Professor Chahan Yeretzian’s research extends from ecologically sustainable coffee farming and molecular analysis of its antioxidant properties, to developing new techniques for controlling roasting and assessing aroma in real time.

How did you become a coffee scientist?

My love for coffee started relatively late. During my student years in Bern, Switzerland, I mainly drank coffee to keep me awake during long study hours and nights spent in the lab. It was only when I arrived as a postdoc at the University of California, Los Angeles (UCLA), USA, that I started to discover the sensory facets of a good cup of coffee. At this point, my approach was still purely hedonic, not scientific. Indeed, I did not imagine that coffee or food in general could be a serious subject for academic research.

Later, I was invited to interview for a position at the Nestlé Research Centre in Lausanne, Switzerland. Visiting the Nestlé Lab was my first encounter with the science of coffee. The breadth and depth of research awakened my interest in this highly complex and fascinating field, and I accepted the position. From that point on, the science of coffee has been central to my professional life.

12 years later, an opportunity arose at the Zurich University of Applied Science, where I could freely expand my research into coffee and teach by insight. From the moment I joined, a totally new horizon emerged, showing me that I was at the beginning of a steep learning curve into the entire coffee world outside Nestlé. I became a board member of the Swiss section of the Speciality Coffee Association of Europe, working with the complete industry – large multinational and small coffee companies, baristas, coffee shops, coffee machine manufacturers, etc.

What processes contribute to the quality of a cup of coffee?

From selecting the seed that one plants to the extraction technique and ceremony of consumption and what it is consumed with – espresso after a meal, a coffee latte with a cereal breakfast – every step matters. But irrespective of objective quality criteria, the care given by the people working with coffee, along the whole supply chain, is just as important.

How does the coffee roasting process impact on flavour?

Formation of aroma during coffee roasting is thermally generated. The most important processes are summarised as the Maillard reaction, but caramelisation also plays a role. Roasting starts at about 180 °C and the final coffee aroma profile depends on the process’s time-temperature history.

Several of your grassroots projects work directly with coffee farmers in India and Bolivia. How will these projects encourage ecological and economic sustainability in coffee growing?

The aim is to assist farmers in improving the quality of coffee while respecting farming practices that are sustainable and often traditional in nature: helping the farmers, their families and communities make a living.

It is important that farmers have economic incentive to respect nature and remain sustainable. Too often, the switch to monocultures and emphasis on short-term benefits (which result in long-term harm to communities and ecosystems) are favoured, as sustainable practices often do not allow farmers to earn enough money. Part of my work therefore involves engaging consumers in farming, by bringing farmers from their countries of origin closer to consumers so they pay a fair price. One solution we also consider is direct buying.

Do you collaborate with any other parties in your investigations?

We are working with most of the major players in the coffee industry, as well as with a large number of medium and small coffee companies directly involved in the coffee value chain, developing products and offers that are relevant to the final quality of coffee, such as companies that produce roasters, grinders and coffee machines.

Which developments in coffee research and production have you seen over the course of your career?

There are many. Progress in the understanding of aroma and antioxidant formation during roasting has excited me most. Also, a better understanding of how to predict the quality of coffee from instrumental measurements; vast improvements in farming practices; the rise of coffee culture; and the closer links we’ve made between farmers and consumers.
Black art: the science of coffee

The Center for Analytical and Physical Chemistry at the Zürich University of Applied Science in Wädenswil, Switzerland, leads the world in knowledge of the coffee value chain. From sustaining coffee supplies to enhancing flavour through roasting, grinding, extracting and consuming, the Center is passionate about the perfect cup.

MORE THAN A THOUSAND years ago, the Arabian philosopher Rhazes extolled the medicinal virtues of coffee. Over the following centuries, it became known as a magical decoction, described as having ‘the odour of musk and the colour of ink’. When coffee was introduced to Europe in the 16th Century, it was allotted various health- and energy-giving properties, and since then, many poems and papers have been written on its varieties, qualities and correct preparation.

Today, it is now known that the green, raw coffee bean contains polyphenolic compounds – antioxidants that neutralise free radicals and enhance metabolism and wellbeing. These compounds, which include chlorogenic (CGA), caffeic, ferulic and quinic acids, are degraded through roasting, producing melanoidins. While melanoidins are less well-characterised than CGAs, they are known to play a role in retaining CGAs during the roasting process. Independently of this, melanoidins are responsible for caramelisation (pyrolysis), browning (through the Maillard reaction) and are also thought to have antioxidant properties.

MAXIMISING POTENTIAL

How to maximise the antioxidant content of coffee is one of the topics under examination in the Center for Analytical and Physical Chemistry at the Zürich University of Applied Science (ZHAW Wädenswil) headed by Professor Chahan Yeretzian. Yeretzian’s multidisciplinary and multicultural research group is a globally acknowledged Centre of Excellence in the science and art of coffee. Their studies explore all aspects of coffee along the value chain in order to enhance sustainability in growing regions and improve the end user’s drinking experience. “Coffee reflects human life and work in all its aspects,” Yeretzian explains. “From quality, price and technology issues faced by coffee farmers, plant geneticists and agronomers, and its impact on our global economy and trade, to the barista’s art and the sensory aspects of consumption, coffee is indeed a world within our world.”

It is this acceptance that sets Yeretzian’s team apart; by taking an holistic approach they are able to support all stakeholders in the coffee value chain – implementing best practices for growers and developing tools for companies to ensure greater standardisation and consistency, while at the same time enabling greater differentiation between brands.

ANTIOXIDANTS

The roasting process and its effects on CGA degradation are investigated using online antioxidant assays coupled with high-performance size exclusion chromatography (HPSEC). While the aim is to maximise antioxidant content, this approach supports monitoring of the relative contribution of CGA and melanoidins to overall antioxidant capacity: “We modulate the time-temperature profile and technological features of the roasting process, while systematically analysing the antioxidants and their amounts in the cup,” Yeretzian explains. In doing so, he has found that most melanoidins form in the first stages of roasting – CGA content diminishes while melanoidin generation increases as roasts become darker. From this work, he has developed a ratio of melanoidin-CGA peak as a predictor of ideal roast degree for maximising antioxidant levels.

But it is not only the macromolecular, non-volatile compounds in coffee that are of interest to the researchers at ZHAW. Online automation of the roasting process ensures a consistent roast and end-product profile. As such, Yeretzian and his colleagues have harnessed the power of a real-time tool to monitor volatile organic compounds (VOCs, responsible for coffee’s strong flavour) with high sensitivity and chemical selectivity in the off-gas of a roaster – a proton-transfer-reaction time-of-flight mass-spectrometry.
The ultimate test of quality lies in coffee’s aroma, taste and texture.