the Food and Agriculture Organization, “Genome sequencing has

the power to revolutionize food security and sustainable agriculture.” The access to Arabica coffee genome enables coffee breeders to accelerate efforts to increase the productivity, quality, and profitability of coffee growing worldwide. Most countries that grow predominantly Arabica coffee have already seen declining production over recent decades.

Having a genome sequence available enables researchers to understand and target key agronomic traits that matter to farmers and coffee drinkers—for example, better or novel flavors, uniform fruit ripening, resistance to disease, adaptation for the hotter, drier climates of the future, or adaptability to growth under shade. Such efforts are expected to have considerable benefits for coffee farmers, coffee drinkers, and the environment.

Genome sequences for other crops allowed breeders to identify the genetic and molecular mechanisms that synchronize the ripening process, improve plants’ resistance to devastating diseases and infections, and to adapt plants for changing climate conditions, including rising temperatures, prolonged droughts, and heavy flooding.

Untangling a complex mystery

“This highly ambitious research project has resulted in the sequencing and reconstruction of the genome of Coffea arabica, an usual plant which has a duplicate set of chromosomes compared with other main cultivated species, Coffea canephora (also commonly called Robusta),” explains professor Michele Morgante, scientific director of the Istituto di Genomica Applicata. “One of the main difficulties was to distinguish between the sequences derived from the two progenitor genomes of Arabica, Coffea canephora and Coffea eugenioides, which are extremely similar. To tackle this problem, we used a hierarchical sequencing approach, in which the genome is divided into relatively small portions before being reconstructed. We are extremely proud to be the first to release the sequence of the Arabica genome and make it available to the scientific community”.

Coffea arabica is a genetically complex species, carrying four copies of each of 11 chromosomes (44 total). Scientists call this a tetraploid species. Arabica is the only tetraploid species in the Coffea family. Technically it is described as an allotetraploid genome, the result of a hybridization between diploid parents *Coffea canephora* and *Coffea eugenioides*.

This genome sequence was derived from a *Coffea arabica* plant of the Red [Bourbon](#) variety.

The genome was sequenced with Illumina technology at the [Istituto di Genomica Applicata](#) in Udine, Italy. Given the inherent complexity of working with a tetraploid genome, it was sequenced using a “hierarchical” approach instead of the more common whole genome shotgun approach. The genome was annotated from the Universities of Padova and Verona. The annotation was

supported by RNA sequencing from 12 different samples derived from 8 different organs.

Key numbers and facts:

- 36,864 genomic fragments were cloned into bacterial artificial chromosomes (BACs) and sequenced in 96 pools of 384 clones
- 488 billion base pairs were produced, corresponding to 132 genome equivalents
- The genome size was estimated to be 1.3 Gb, based on a k-mers analysis
- 96 independent assemblies were generated, using the software programs ABySS and SSPACE, and then merged to generate a multifasta file (downloadable and available below).
- The sequence contains 1.51 billion base pairs, divided into 164,254 scaffold sequences
- 78,311 genes were predicted and functionally annotated in *Coffea arabica*

The first fully open-access Arabica genome

This is the first time that the raw data for a *Coffea arabica* genome is being made publicly accessible. The open-access data files can be downloaded by researchers anywhere in the world on the World Coffee Research website (worldcoffeeresearch.org/genome). Tools to enable browsing of the genome will be released in the weeks ahead.

This action follows the announcement of *Coffea arabica* genome sequencing given by the partnership in March 2014.

About illycaffè

illycaffè is an Italian family business, founded in Trieste in 1933 and committed to offering the greatest coffee to the world. illy is the world's most global coffee brand, producing the unique illy 100% Arabica blend made of 9 of the world's best selections of Arabica; each day more than 7 million cups are served in over 140 countries in the finest cafés, restaurants, hotels and in offices and homes. illy has become the standard forerunner of espresso, and thanks to three critical innovations, is considered the leader in the science and technology of coffee. With the bestowing of the first "Ernesto Illy Award for quality espresso coffee" in 1991 in Brazil, illy also pioneered direct sourcing, sharing know-how and paying a premium price for the best quality, based on partnerships underwritten by the principles of sustainable development. The company also founded the University of Coffee with the aim of fostering and spreading its culture, providing comprehensive academic and hands-on training for coffee growers, baristas and coffee lovers in order to cover every aspect of the product. Everything

'made in illy' is enhanced by beauty & art, which represent founding values of the brand, starting from its logo – designed by an artist, James Rosenquist – and including the renowned illy Art Collection, comprised of over 100 cups designed by international artists. In 2017 the company was employing 1,290 people and posted consolidated revenues of €467 million. There are approximately 244 mono-brand stores in 43 countries.

www.illy.com

About Lavazza Group

Established in 1895 in Turin, the Company has been owned by the Lavazza family for four generations. Among the world's most important roasters, the Group currently operates in more than 90 countries through subsidiaries and distributors, exporting 63% of its production. Lavazza employs a total of about 3,000 people with a turnover of more than €2.0 billion in 2017. Lavazza invented the concept of blending — or in other words the art of combining different types of coffee from different geographical areas — in its early years and this continues to be a distinctive feature of most of its products.

The company also has about 30 years' experience in production and sale of portioned coffee systems and products. It was the first Italian business to offer capsule espresso systems.

Lavazza operates in all business segments: at home, away-from-home and office coffee service, always with a focus on innovation in consumption technologies and systems. Lavazza has been able to develop its brand awareness through important partnerships perfectly in tune with its brand internationalization strategy, such as those in the world of sport with the Grand Slam tennis tournaments, and those in fields of art and culture with prestigious museums like New York's Guggenheim Museum, the Peggy Guggenheim Collection Venice, and The Hermitage State Museum in St. Petersburg, Russia.

As the company continues on a strategic globalization path, the Lavazza Group has acquired local jewels in key markets such as Denmark's Merrild (2015), France's Carte Noire (2016), and North America's Kicking Horse Coffee (2017). Additionally, in 2017 the Group amplified its distribution reach with the acquisition of France's Espresso Service Proximité, Italy's Nims and in 2018 Australia's Blue Pod Coffee Company.

www.lavazza.com

About World Coffee Research

WCR is a nonprofit collaborative research and development program of the global coffee industry to grow, protect, and enhance supplies of quality coffee while improving the livelihoods of the families who produce it. The program is funded and driven by the global coffee industry, guided by producers, and executed by coffee scientists around the world.

www.worldcoffeeresearch.org

About Istituto di Genomica Applicata

The Istituto di Genomica Applicata (IGA) is a nonprofit research institute. The core work is DNA sequencing and the analysis of plant genome structure and evolution. IGA conducts research in plant genetics and genomics, for the identification of genes and their functions to advance the development of agriculture to improve plant breeding in a climate-changing scenario.
www.appliedgenomics.org

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