



Tracking your extraction

TDS, acidity and brewing chart

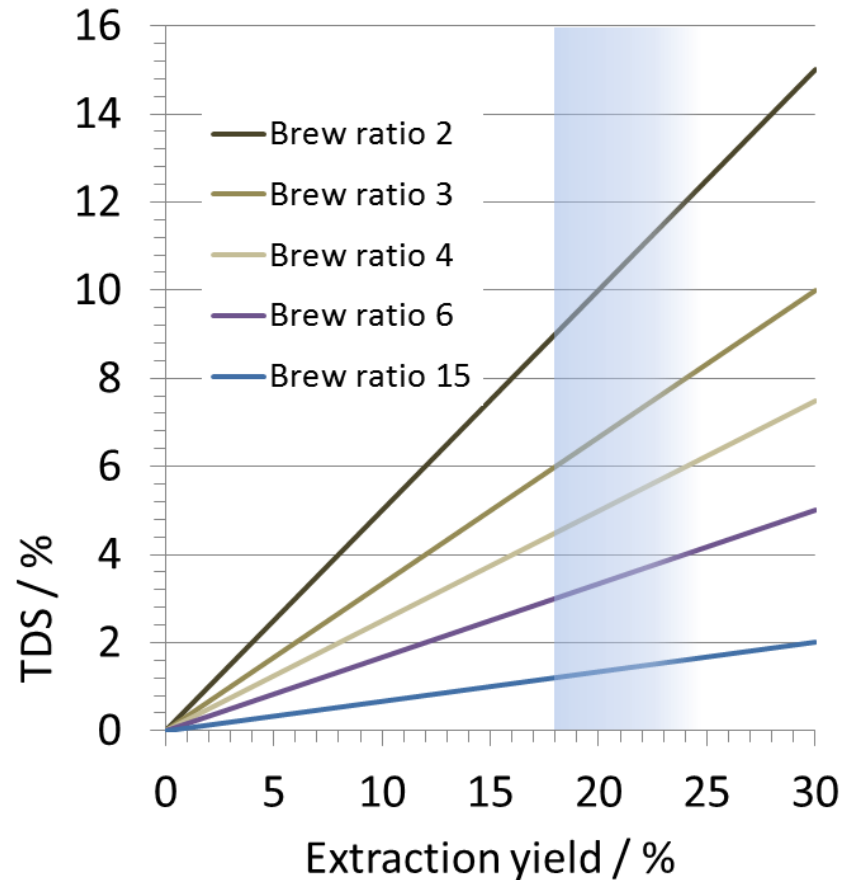
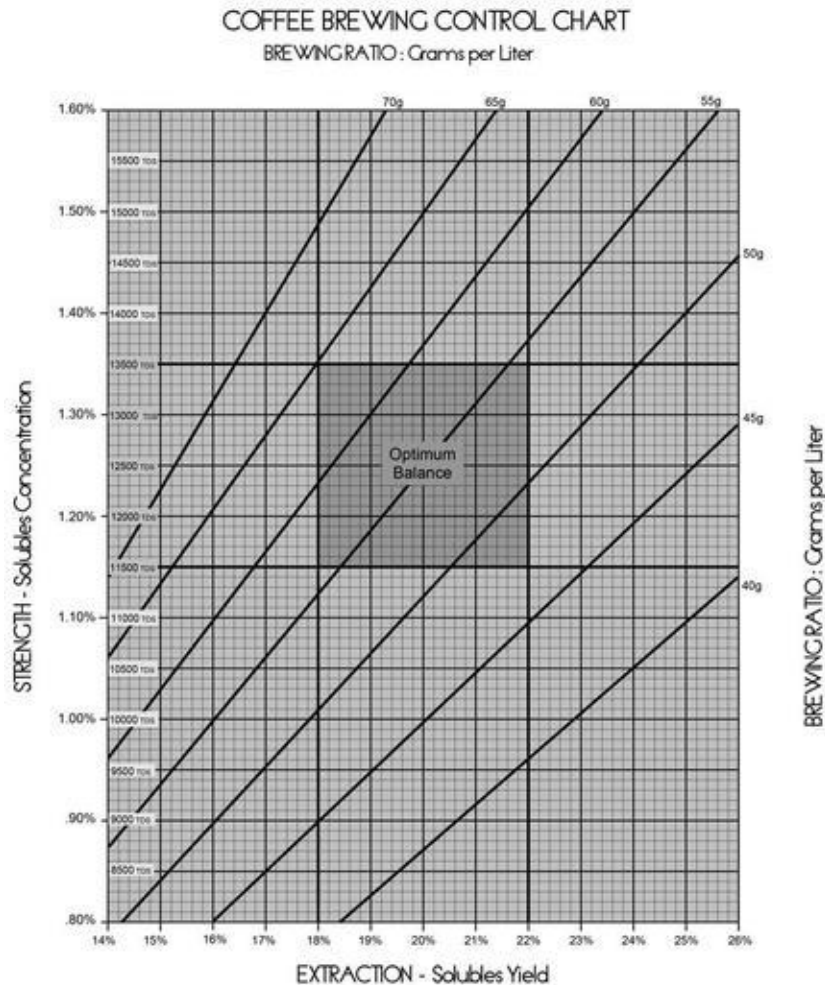
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Mizue Kishigami, Chahan Yeretzian

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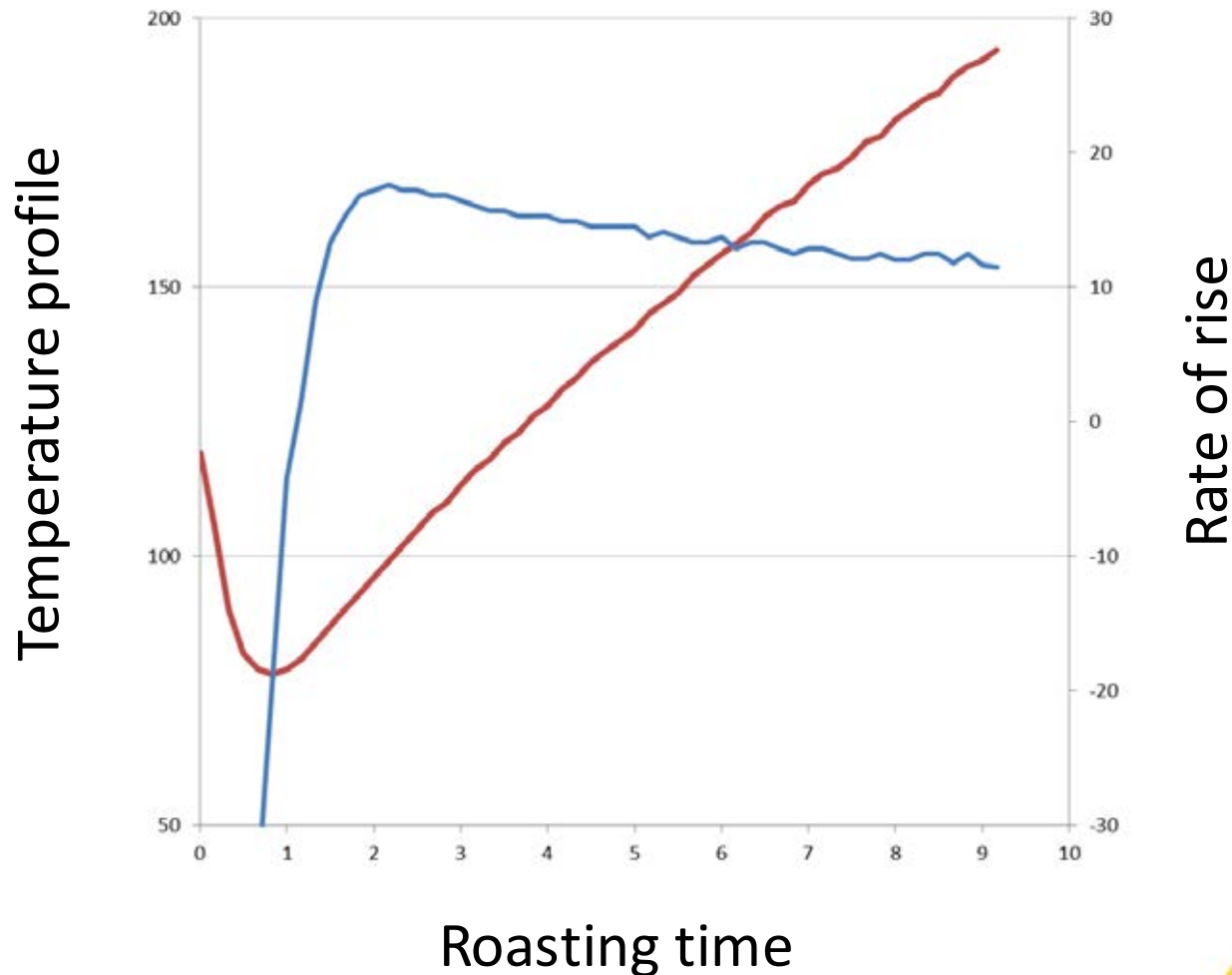
Brewing control chart

TDS // brew ratio



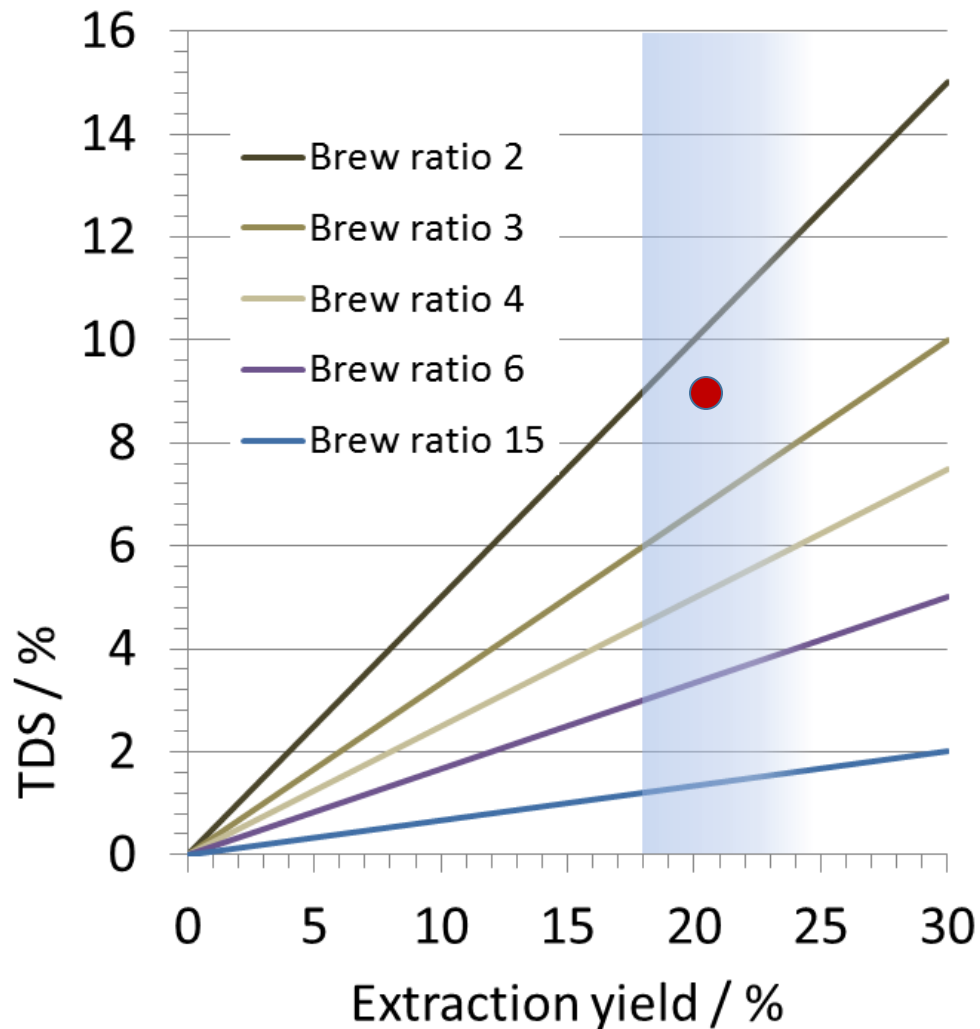
Roasting profile

Continuous monitoring of the process, from start to end




Brewing chart

Only end-point of the extraction



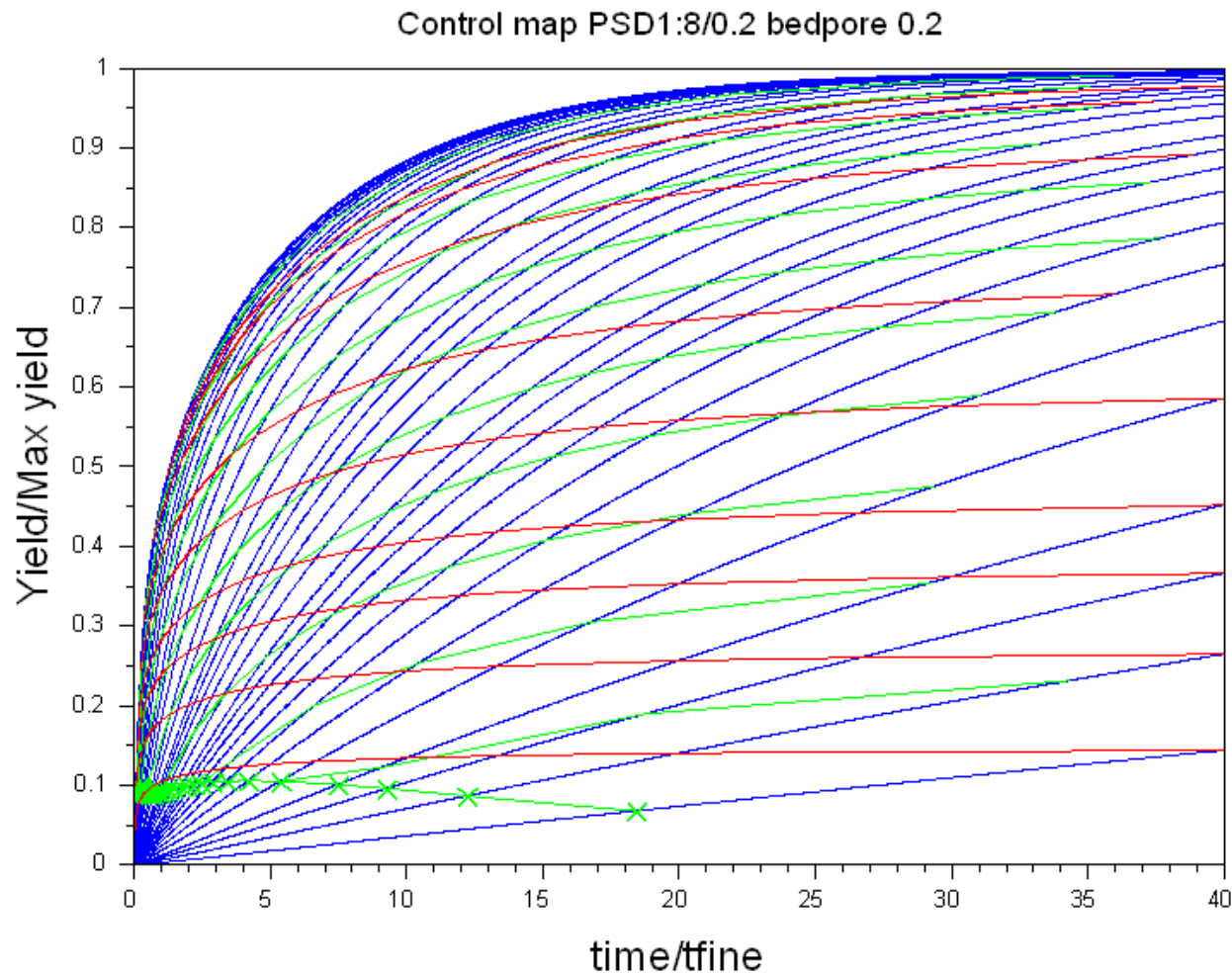
$$\text{Yield} = \text{TDS} * \text{Brew ratio}$$





**What can we do to use
the existing brewing
chart to provide more
information about
extraction?**

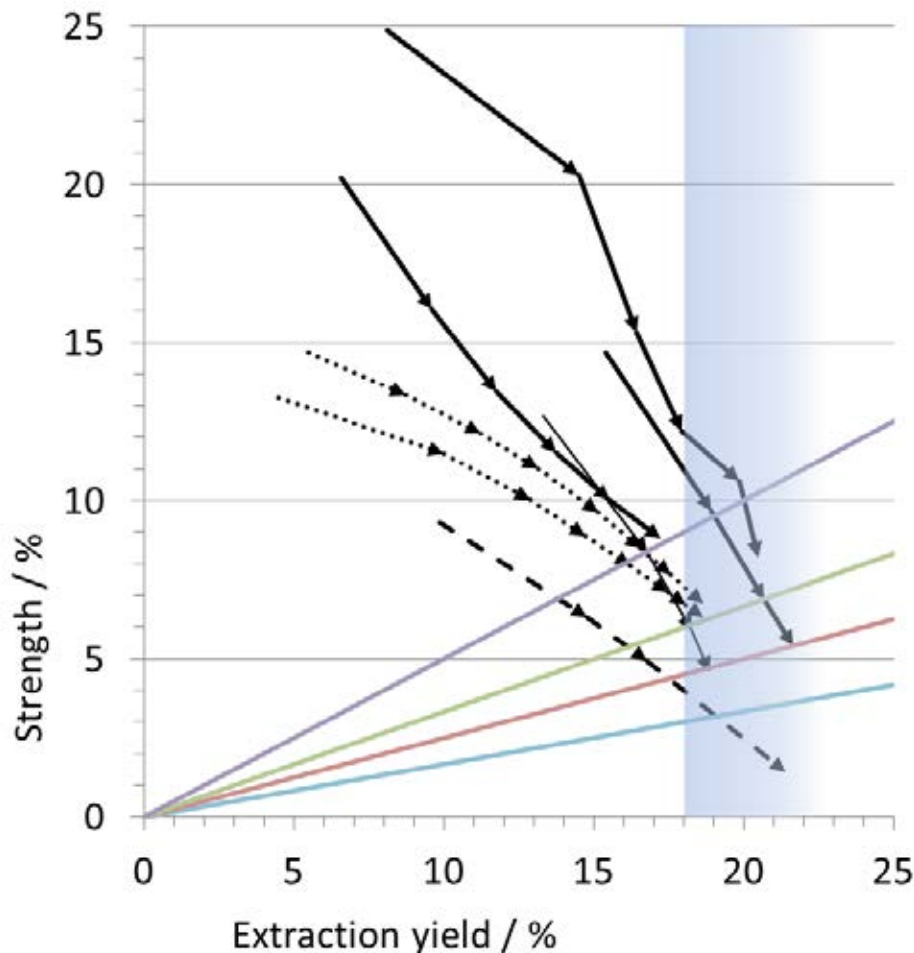
Scientific approach to the brewing control chart



Melrose et.al., Towards a new Brewing control chart for the 21st century, ASIC2016



Range of paths on the brewing chart to achieve the final point



Depending on the flow rate and evenness different extraction paths can be achieved

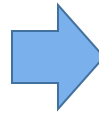


TDS – what is it?



+

H_2O



+



m (coffee)

m (water)

m' (water)

+

TDS

m (coffee)

-

TDS

+

(and some water)

Actually dissolved solids

Measured by:
Refractometer
Evaporation



TDS of water vs TDS of coffee

TDS of beverages

- Based on refractometry
- Range: 0.1- 20 %
- High precision method:
< 5 % relative error

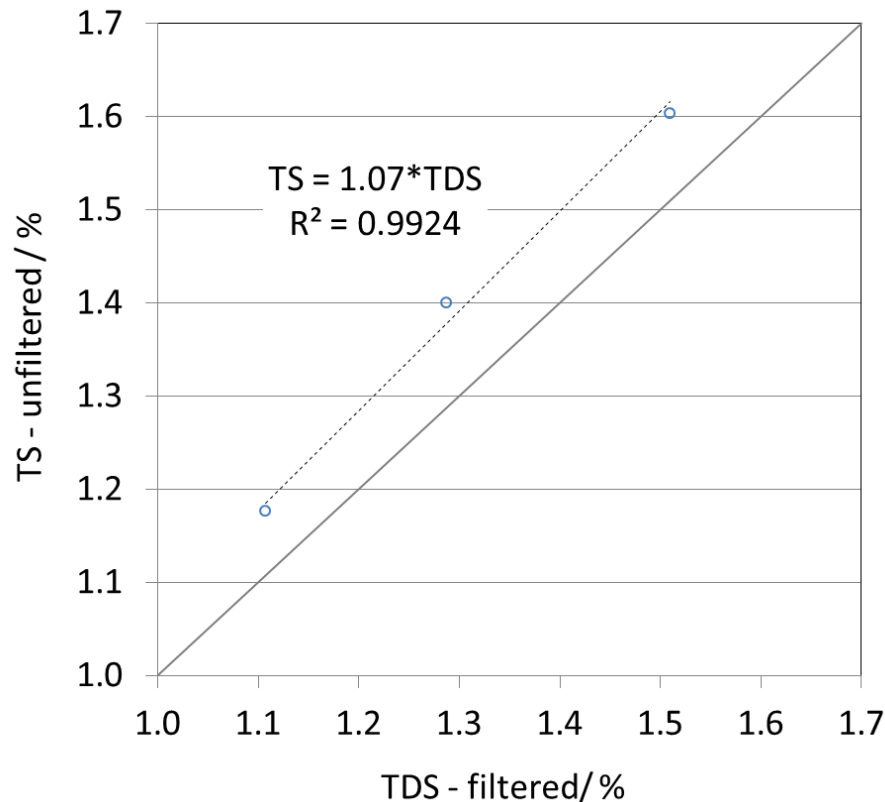
TDS of water

- Based on electrical conductivity
- Range: 0.0001-0.1 %
(= 1-1000 ppm)
- Rough estimate:
typical error of 30%

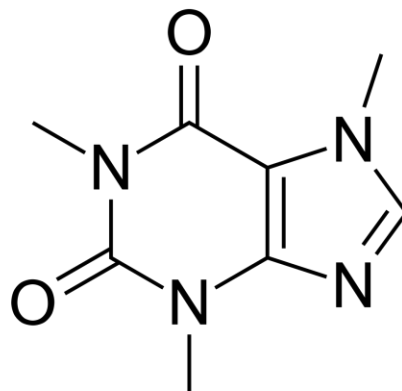
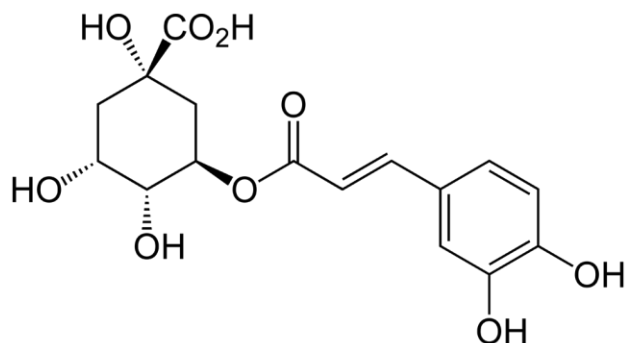


TS or TDS

- French press extraction: 50, 60 and 70 g/L
 - Unfiltered method overestimates extracted solids content by 7%



Chlorogenic acids and caffeine



- Sensory and physiologically active
- CGA: **lights** roasts contain **more**, **dark** ones **less**
- Caffeine is almost constant from light to dark roast



Acidity and alkalinity

The basics on the equilibrium between acids and bases for coffee



Total hardness and alkalinity in water come from limestone

Limestone  Total hardness + Alkalinity

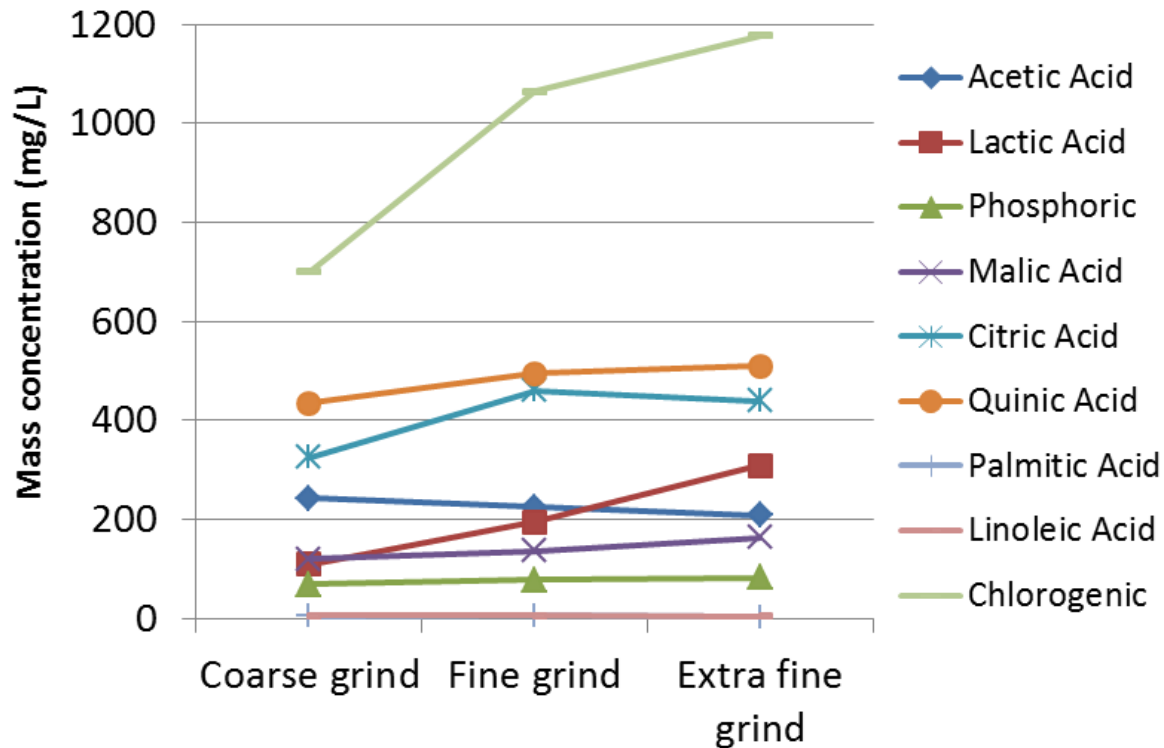


What is alkalinity?

- Alkalinity = Acid buffer capacity:
Alkalinity buffers the effect of acids extracted from coffee
- Amount of acid to be added for a water sample reach pH 4.3
- For almost all tap waters determined by hydrogen carbonate (bicarb) and carbonate ions



How to measure acids in coffee – by mass



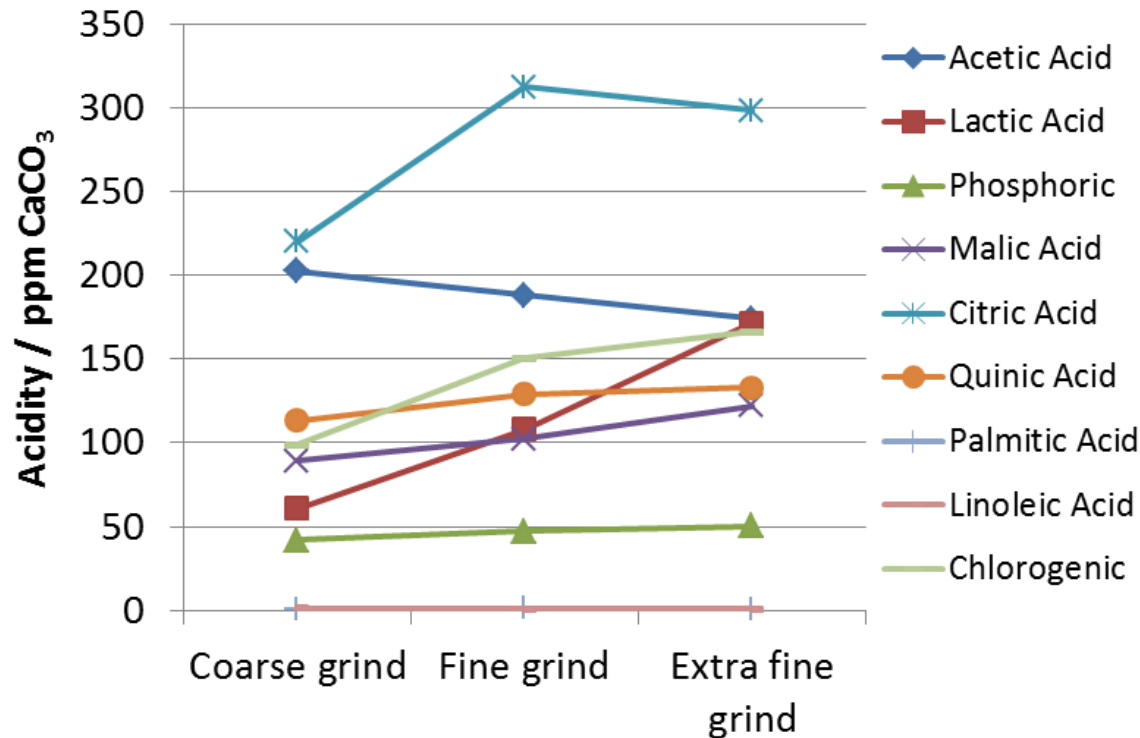
Total acid content / mg/L		
Coarse grind	Fine grind	Extra fine grind
2010	2670	2900

Sensory Evaluation of Coffee: Technical Unit Quality Series. No 9.
International Coffee Organization. 1991. 209-243.



How to measure acids in coffee – by amount

Titration acidity



Total acid content / ppm CaCO ₃		
Coarse grind	Fine grind	Extra fine grind
830	1040	1120

Sensory Evaluation of Coffee: Technical Unit Quality Series. No 9.
International Coffee Organization. 1991. 209-243.



Tracking your extraction

Applying the lessons learned on TDS and acidity to compare different extractions with each other or to study the evolution of your extraction over time



3 grinders 1 machine 300kg coffee

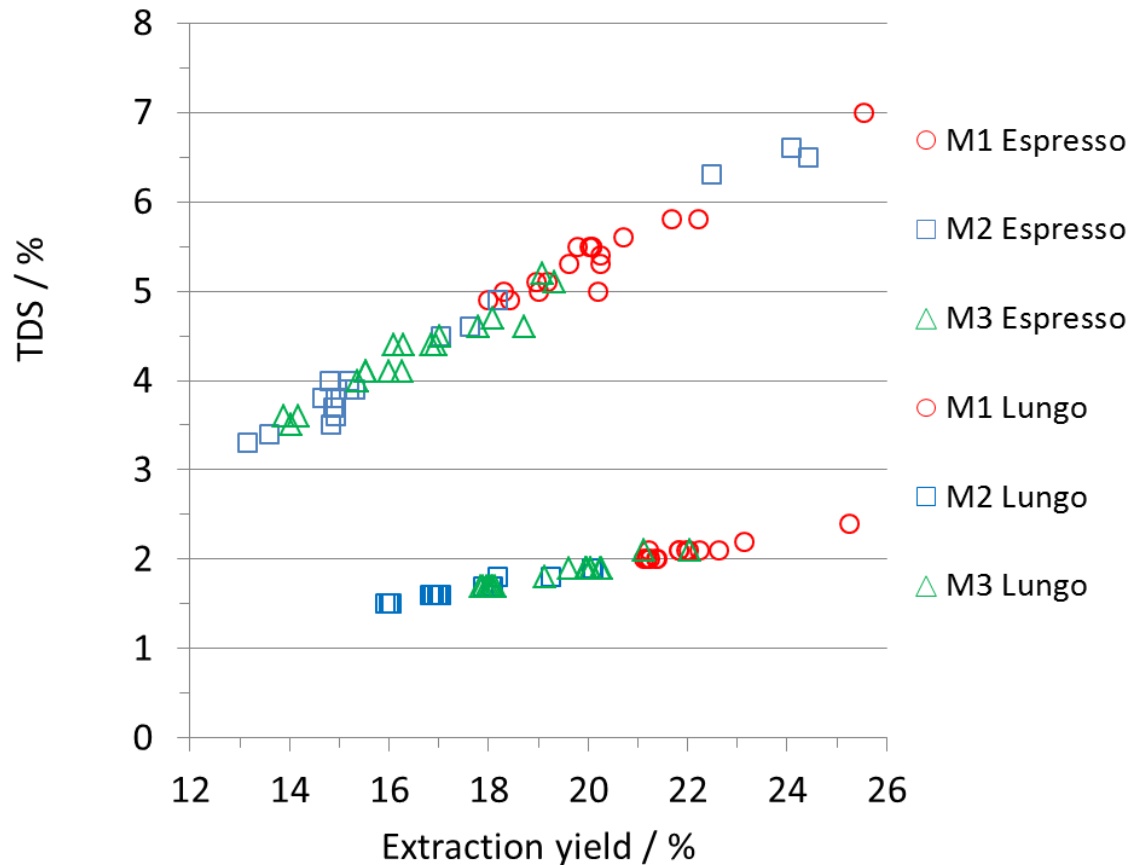
Performance study on grinders from fully-automatic for home use – one from each Italy, Switzerland and Germany

Measure physical and chemical characteristics of the extractions over the course of grinding 100 kg on each grinder

After 1 kg, 25 kg, 50 kg, 80 kg and 100 kg



TDS - where are the end-points of the brews?

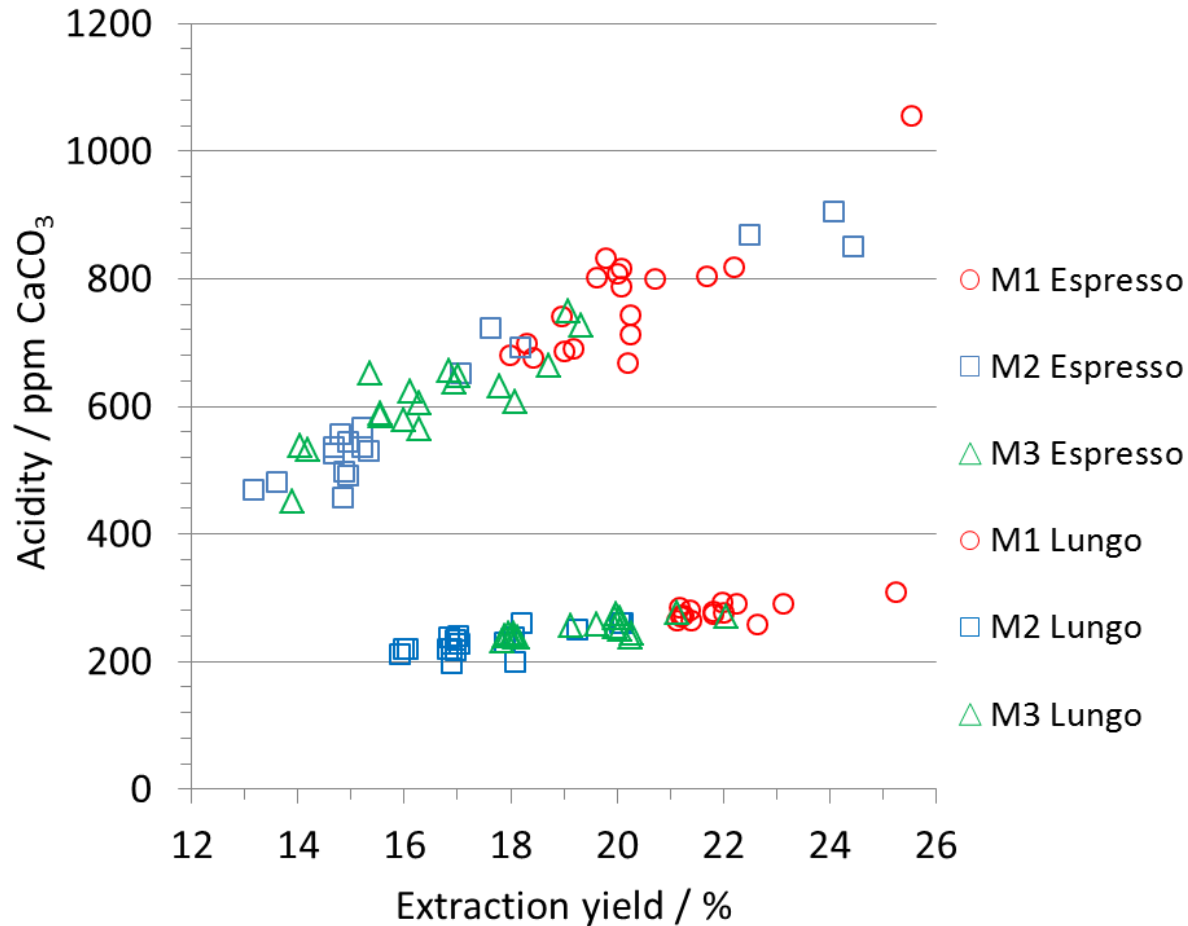


108 extractions at two brew ratios:

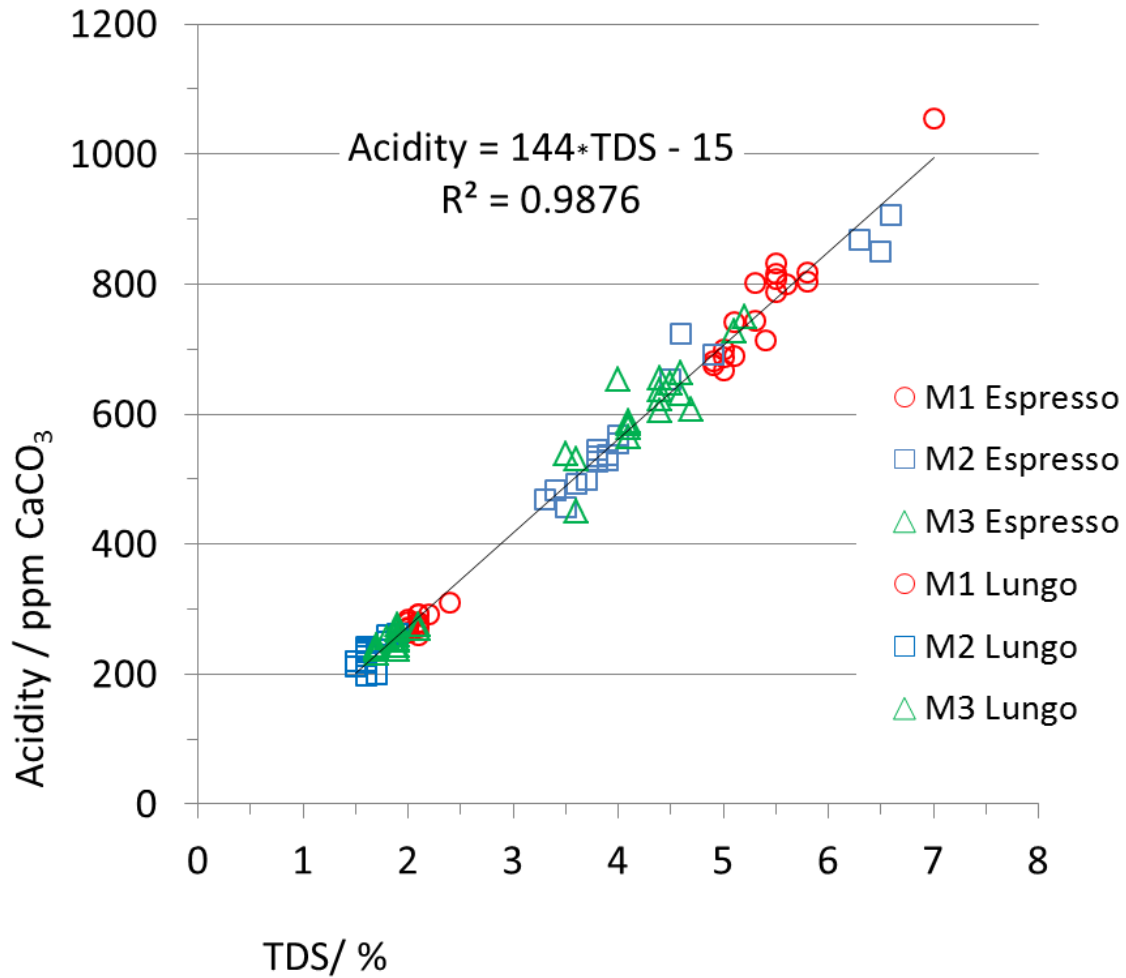
- Lungo at brew ratio 12:
1.5 – 2.4 % TDS
- Espresso at brew ratio 4:
3.3 – 7 % TDS



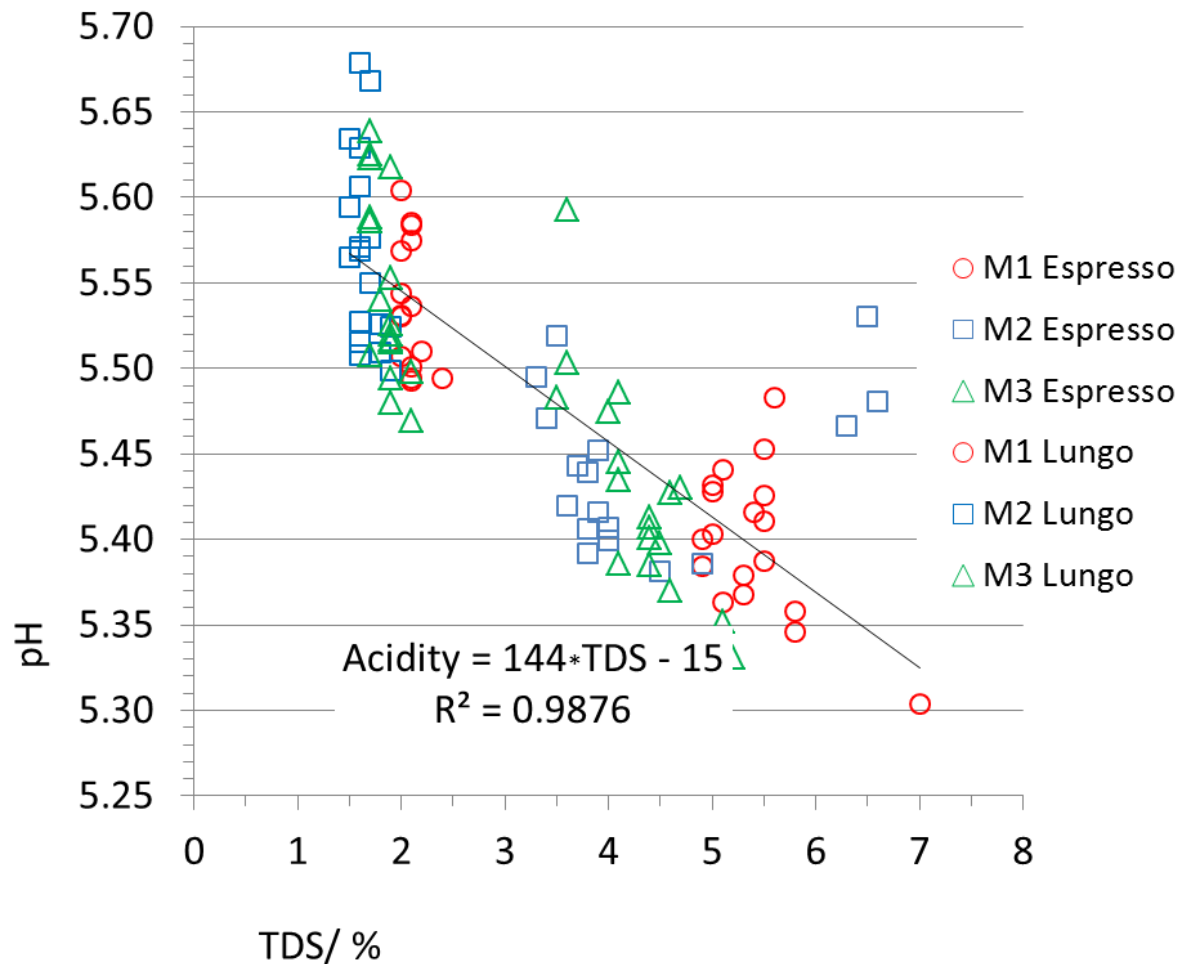
How acidity related to yield?



TDS predicts acidity



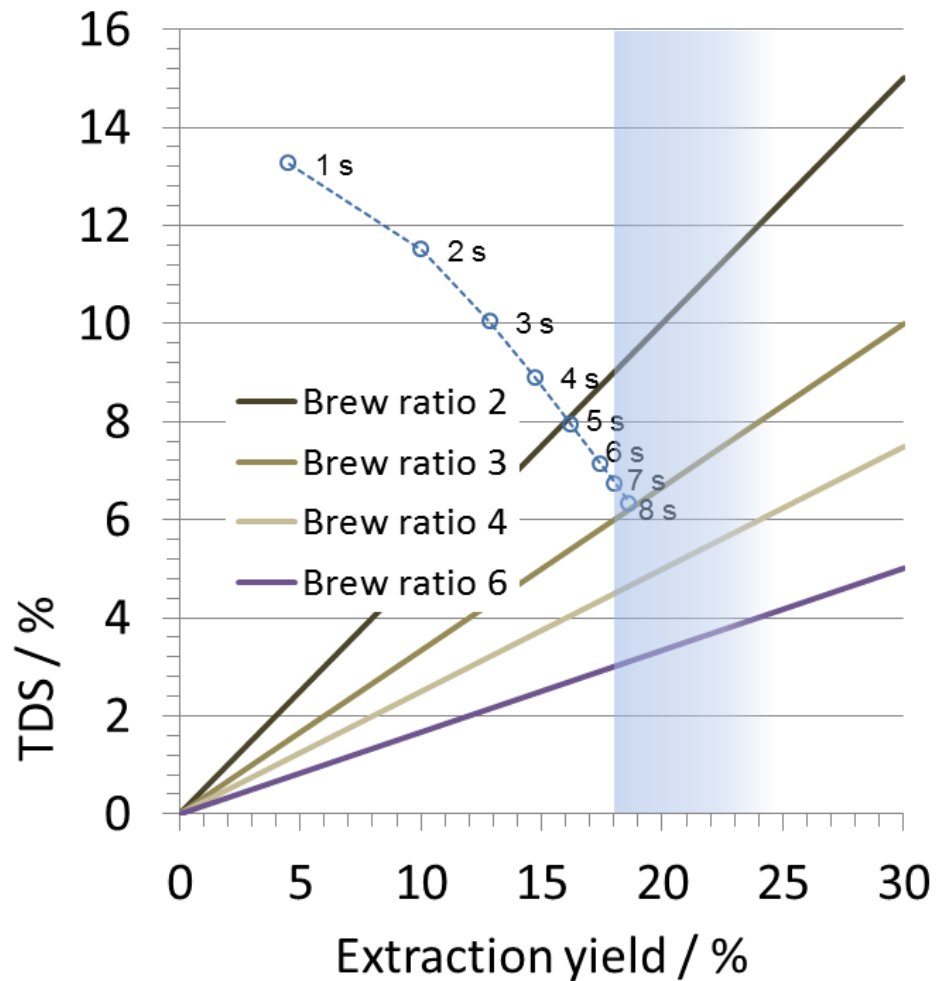
What about pH?



Combining the brewing control chart and other chemical markers



Tracking extraction of a fully-auto



18.7 % extraction
yield in a 8 s

And even 14.8 %
extraction yield after
only 4s



Experimental series with fully automatic machine

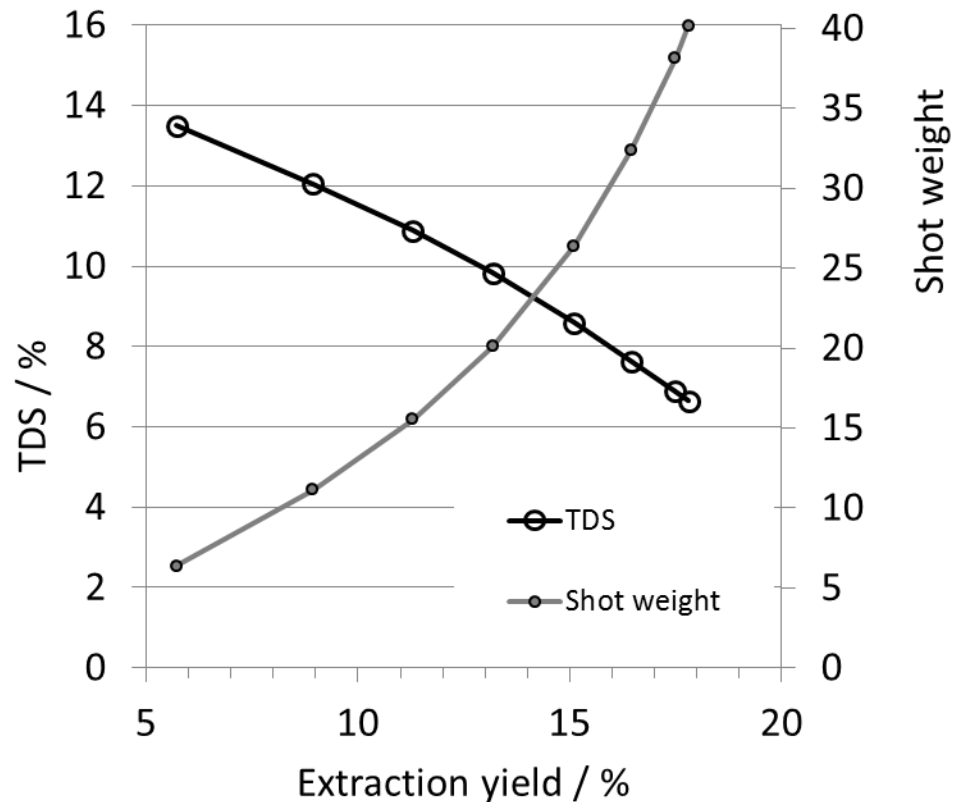
- Single origin coffee from Brasil with a medium roast level (95 Colorette)
- 20 s extraction time
- Brew ratio 3
- Split into 8 fractions (4 x 2 s and 4 x 3 s)
- TDS, acidity, caffeine and chlorogenic acids



Evolution of a fully-auto extraction

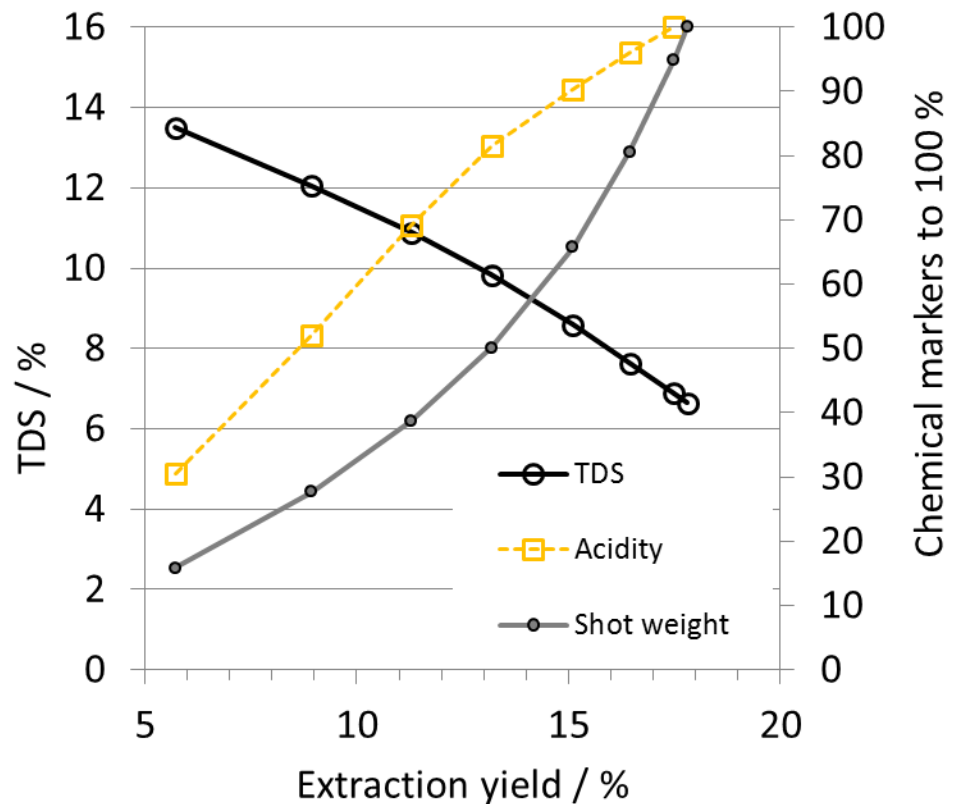
Extraction starts highly concentrated

The first half of the beverage contains 2/3 of the dissolved solids



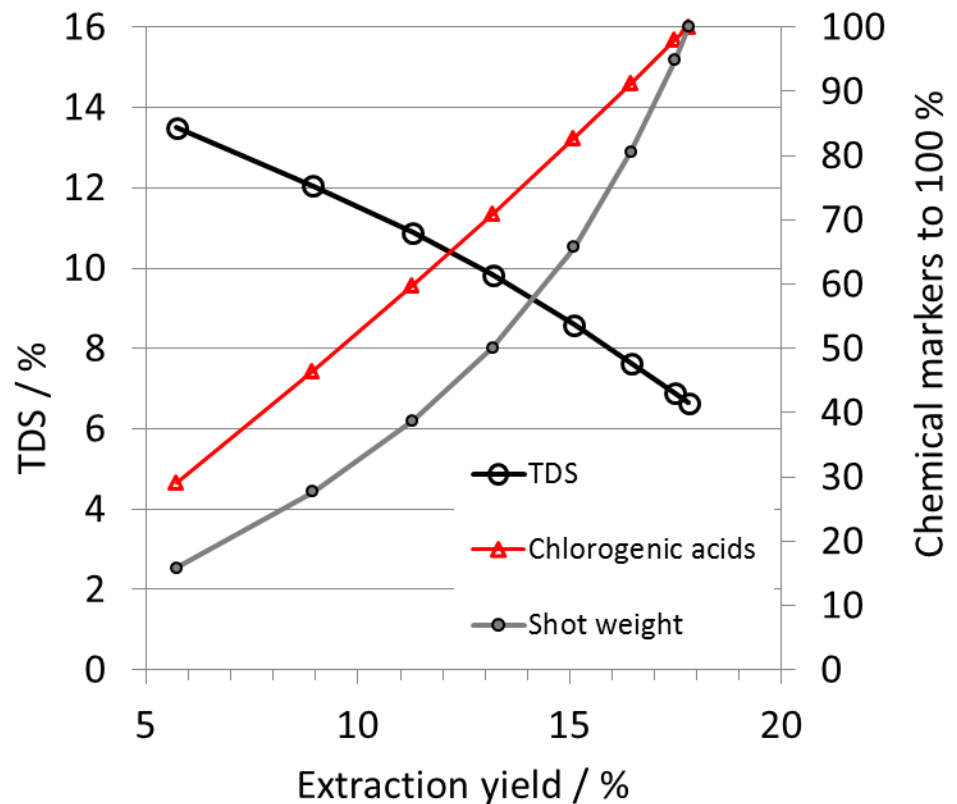
Evolution of acidity

Acidity starts out at a much higher rate initially and slows down in the last third



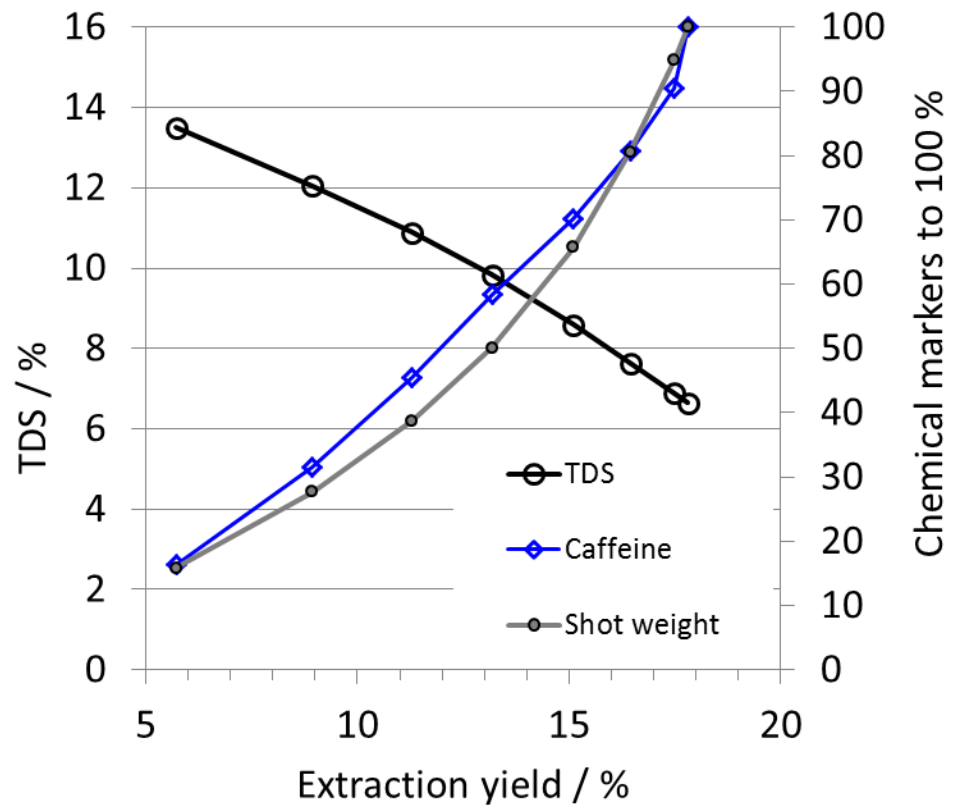
Evolution of chlorogenic acid

Chlorogenic acids extract at the same rate as the total dissolved solids overall



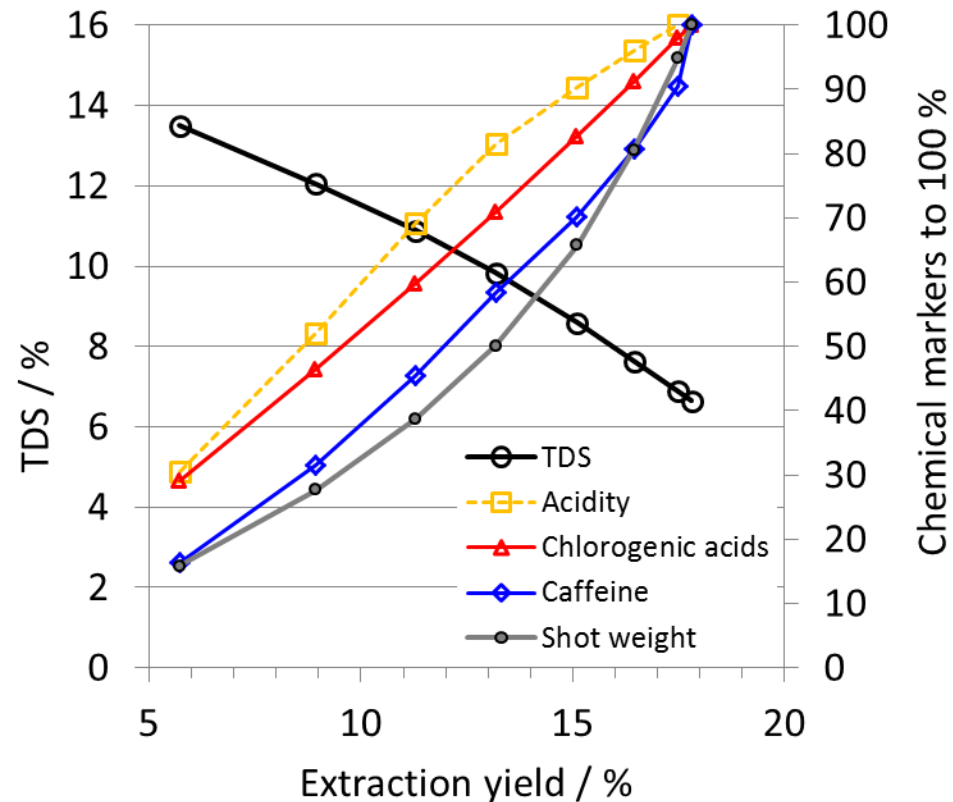
Evolution of caffeine

Caffeine shows a much slower increase initially and speeds up in the last part

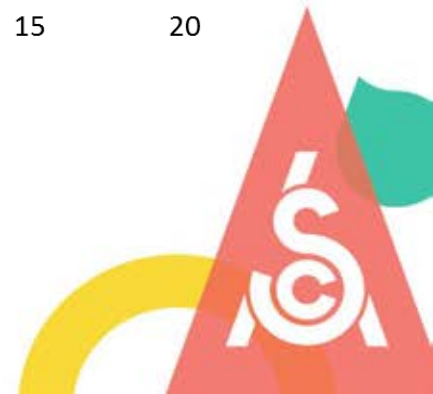
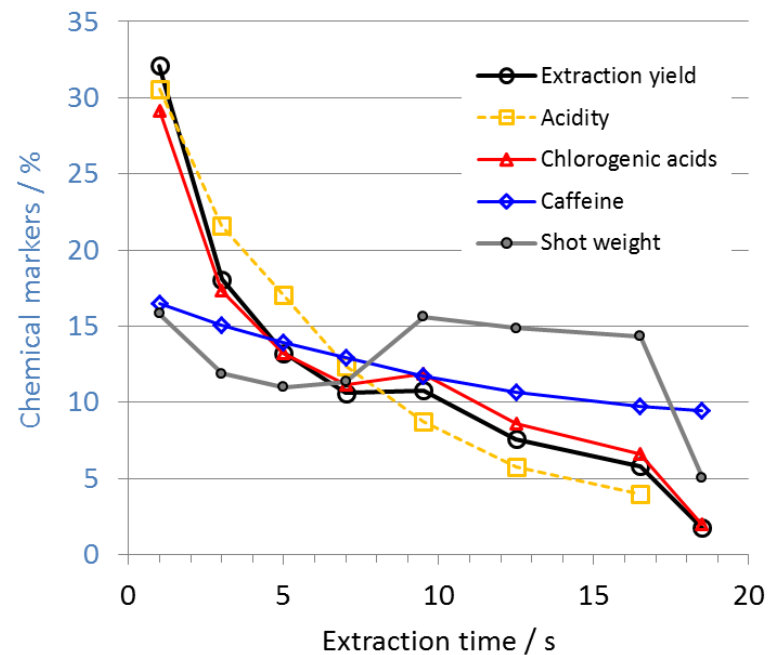
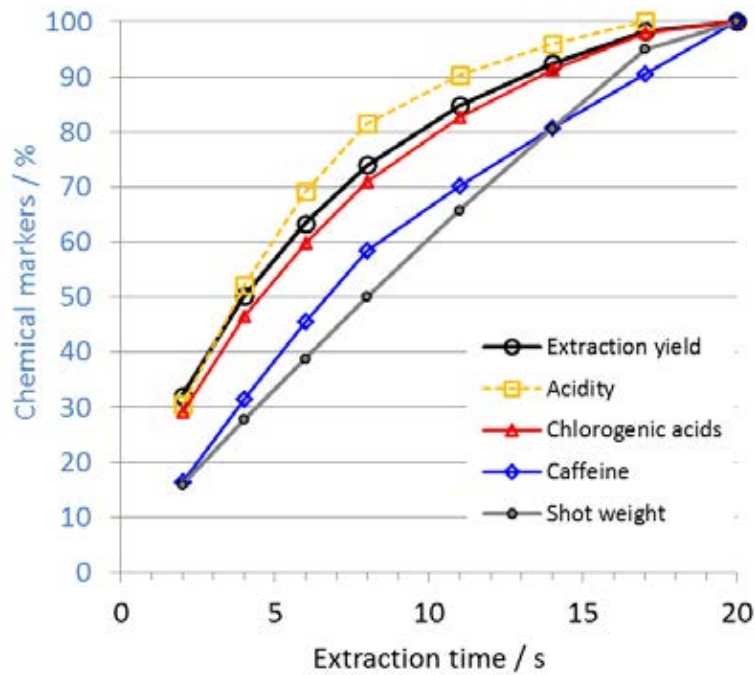


Putting it all together

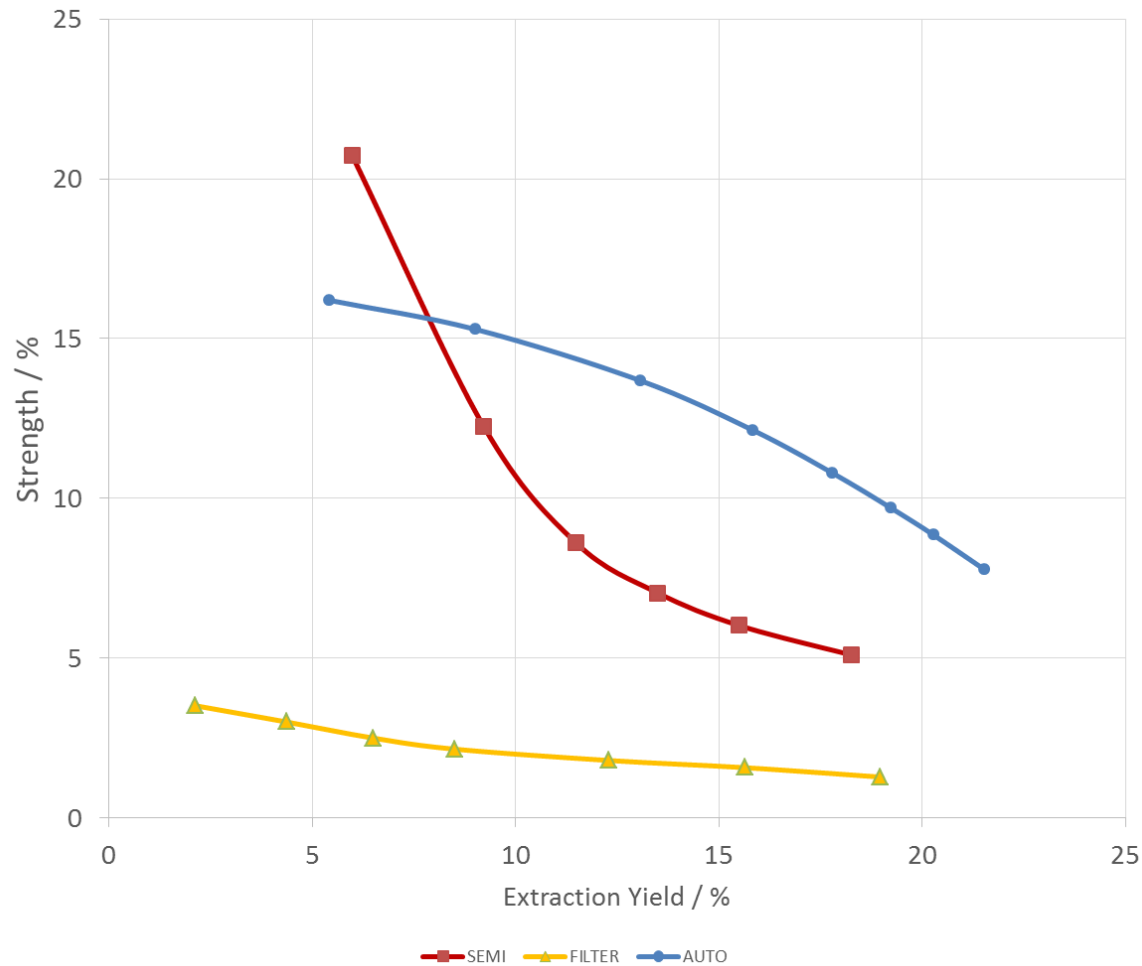
Marked differences of how the markers evolve over the extraction



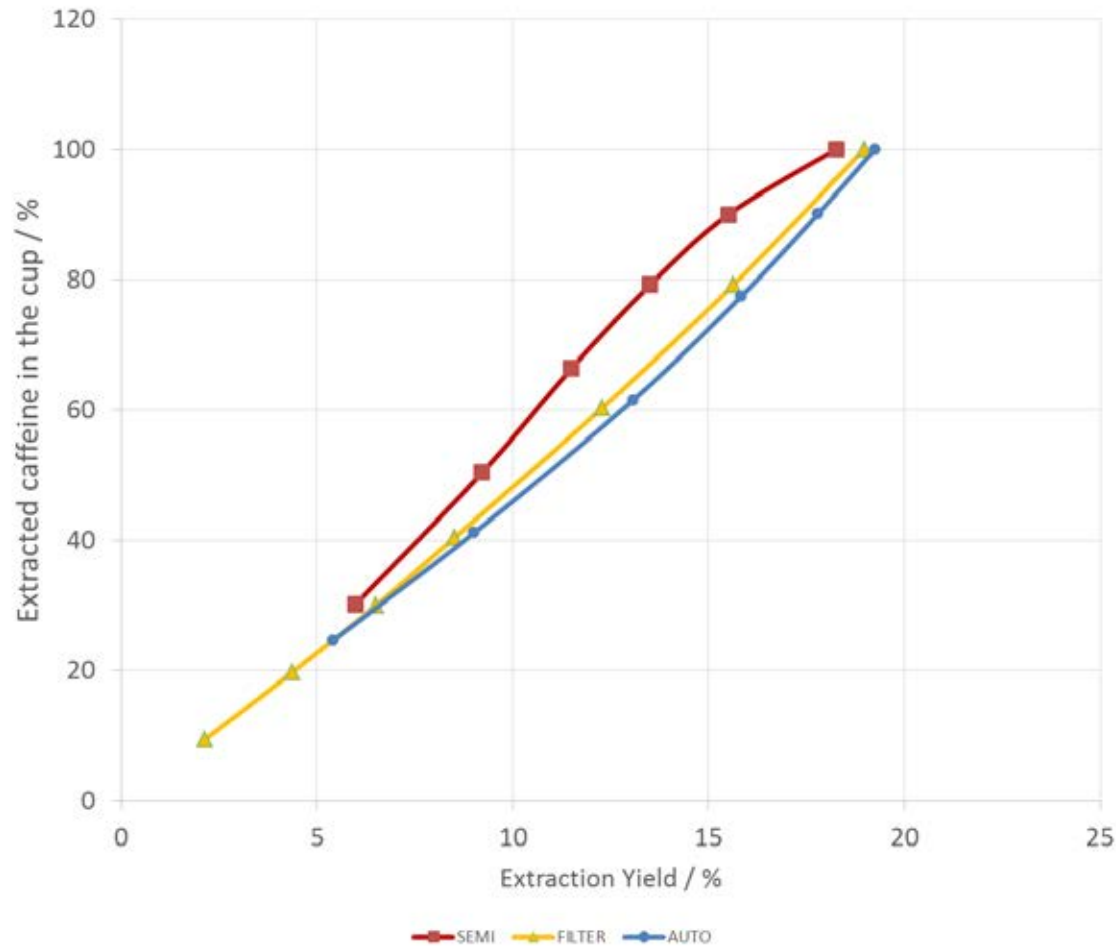
Evolution of the extraction over time



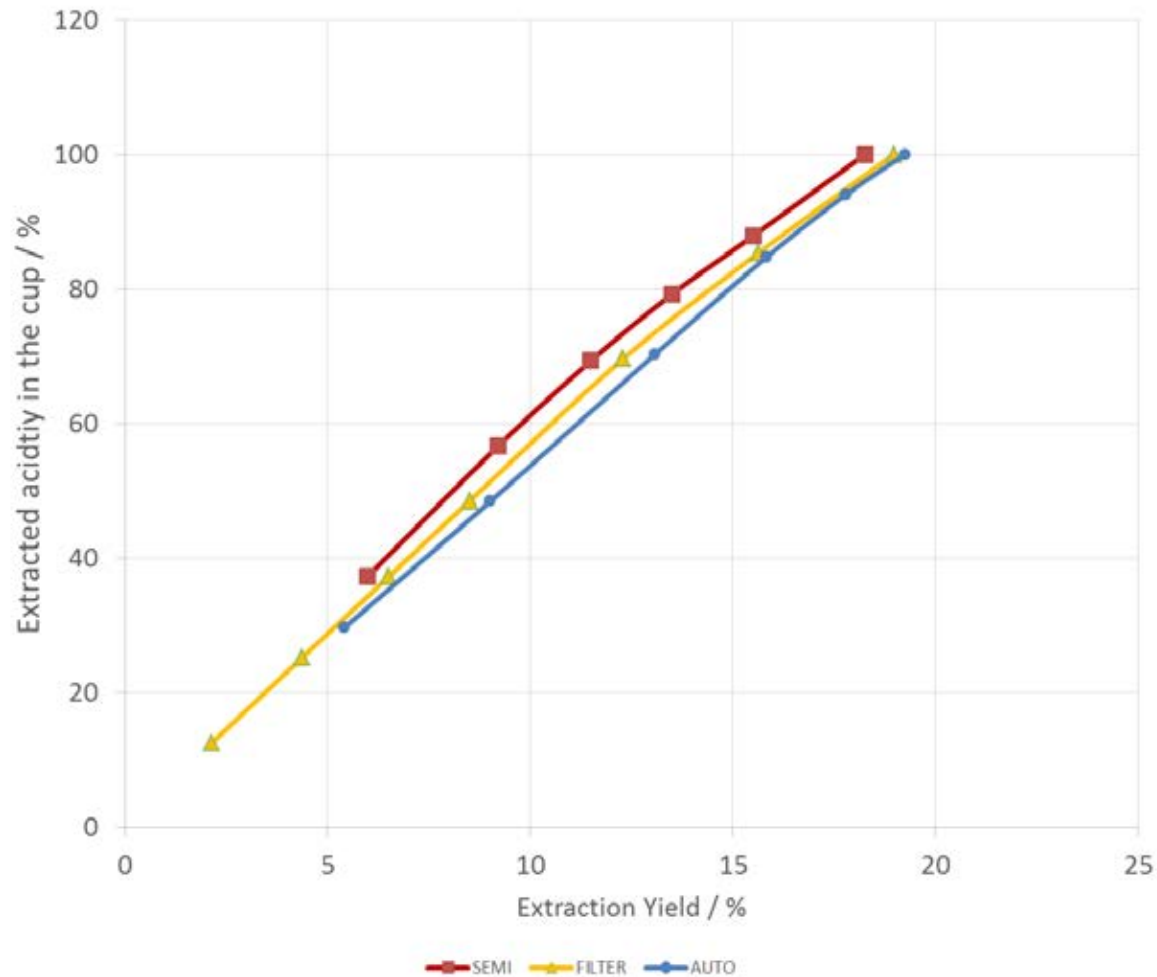
How different brewing methods compare?



How different brewing methods compare?



How different brewing methods compare?





Coffee Excellence Center



Prof Coffee. Dr. MBA Chahan Yeretzian

Professor for Analytical Chemistry, Bioanalytical Chemistry and Diagnostics

Head Coffee Excellence Centre

Head Analytical Technologies

Boards of Directors SCA, Chair of Research Advisory Council

Board member and Secretary of ASIC



Origin



Dr. Sebastian Opitz

Transformation



Dr. Samo Smrke

Extraction



Dr. Marco Wellinger

Aroma

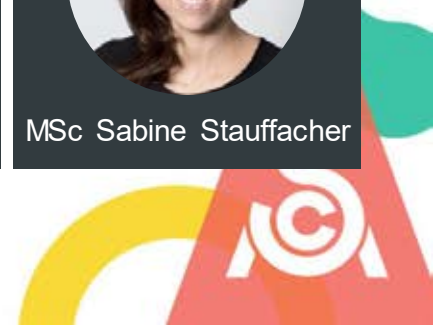


Dr. Anja Rahn

Continuing Education & Sustainability

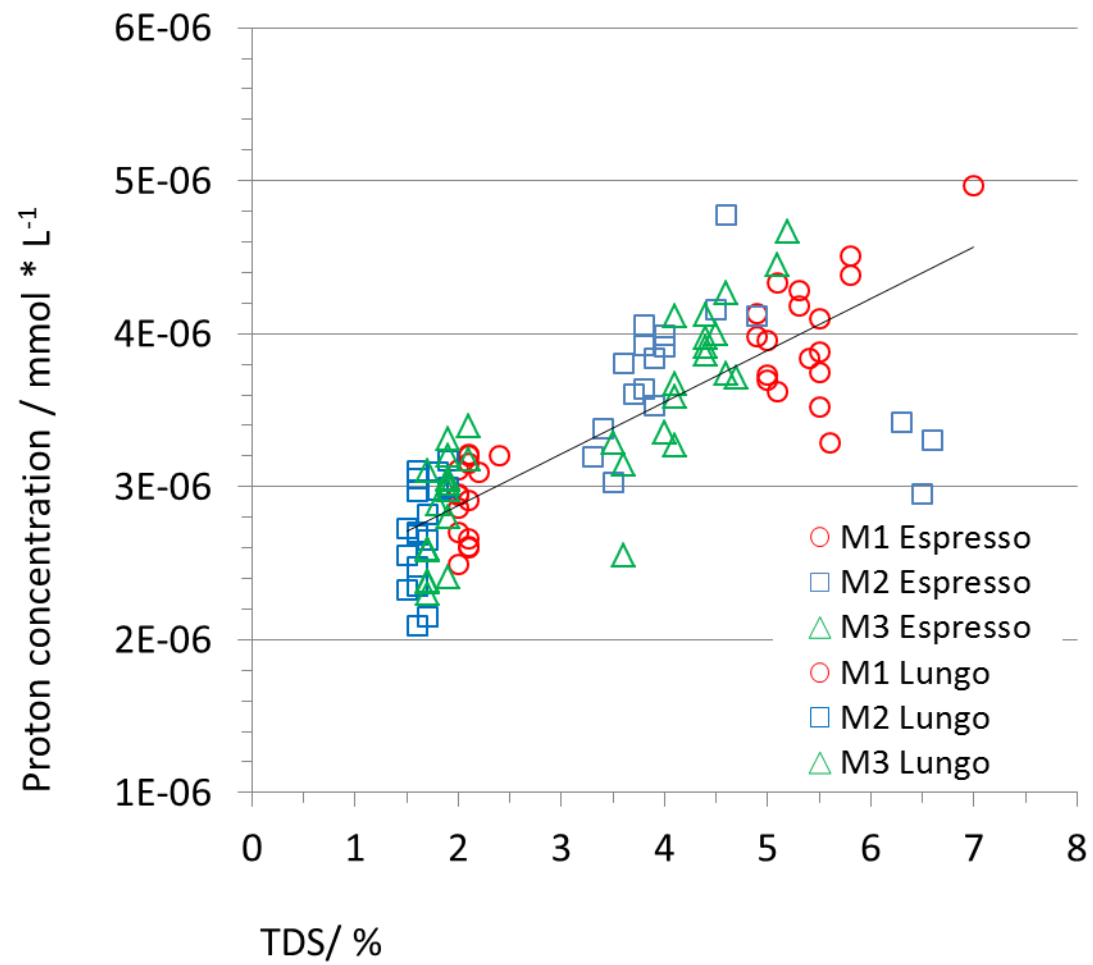


MSc Sabine Stauffacher

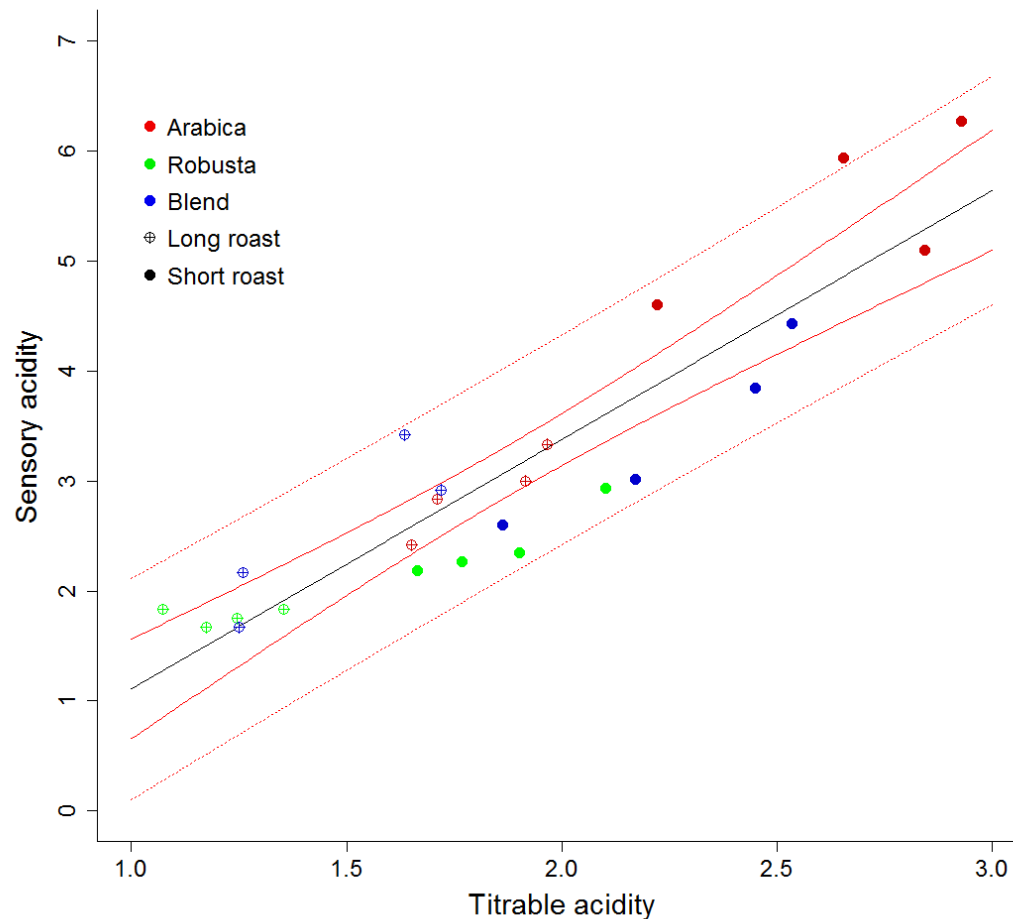




**Specialty
Coffee
Association**



Sensory acidity vs titrable acidity



Influence of bean composition on extraction speed on a fully-auto

- Below are shot weight vs time of three different roast coffees. To the left a blend of arabica and robusta containing various bean sizes and an rather uneven roast level (pre-blend) – in the middle a unusually large sized single origin from Guatemala (lower range of speciality grade) - to the right is a small siuzed rather light roasted single origin from Kenya. The variations in flow speed are quite drastically decreasing from left to right, most probably due to inconsistencies in the ground and dosed amount of coffee

