

Coffee Excellence Center

Zurich University of Applied Sciences
(ZHAW)

www.zhaw.ch/icbt/coffee/





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BSc Sierra Yeo



MSc Brian Weisenstein

Education

Analytical & Technical Experts



MSc Oliver Lipp



MSc Jaloliddin Khushvakov



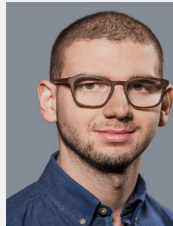
MSc Linda Manthey



MSc Babette Klopprogge



BSc Alexander Mistretta



BSc Aviel el Khouri



BSc Nadia Plüss



BSc Jasmin Sun



BSc Raphael Schwyn



BSc Fabian Gass

Research Fields



Origin, Green



Dr. Sebastian Opitz



Transformation



Dr. Samo Smrke



Extraction



Dr. Marco Wellinger

Sustainability along the whole value chain

Mastering coffee flavor and quality

Green Coffee

Roasting

Grinding

Storage

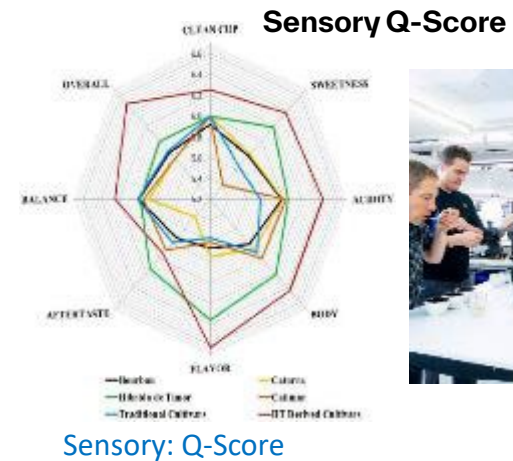
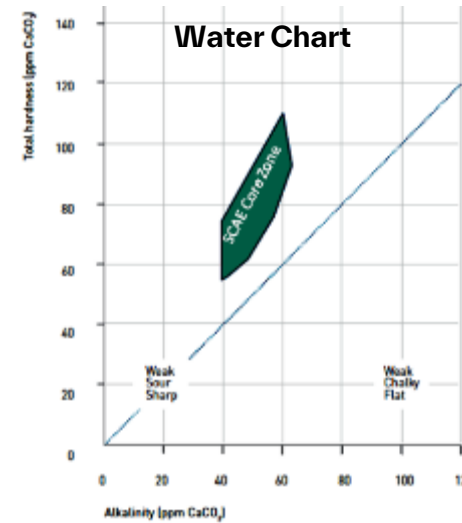
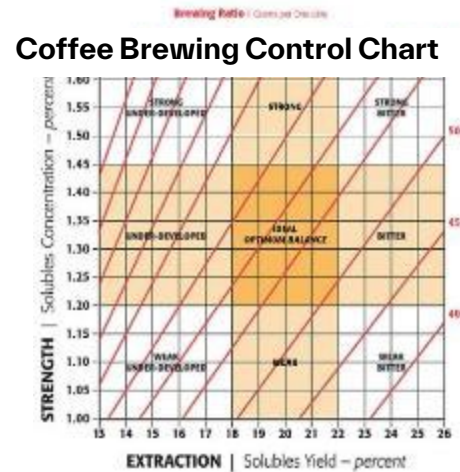
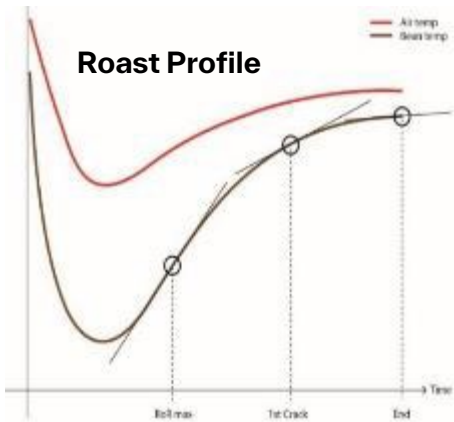
Extraction

Consumption

The Science



The Craft



Beyond traditional coffee

From cell culture to surrogates all the
way to syntenic coffee

Prof. Dr. Chahan Yeretzian

27 June 2024 / WOC Copenhagen





Almost
everybody*
likes coffee

(Daily consumption \pm 2 billion cups*

<https://britishcoffeeassociation.org>

A world map where the continents are filled with dark brown coffee grounds, set against a white background. The map is centered and occupies most of the frame.

\$ 540 bn

2025

CAGR 4,5% (2023-2025)



but to

enjoy this

A high-speed photograph of water splashing, with numerous droplets and streams of water captured in mid-air against a light blue background. The water is clear and glistening, creating a dynamic and refreshing visual.

21,000 l

1 kg coffee



1 cup coffee
0,13 m²

A photograph of a line of trucks in traffic, viewed from the side. The trucks are white with various markings and are stopped at a traffic light. The background shows a road and some trees. Overlaid on the image is large white text.

Impact on climate change
17 kg CO₂
per kg coffee

Rising temperatures

Will reduce the area suitable for growing coffee by up to 50% by 2050

Source: Interamerican Development Bank
<https://www.iadb.org/en/improvinglives/most-unexpected-effect-climate-change>

Increasing labour cost

Labour makes ~ 50% of total expenses on a typical coffee farm

Source:
<https://intelligence.coffee/2022/08/coffee-producers-manual-harvesting-costs/>



Ensure Supply

Coffee consumption has been steadily increasing over many decades and is part of our daily routine and life-style.

In contrast to the positive outlook on the consumption side, risks are appearing on the production side. Production is challenged by climate change, pests & diseases, rural depopulation and substitution by more lucrative crops. Rising temperatures will reduce the area suitable for growing coffee by up to 50% by 2050. Coffee is threatened on multiple fronts.

Reduce Environmental Footprint

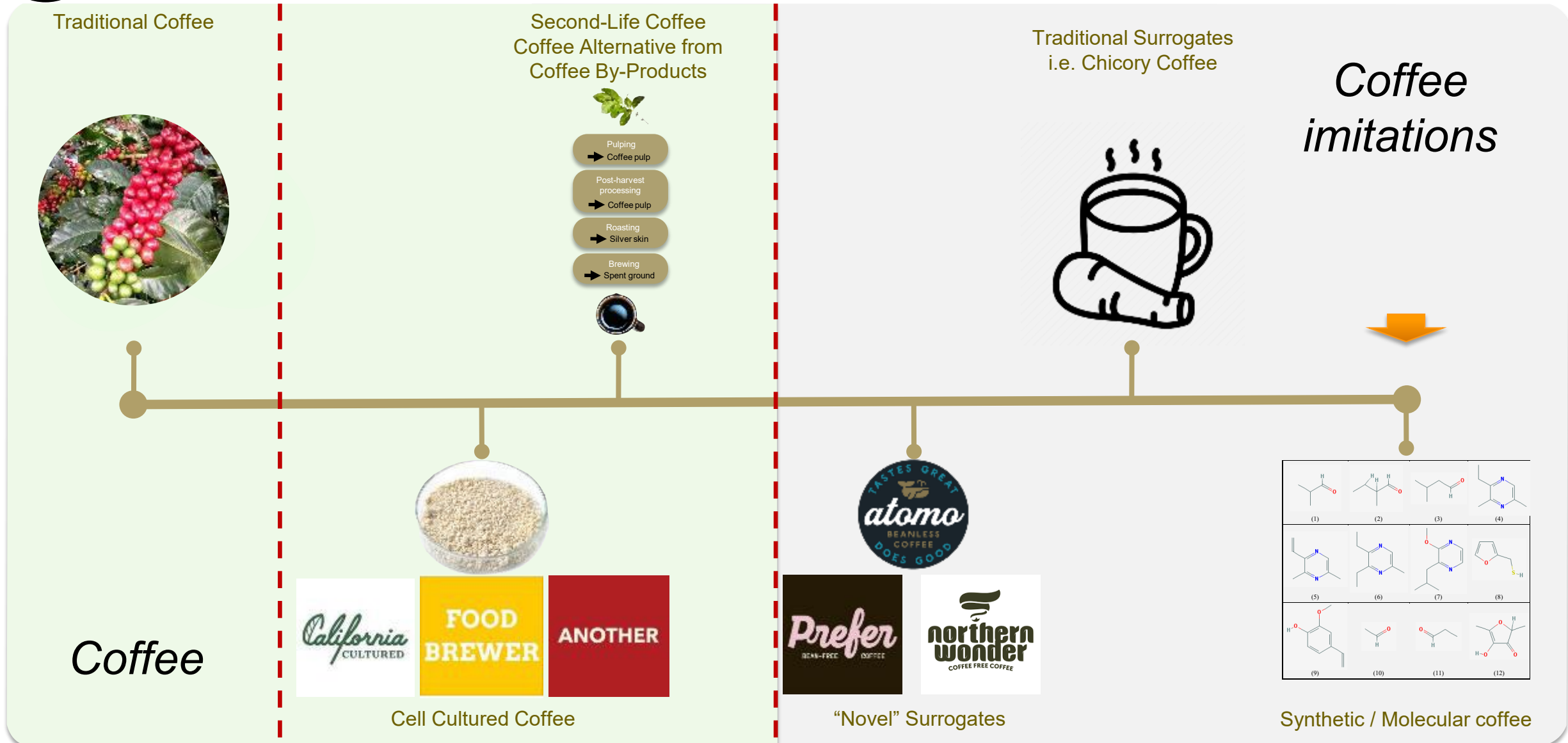
Coffee production, transportation and transformation, from crop to cup, is resource and energy intensive with high external input such as fuel, fertilizers, pesticides and water. More sustainable routes to coffee production are in urgent demand.

Make our daily cup of coffee more sustainable and future-proof

A satellite view of Earth from space, showing the Americas. The image is a high-resolution photograph of the planet, with the United States, Mexico, and Central America visible in the upper half, and South America in the lower half. The oceans are a deep blue, and the landmasses are a mix of green and brown. White clouds are scattered across the globe. In the bottom left corner, there is white text that reads: "To make it sustainable We need to change coffee production".

To make it sustainable
We need to change coffee
production

From Coffee Tree to Synthetic Coffee

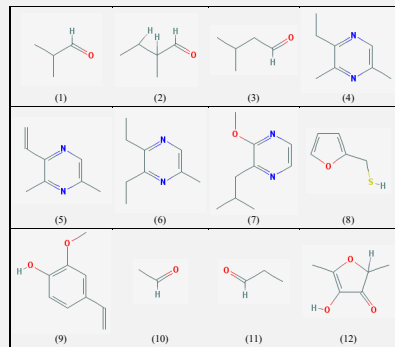


Pulping
→ Coffee pulp

Post-harvest processing
→ Coffee pulp

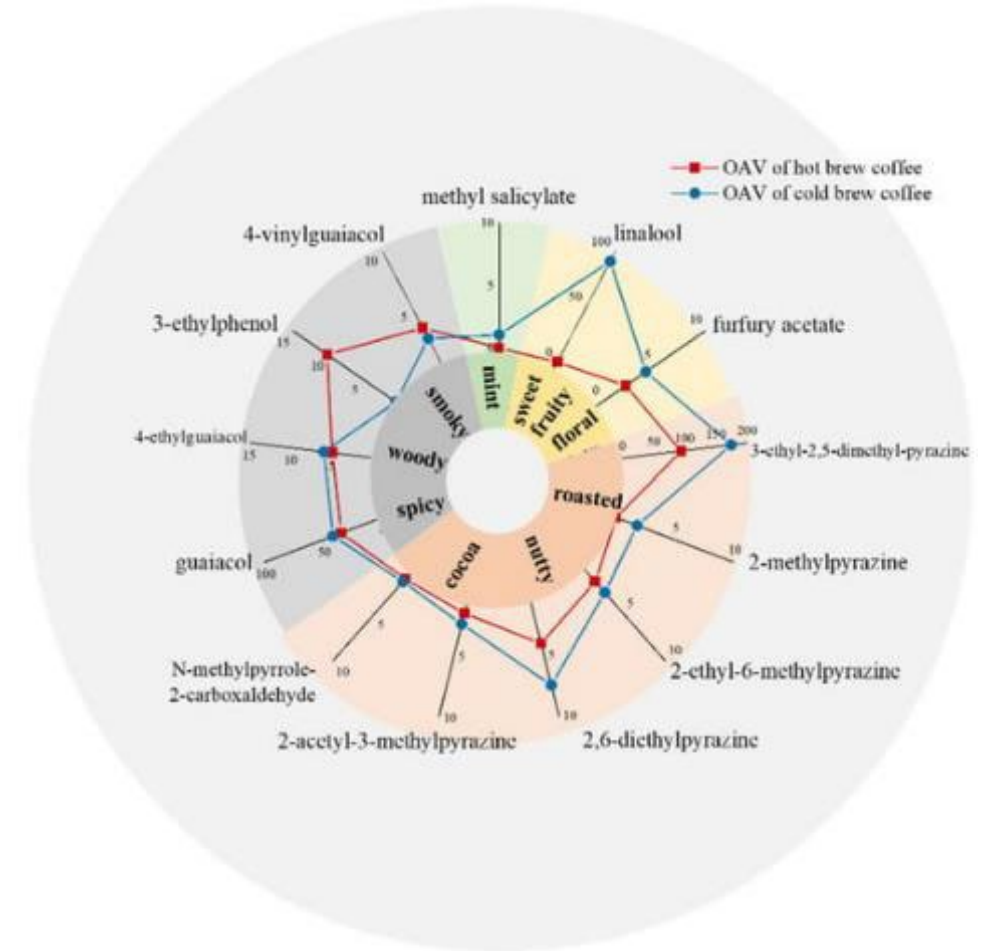
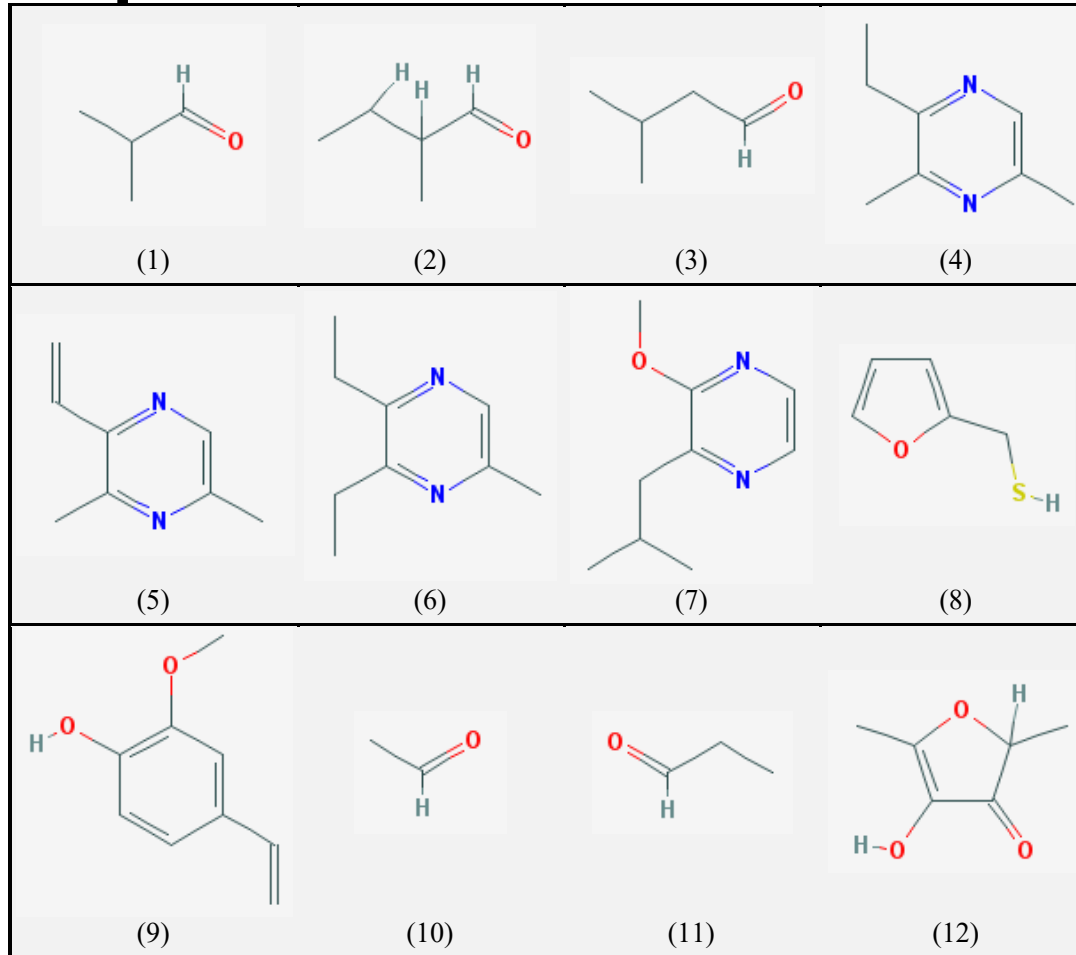
Roasting
→ Silver skin

Brewing
→ Spent ground

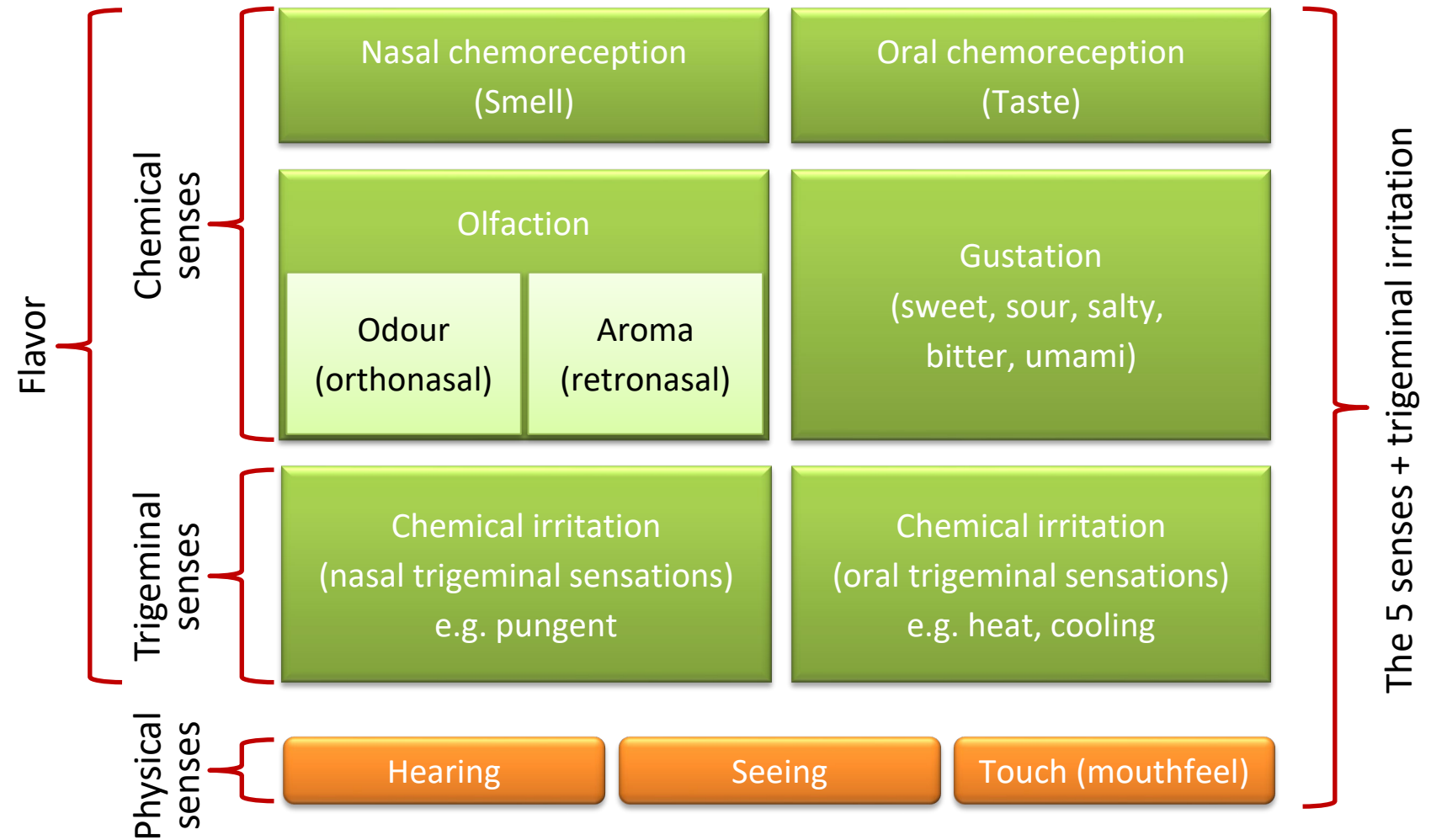


A Molecular Reconstitution of the Coffee Experience

The Smell

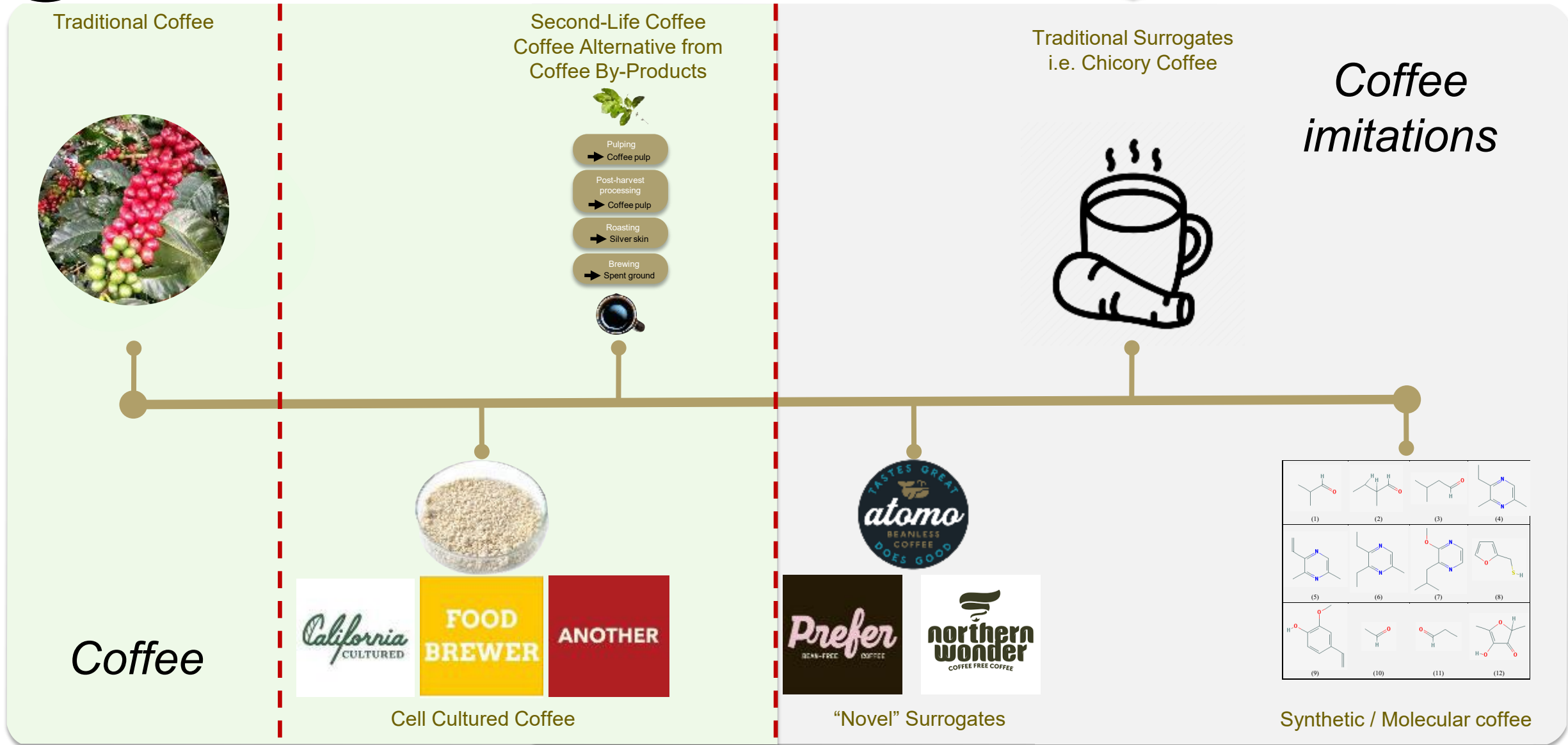


A Molecular Reconstitution of the Coffee Experience



Long-Term Impact: Caffeine, Antioxidants, health / wellness active compounds

From Coffee Tree to Synthetic Coffee

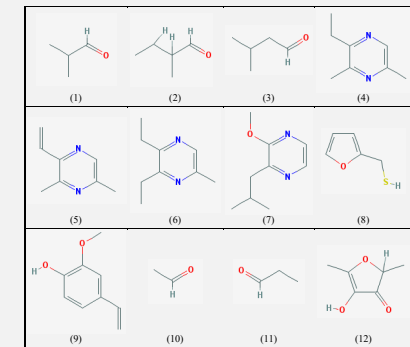


Pulping
→ Coffee pulp

Post-harvest processing
→ Coffee pulp

Roasting
→ Silver skin

Brewing
→ Spent ground



Non-coffee products, usually without caffeine, that are used to imitate coffee

Typical ingredients: almond, asparagus, malted barley, carrot, chicory root, corn, soybeans, cottonseed, boiled-down molasses, okra seed, pea, potato peel, sweet potato, ...



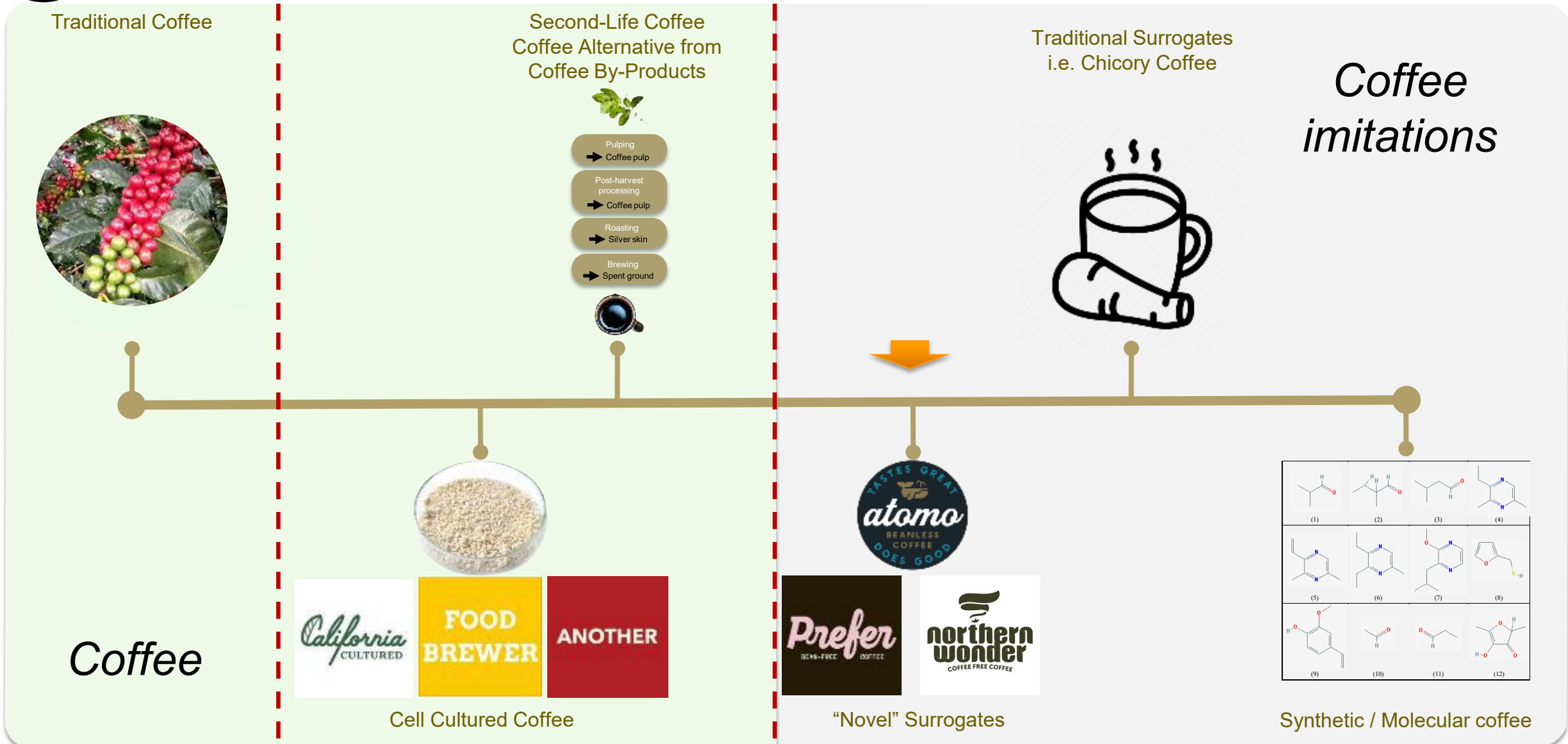


Coffee 52 %, Chicory 48 %



Barley, barley malt, Chicory, Rye

From Coffee Tree to Synthetic Coffee

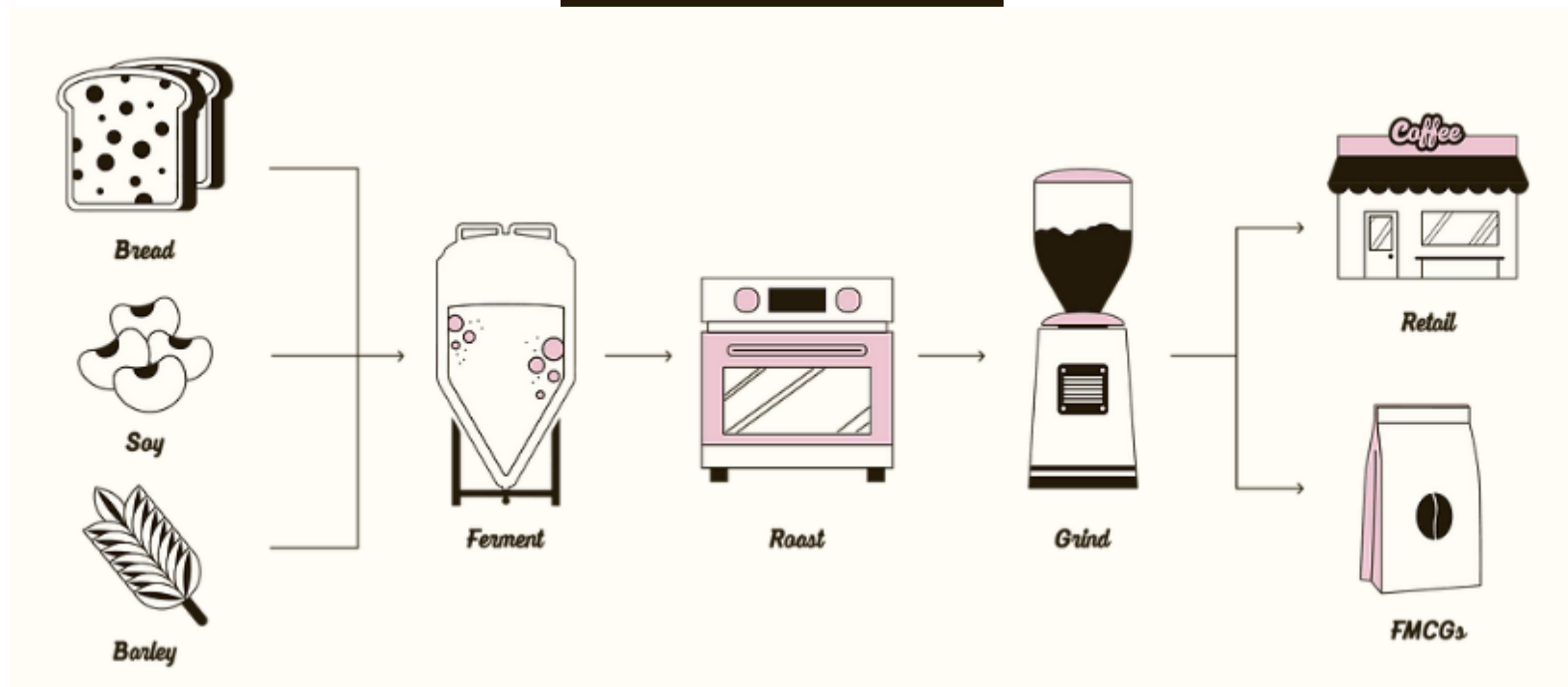


Novel Surrogates / Coffee Substitutes





Date Seeds, Ramon Seeds, Sunflower Seed Extract, Fructose, Pea Protein, Millet, Lemon, Guava, Defatted Fenugreek Seeds, Caffeine (100 mg of per serving), Baking Soda



Coffee Free Coffees are made from non-tropical ingredients. By meticulously fine-tuning the combination of natural molecules, our ultimate goal is to mimic coffee down to the details.

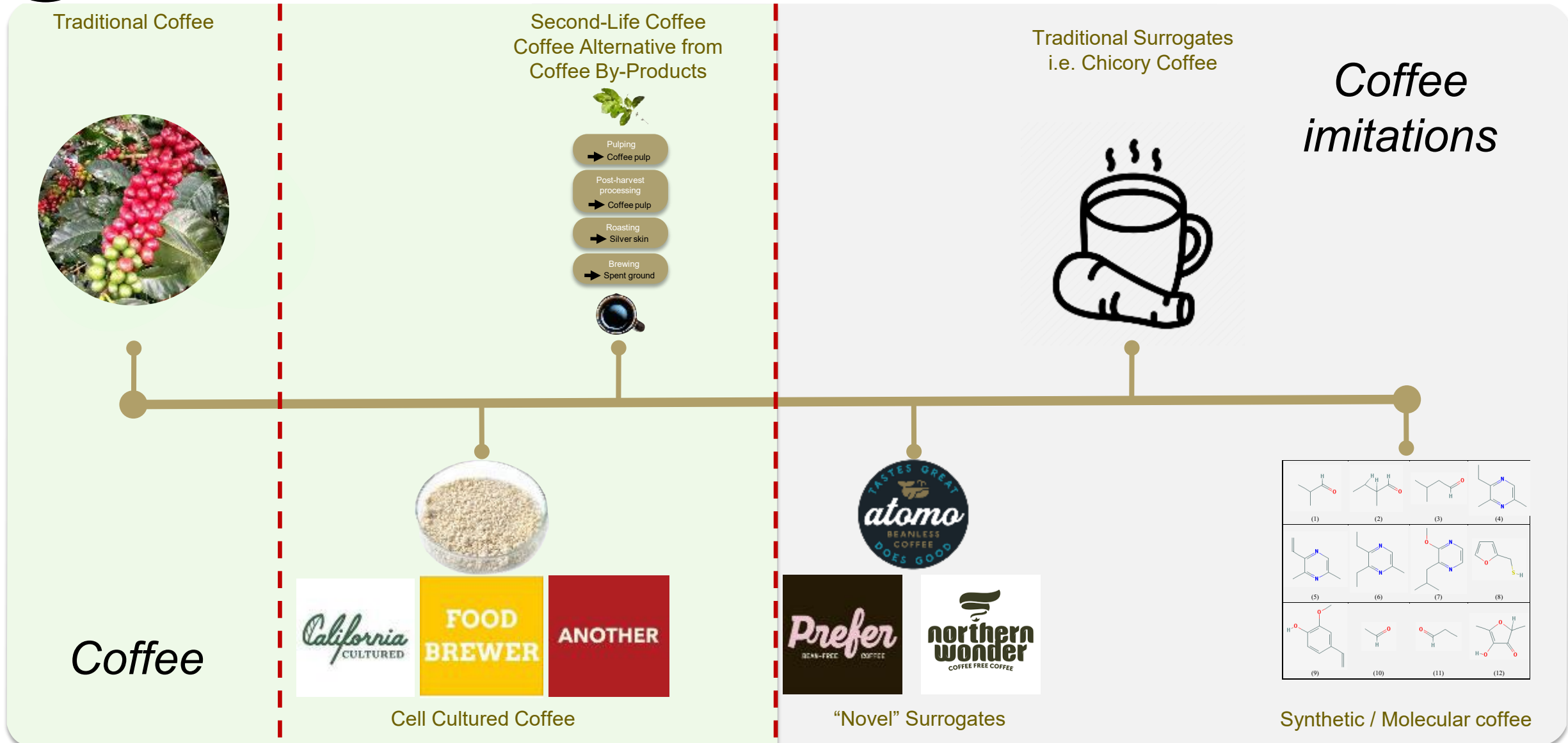


Roasted lupin, barley, chickpeas, chicory, natural aroma, dried black currant, citric acid and caffeine.

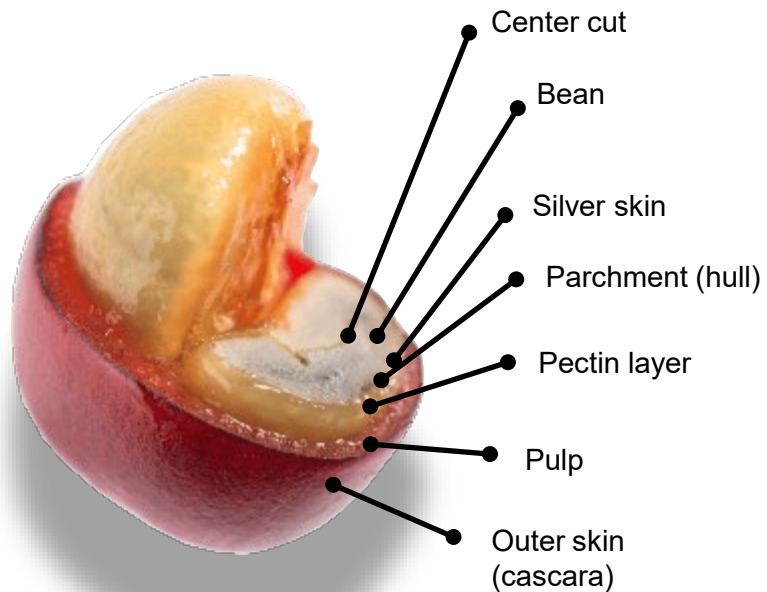
The decaf version does not contain caffeine.



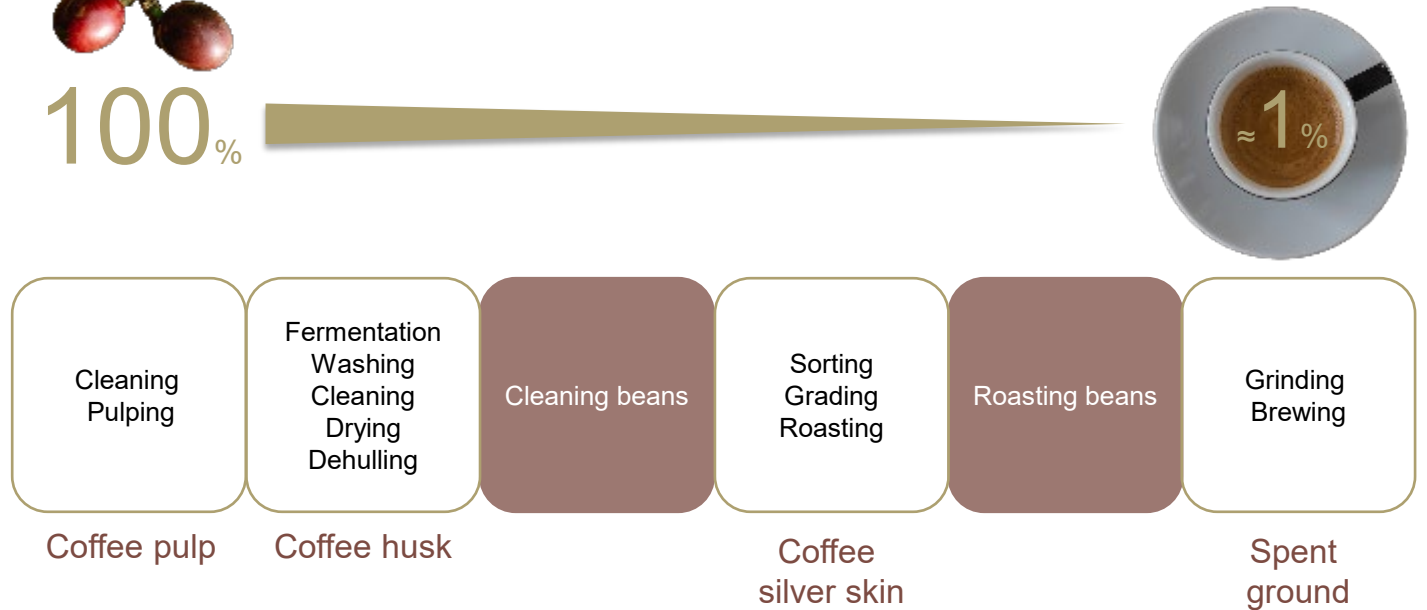
From Coffee Tree to Synthetic Coffee



Upcycling and Re-Valorisation of Coffee Side-Products

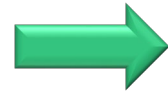


100%



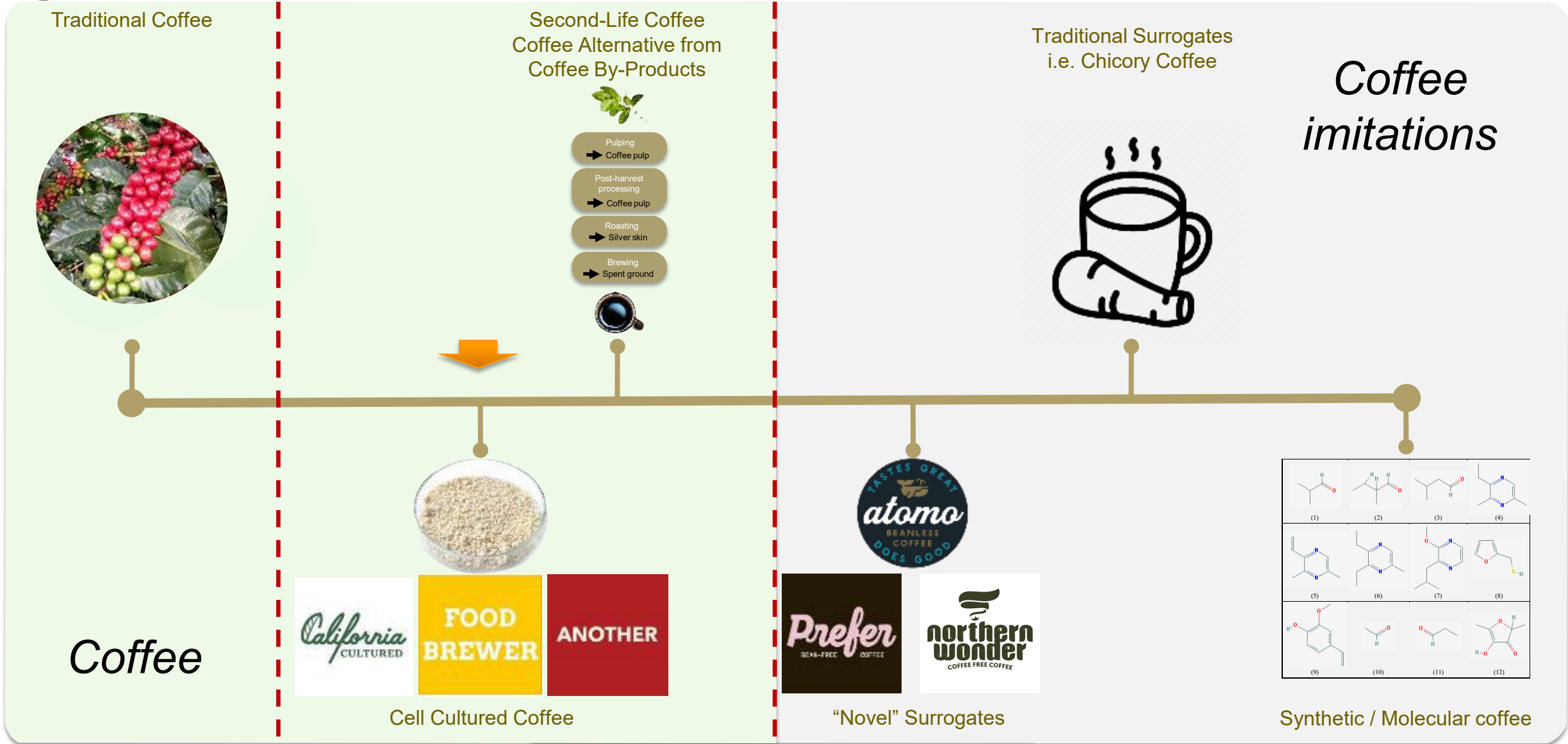


Spent Coffee
Grounds (SCG)



- Pre-treatment
- Enzymatic hydrolysis
- Yeast fermentation
- Maillard reaction





FROM CELLS ...



... TO CUP



Coffee Explant

Cell Biomass

Lyophilisation

Roast

Extract

“Barriers”

- Nagoya Protocol
- Novel Food

Fit ↔ Gap Analysis | Similarities ↔ Differences



Unroasted Coffee – Precursor Analysis

Roasted Coffee – Aroma Analysis

Coffee Brew – Extraction and Cupping



Caramelization

Maillard Reaction

Strecker Degradation

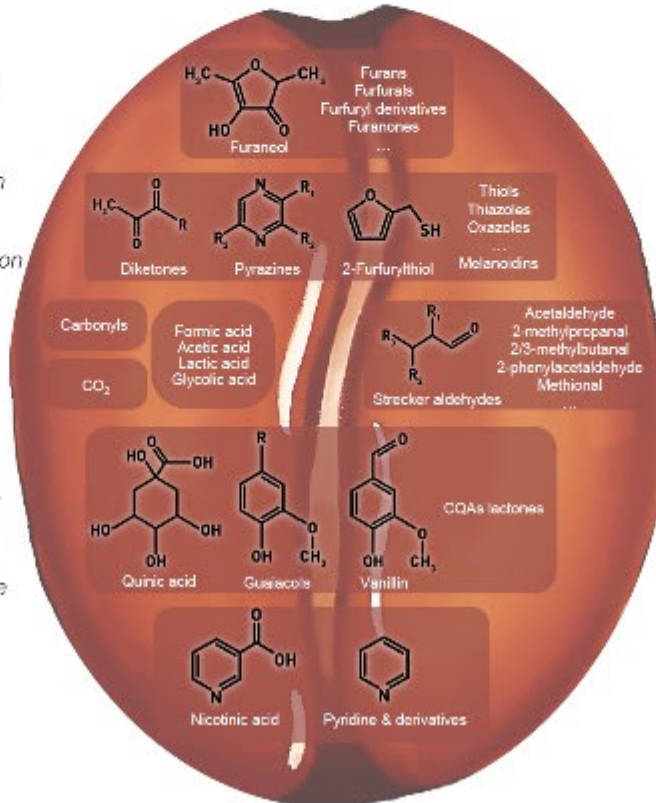
Fragmentation

Lipid Oxidation

CQAs Degradation

Partial Trigonelline Degradation

Pyrolysis



Aroma

Flavor

Acidity

Sweetness

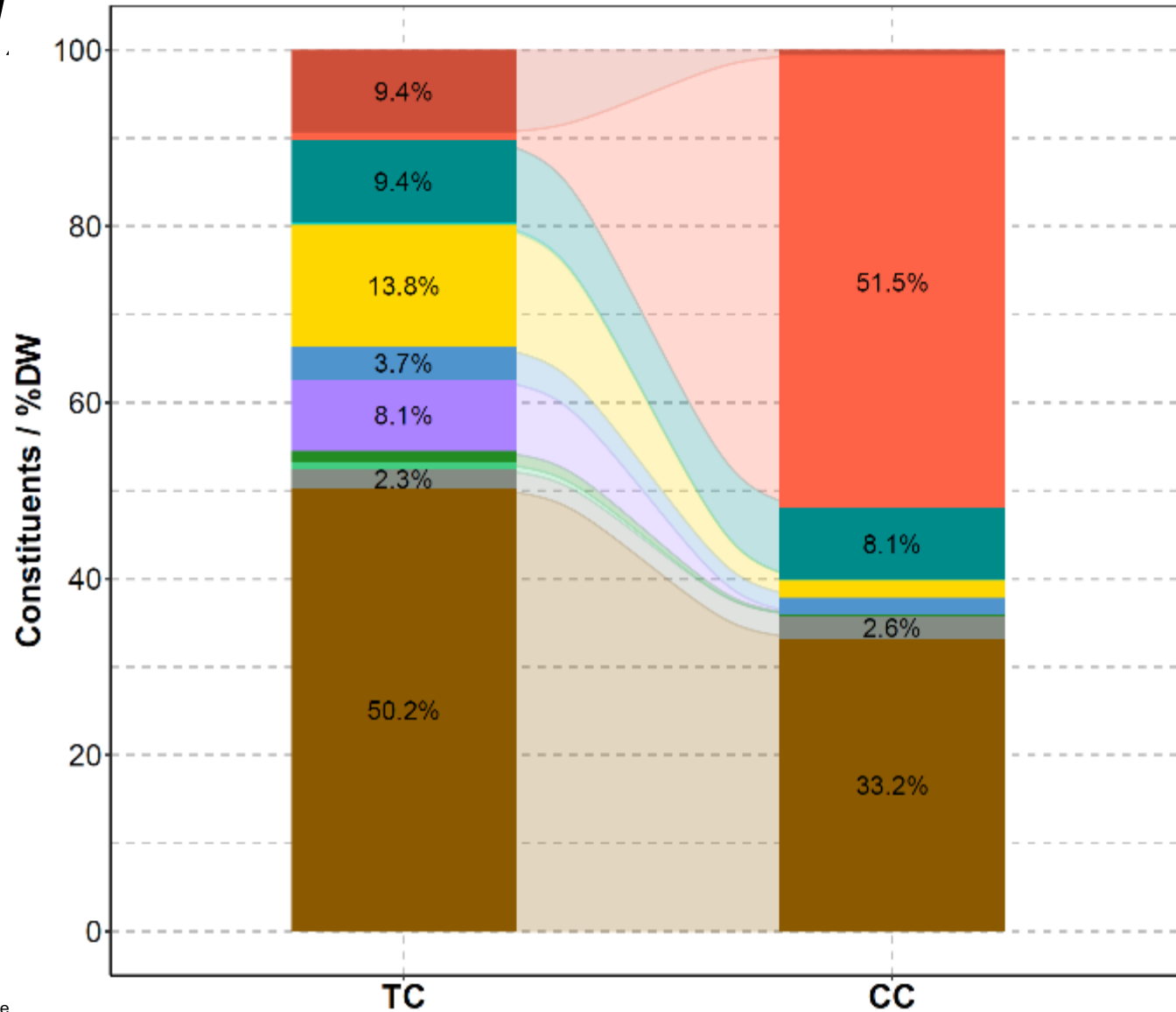
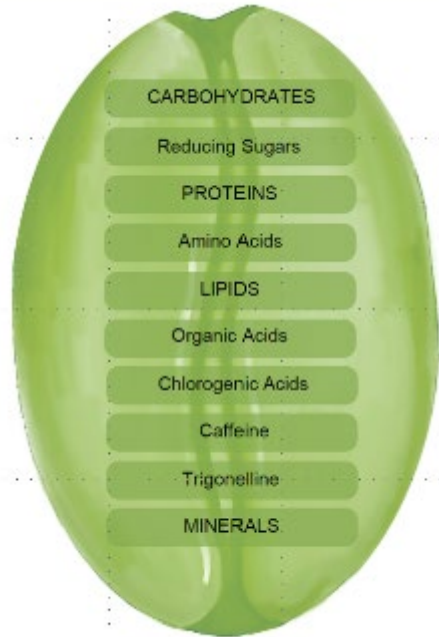
Bitterness

Body

Comparison of the chemical composition / unroasted (Overview)

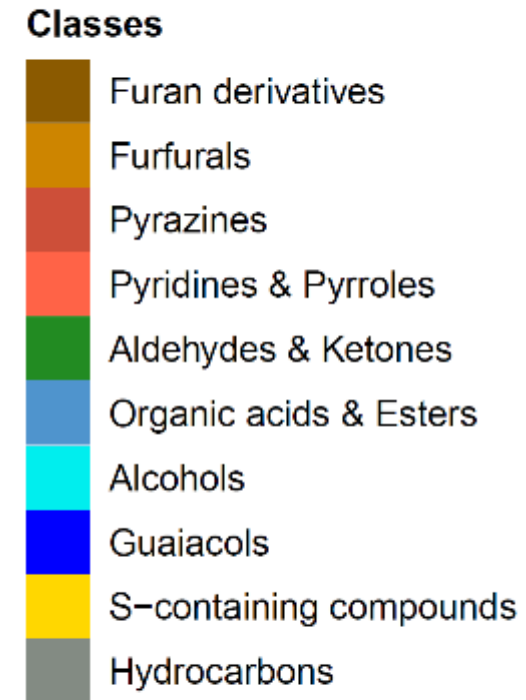
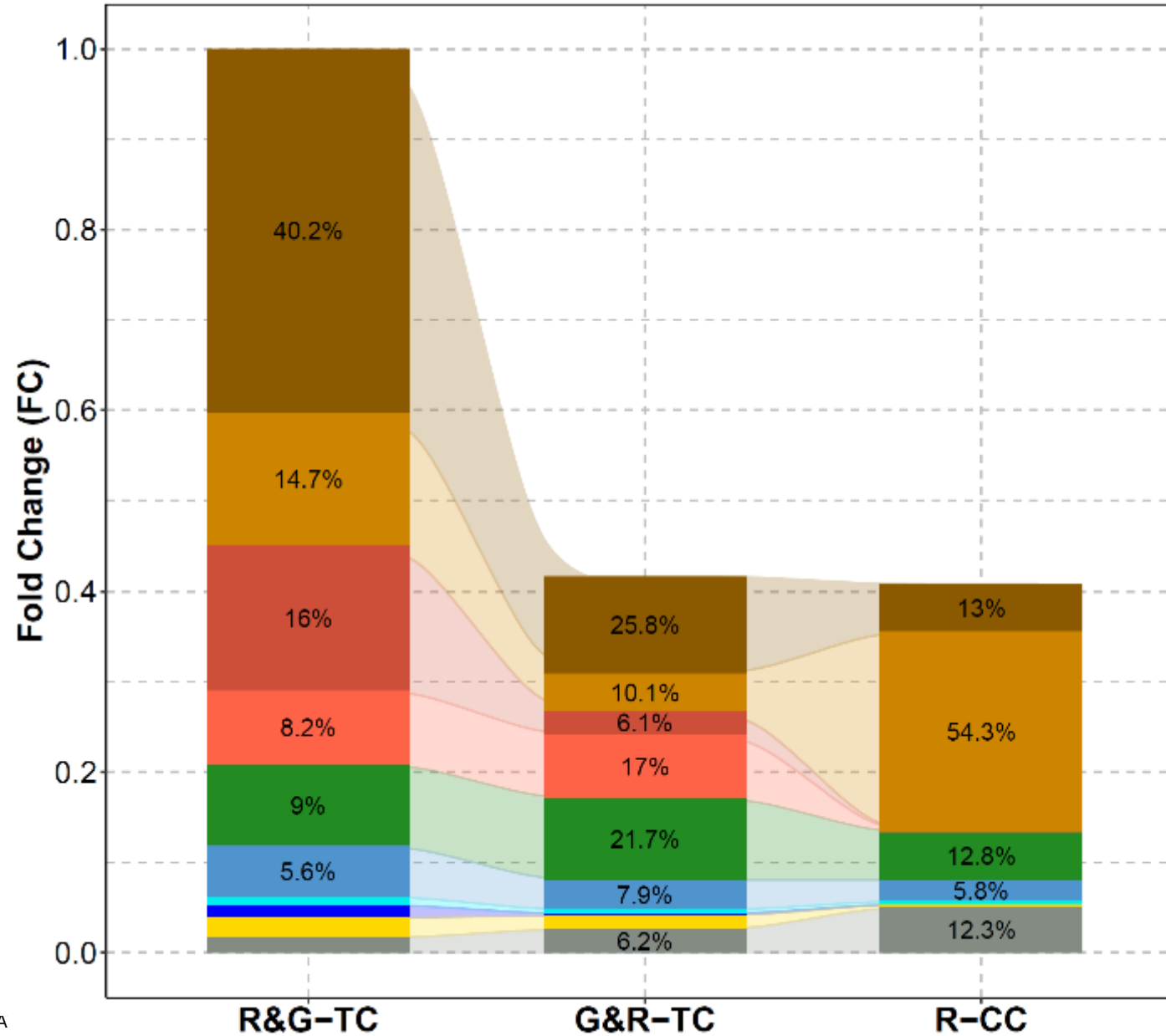
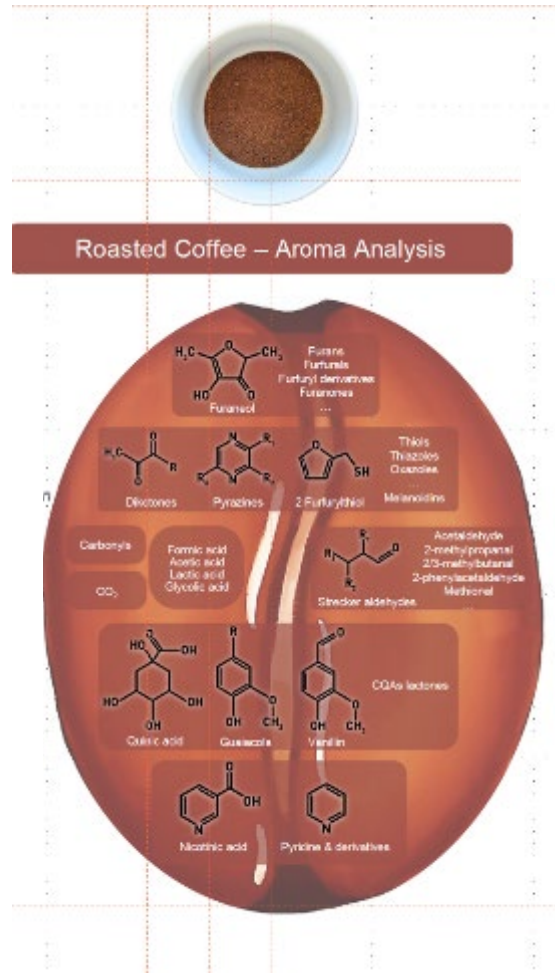


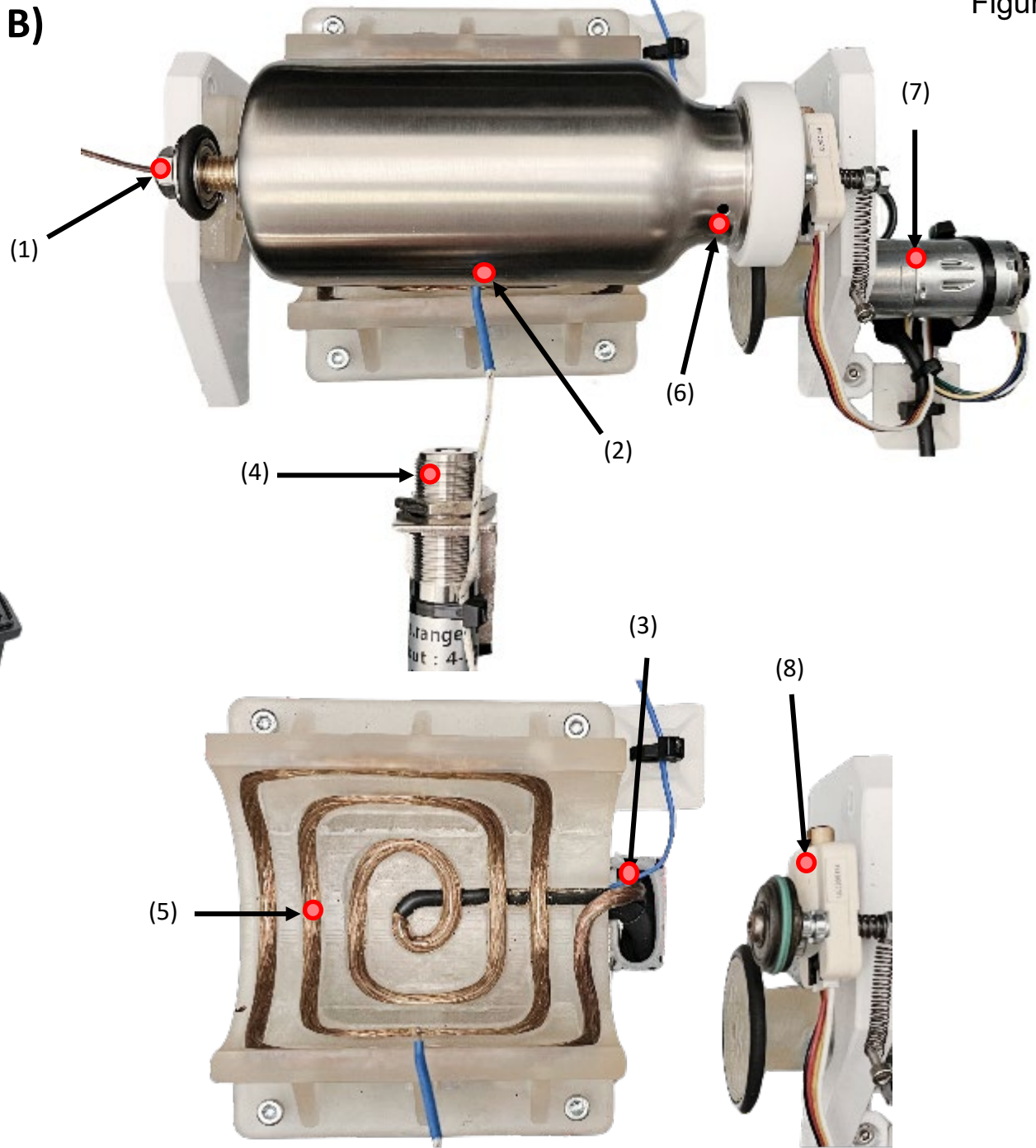
Unroasted Coffee – Precursor Analysis

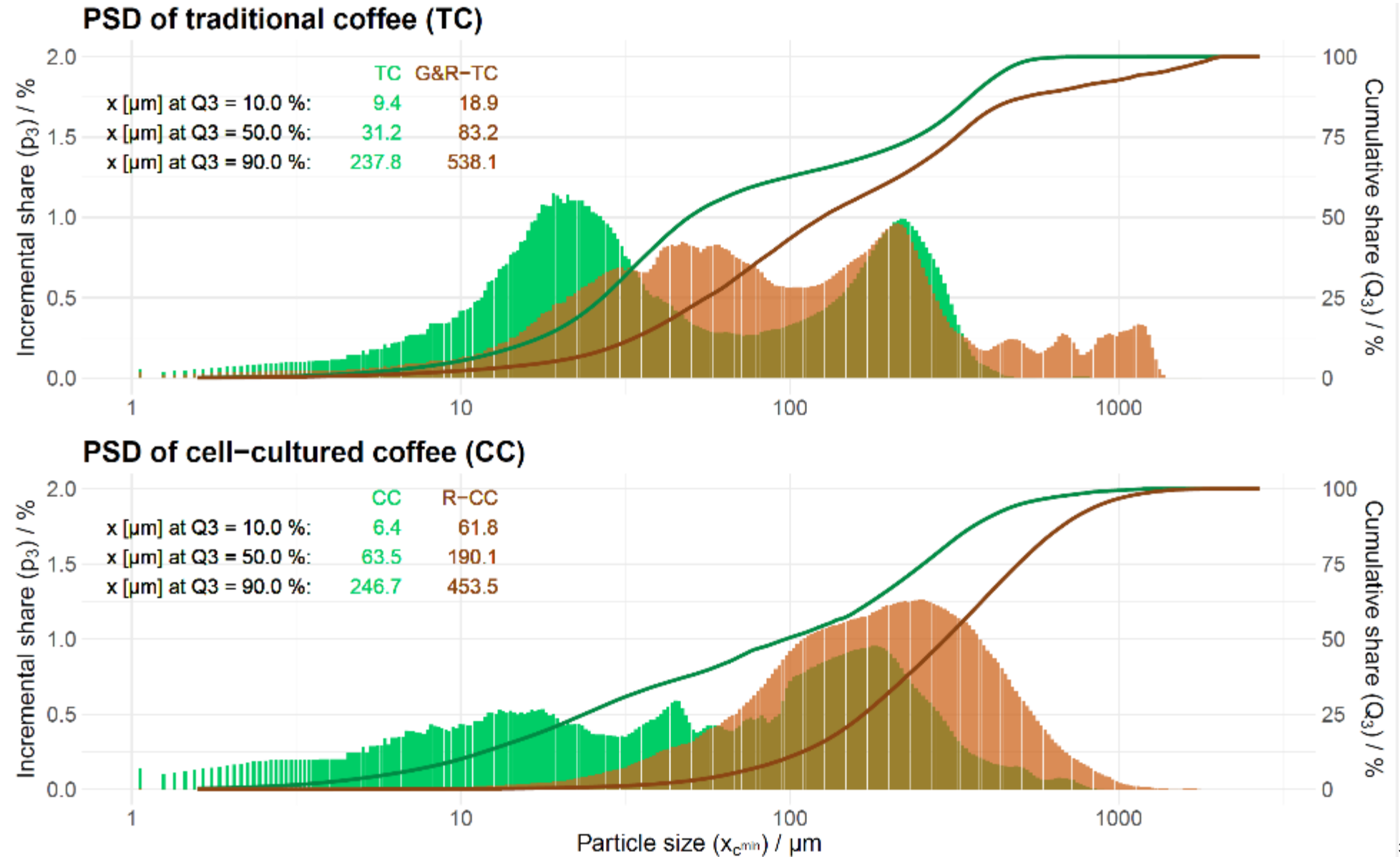


Constituents

- Sucrose
- Monosaccharides
- Proteins
- Amino acids
- Lipids
- Organic acids
- Chlorogenic acids
- Caffeine
- Trigonelline
- Minerals
- Carbohydrates&Others







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