

### Investigating the Antioxidant Capacity of Coffee!

**Abstract:** In the 1990s we began to understand that free radical damage is involved in artery-clogging atherosclerosis and health problems like vision loss, cancer or chronic diseases. Studies have shown that the damage especially affects people with a low consumption of antioxidant-rich fruits, vegetables...and coffee. Is this just a fairy tale promoted by the coffee industry? Scientists at the Zurich University of Applied Sciences (ZHAW) in Wädenswil wanted to get to the bottom of the question.

**Keywords:** Antioxidant potential · Coffee · Folin-Ciocalteu reagent (FCR) · Roasting conditions

For some years now there have been reports on epidemiological evidence suggesting that a few cups of coffee a day reduce the risk of the development of certain neurological disorders such as Parkinson's disease, as well as inflammatory and cardiovascular disorders, type 2 diabetes, liver disease and various types of cancers.

### Knowing is Better than Believing

The group headed by Professor *Chahan Yeretzian* at the Zurich University of Applied Sciences in Wädenswil wanted to know for sure. ZHAW Wädenswil is a centre of expertise in the Science and Art of Coffee and boasts highly qualified specialists with experience in coffee. ZHAW possesses an excellent infrastructure with state-of-the-art technologies for analysing key coffee ingredients and for processing coffee from the green bean to the cup.



Aspects of laboratory work: ZHAW Wädenswil is a centre of expertise in the Science and Art of Coffee and boasts highly qualified specialists with experience in coffee.

Addressing the issue of antioxidants and their link to potential health benefits, Chahan Yeretzian referred to one of the weak points that need to be addressed, *i.e.* the analytical techniques commonly used to measure and quantify antioxidants in coffee. Indeed, if we want to ascertain a potential link between coffee antioxidant and our well-being and health, the first step is to develop accurate and validated methods for quantifying antioxidants in coffee, examine the contribution of specific compounds to the overall antioxidant potential and explore the interactions and reactivities of these antioxidants with coffee components. But unfortunately, much remains to be done here. A wide range of methods are reported and used with limited insight into the underlying chemistry. This stands in the way of a rational interpretation of the differences between the responses observed across different assays and, ultimately, the link between antioxidant content and claimed health benefits. But measuring the influence of roasting conditions on the antioxidant values of coffee brews, for example, calls for sound knowledge of specific antioxidant assay methods.



ZHAW possesses an excellent infrastructure with state-of-the-art technologies for analysing key coffee ingredients and for processing coffee from the green bean to the cup.

### The Agony of Choice

The ZHAW team set out to revisit a range of antioxidant assays. They then created a platform composed of three complementary and validated antioxidant assays: Folin-Ciocalteu reagent (FCR) is a mixture of phosphomolybdate and phosphotungstate used for the colorimetric *in vitro* assay of phenolic and polyphenolic antioxidants. ABTS, or 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid), is a chemical compound used to observe the reaction kinetics of specific enzymes, while ORAC (oxygen radical absorbance capacity) is a method of measuring antioxidant capacities in biological samples *in vitro*. The first two methods are based on electron transfer reactions: the FC assay for total phenols and the ABTS assay which, on oxidation, forms the cationic chromophore ABTS. The third assay, ORAC, is based on hydrogen atom transfer, in which the antioxidant and the sub-

strate fluorescein compete for thermally generated peroxy radicals after their formation by the decomposition of 2,2'-azobis-2-amidinopropane, dihydrochloride (AAPH).

“Given the many assays that have been reported for measuring antioxidants, we have focused on identifying a small group of validated assays that can reliably measure the total antioxidant capacity in coffee brews, and the antioxidant capacity of various coffee components that have been associated with potential beneficial health effects”, comments chemist and coffee specialist Chahan Yeretzian. However, the interpretation of results is complicated by the complexity of coffee brews. One approach might involve chromatographic separation of the components of the brews prior to antioxidant analysis. Additionally, rapid assessment of the antioxidant capacity is important because of the possible occurrence of unwanted oxidation processes during the separation, and also because of possible synergistic effects of antioxidant mixtures in real food samples.



Dr. Alexia Gloess analysing and discussing results with Prof. Dr. Chahan Yeretzian. (Pictures ZHAW Wädenswil)

## A Single Platform for all Analyses

“The principal aim of this work has been to develop a platform of antioxidant assays that can be used routinely for the assessment of coffee brews and quality control”, recalls Chahan Yeretzian. “However, all assays are based on chemical reactions, and it is a big, and not altogether justifiable, step to equate their results with any specific health consequences arising from consumption of the beverage.” Nevertheless, because of the currently held common view that antioxidants in foods convey health benefits to the consumer, it is important to have a set of simple and reliable assays that can be used for the characterization and quality control of the product. The methods developed by the ZHAW researchers have been chosen to measure different aspects of the antioxidant activity in coffee brews, and thus to produce a more differentiated and complete picture of their antioxidant activities than can be obtained with a single assay. The three assays have been thoroughly validated and are now suitable for routine measurements. While fundamental studies aimed at acquiring a better understanding of the underlying chemical processes of these assays are under way, they are currently also being used within a larger project designed to maximize the antioxidant potential of coffee *via* specific time-temperature roasting profiles. This research has led to a series of publications,<sup>[1,2]</sup> and more are expected as the ZHAW team progresses in their endeavour.

For further information please contact Professor Chahan Yeretzian, Life Sciences and Facility Management, ZHAW Wädenswil, E-mail: [chahan.yeretzian@zhaw.ch](mailto:chahan.yeretzian@zhaw.ch), [www.icbc.zhaw.ch/coffee](http://www.icbc.zhaw.ch/coffee)

Received: December 5, 2013

- [1] S. Petrozzi, F. Wieland, A. N. Gloess, L. D'Amberoso, C. Yeretzian, 'Flow Injection Analysis for the Direct Quantification of the Total Polyphenol Content in Coffee Brews', *J. Flow Inj. Anal.* **2011**, 28, 23.
- [2] S. Smrke, S. Opitz, I. Vovk, C. Yeretzian, 'How does roasting affect the antioxidants of coffee brew? Exploring the antioxidant capacity of coffee via on-line antioxidant assays coupled to size exclusion chromatography', *Food & Function* **2013**, 4, 1082.