ACADÉMIE DU CAFÉ

GENÈVE VEVEY

# The Smell Of Coffee

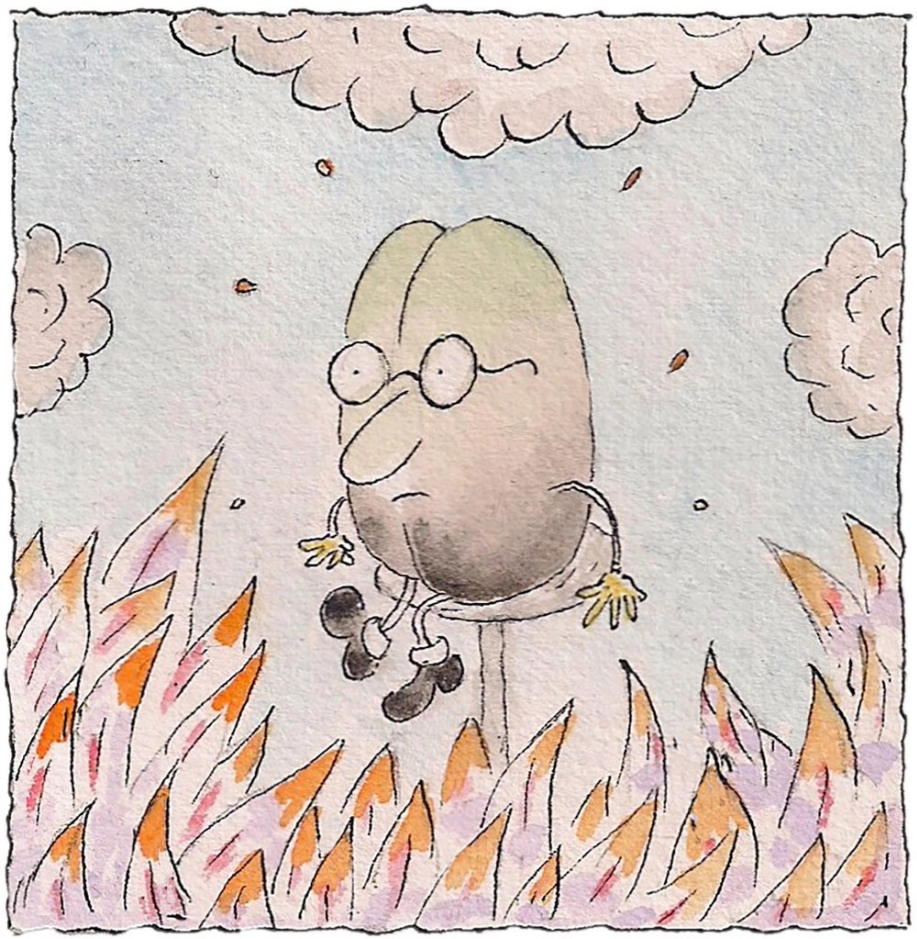
# AROMA IN ESPRESSO

**Ennio Cantergiani**

**Meet the Manufactuirer, Mannheim**
**2022**

# Main research groups in Coffee Aroma analysis

- **Nestlé NRC**
  - Blank, Poisson, Baggenstoss, etc.
- **Munich University**
  - Hoffmann
- **Zurich ZHAW**
  - Yeretzian
- And a lot of other scientists !



Source: Victoria Roberts

# «TERROIR»
# Green coffee
## factors influencing composition of coffee varietals

**Soil**

**Fertilizers**

**Gene/variety**

**Shade**

**Altitude**

**Storage**

**Post harvest Process(es)**

**Drying process**

**Density**

**Others ?**

**Composition** = f(Gene, Soil, Fertilizers, Shade, Altitude, Postharvest process, Drying process, etc…)

# New Post-harvest Processes

- Anaerobic fermentation in cherry (a few hours up to weeks !)
- Anaerobic fermentation in parchment
- Carbonic maceration
- Maceration in juice from coffee pulp
- Maceration with aromatic herbs or fruits (aniseed, lemongrass, cardamom, strawberry, banana, orange, etc)
- Yeast inoculation
- Koji fungi or special micro-organism inoculation
- Mix of some of the above techniques (i.e.: Yeast & Orange, Yeast & Strawberry)

→ NEW CATAGORY ?: PROCESSED COFFEES

# What is espresso roast ?


Is there any «TERROIR» in espresso ?

# Influence of roasting degrees on our senses

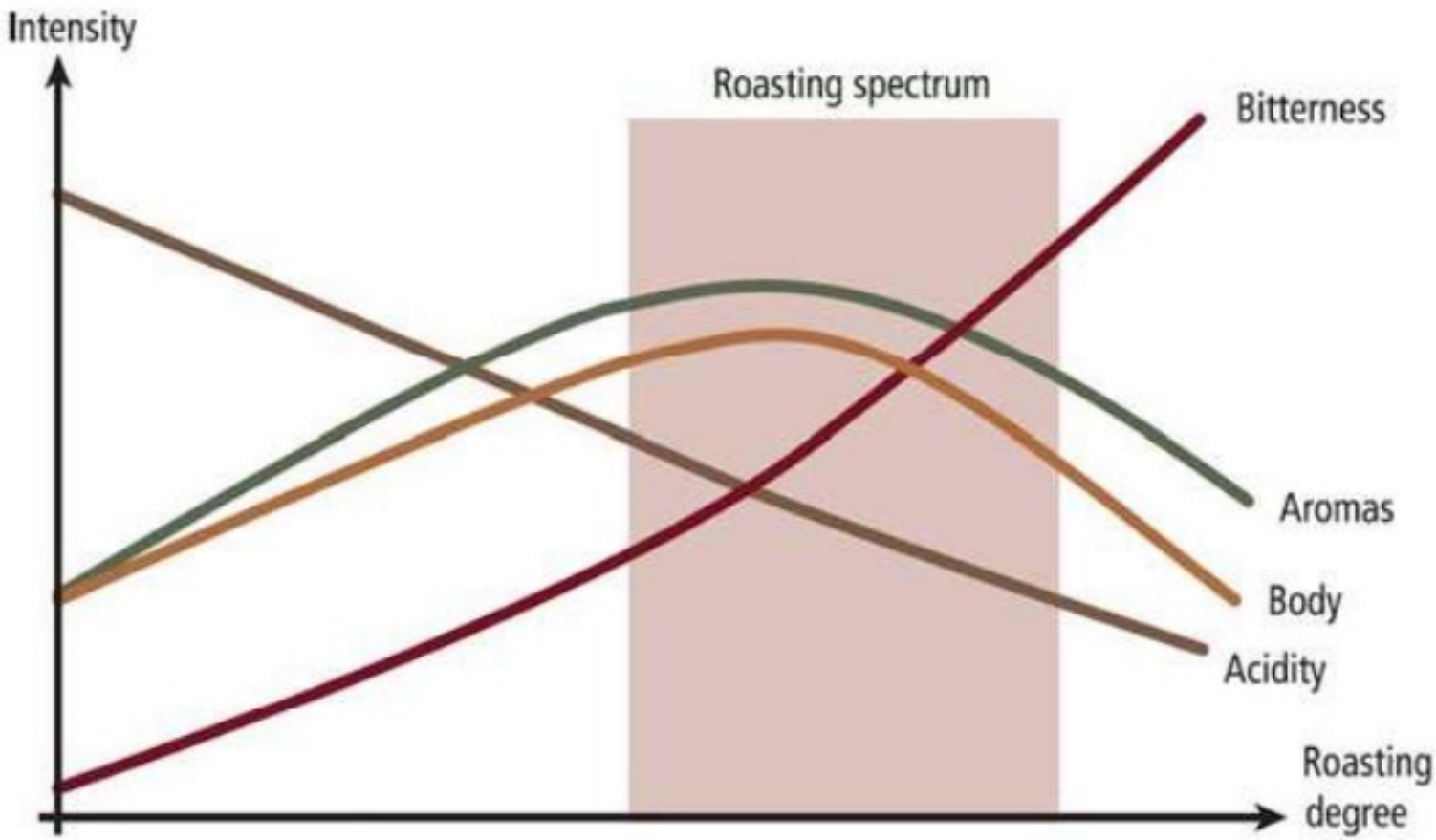



**FIGURE 12.5** Schematic presentation of the kinetics of flavor evolution during roasting.

# Volatile compounds in Green Coffee

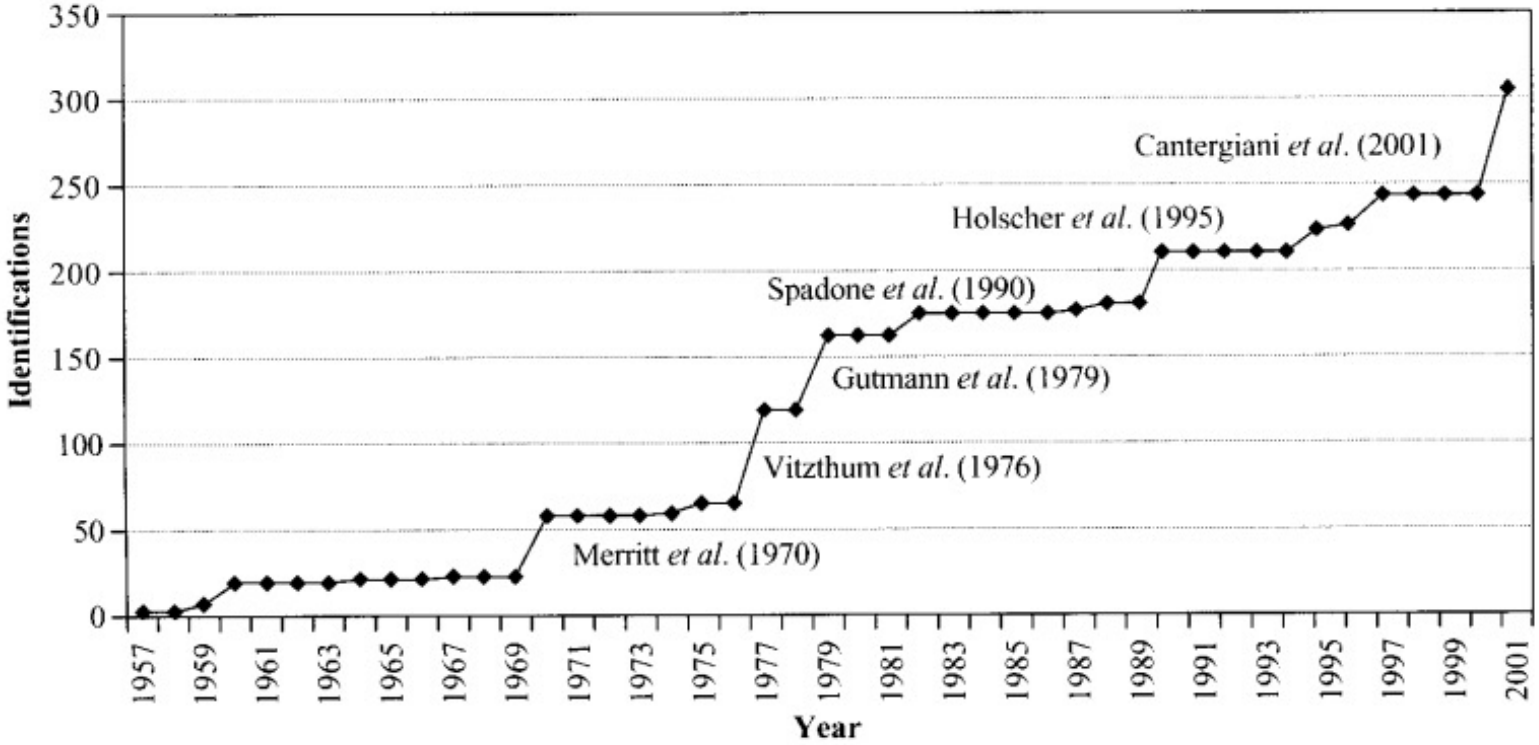



**Fig. 2.11** Progressive identification of green coffee volatile constituents

Source: Flament, I., Coffee Flavor Chemistry

# Volatile compounds in Roasted Coffee

A Historical Survey of Coffee Aroma Research

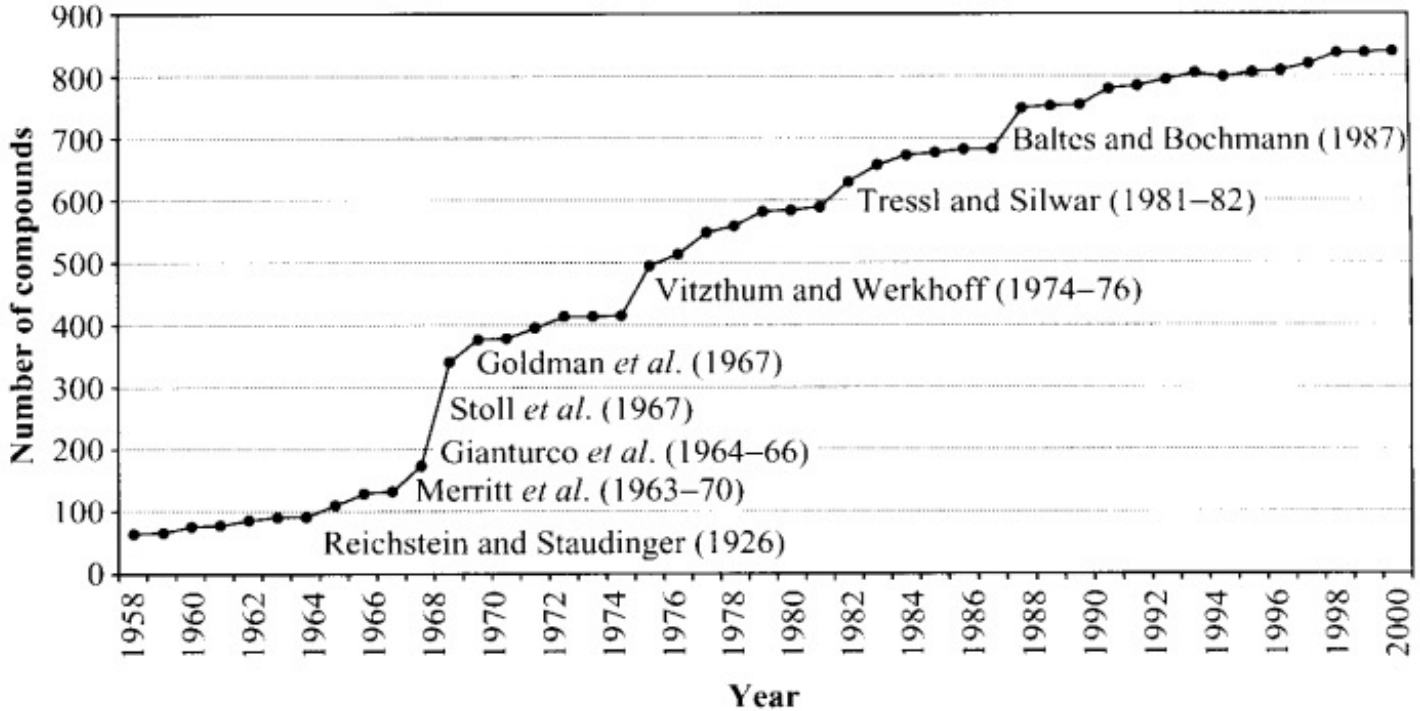


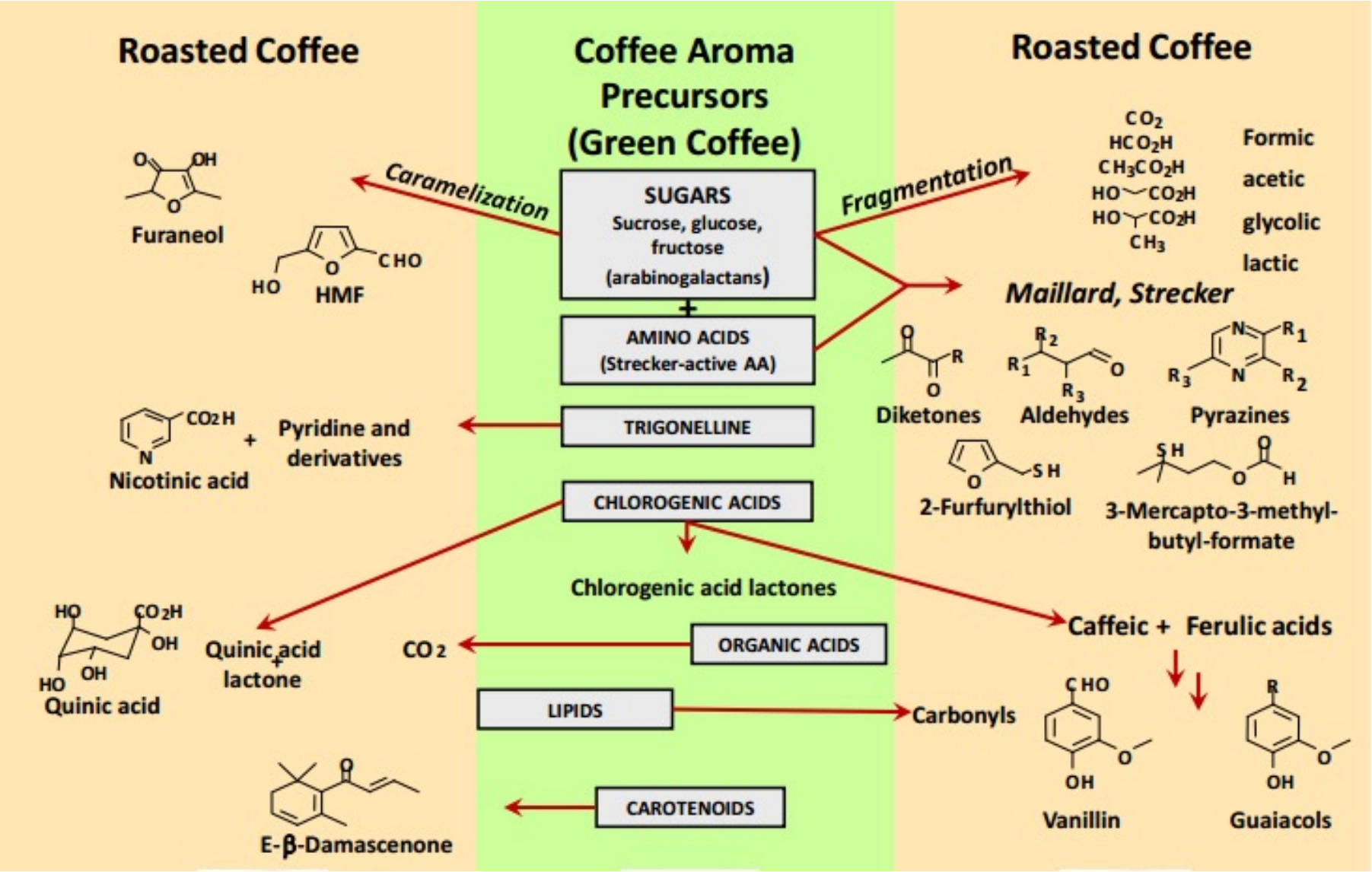

**Fig. 4.1** Identification of roasted coffee flavor constituents

Source: Flament, I., Coffee Flavor Chemistry

# Some chemical reactions occuring during roasting

- **Lipids** — No/few modifications
  - Carrier for flavourings
- **Carbohydrates** — degradation and reactions
  - Furfural, Maillard reaction products, Caramelization, Strecker degradation
- **Proteins** — degradation and reactions
  - Maillard reaction products, sulphur from amino acids
- **Chlorogenic acids** — degradation
  - Phenols and phenolic derivatives (guaiacol, indanes, …)
- **Acide organiques** — degradation depending on the roast degree
  - Citric, malic, acetic
- **Caféine** — No modification
- **Trigonelline** — No/few modification

# Flavourings during roasting process



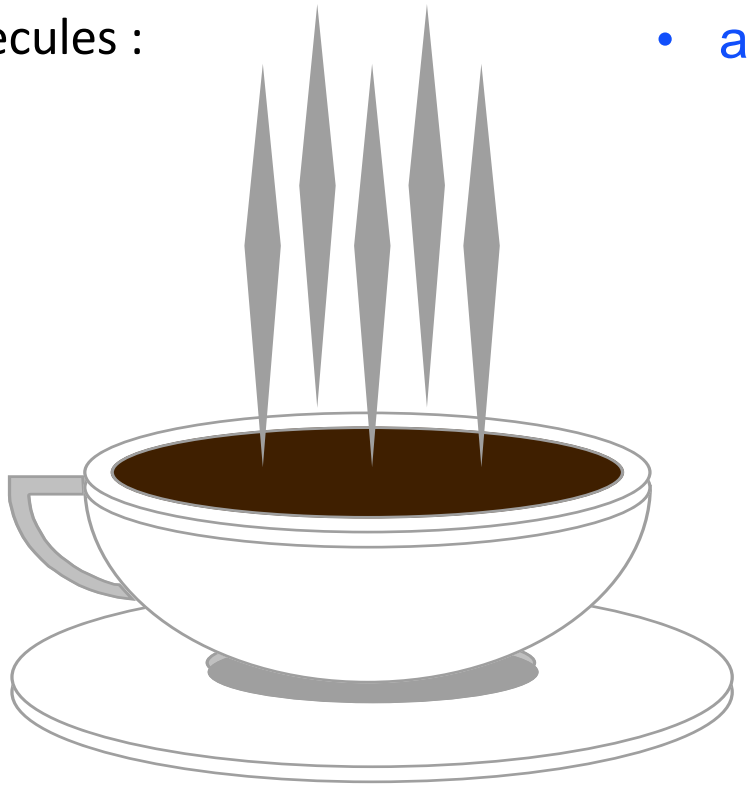



Source: Blank, I., et al.

# The Smell Of Coffee

## GREEN COFFEE

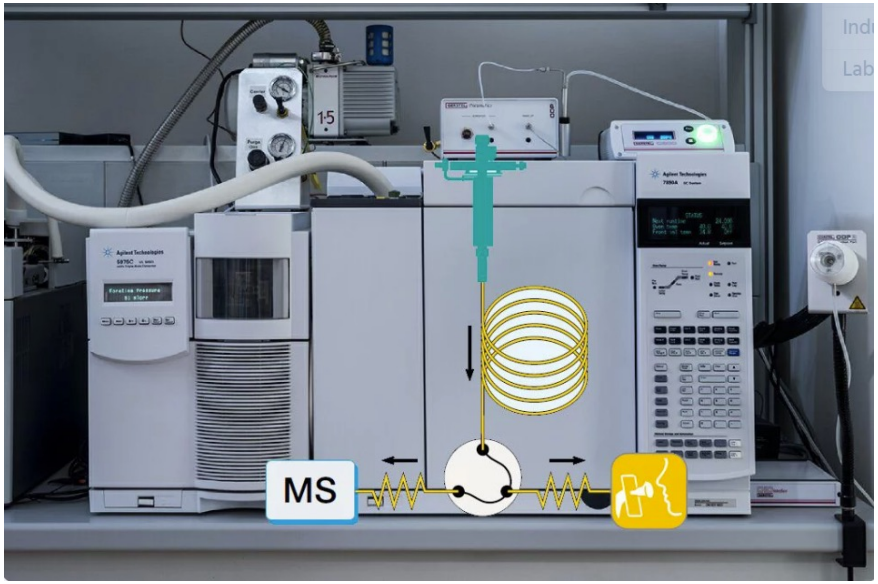
- approx. 300 molecules :
  - aldehydes
  - ketones
  - alcohols
  - Organic acids
  - esters
  - terpenes
  - ...

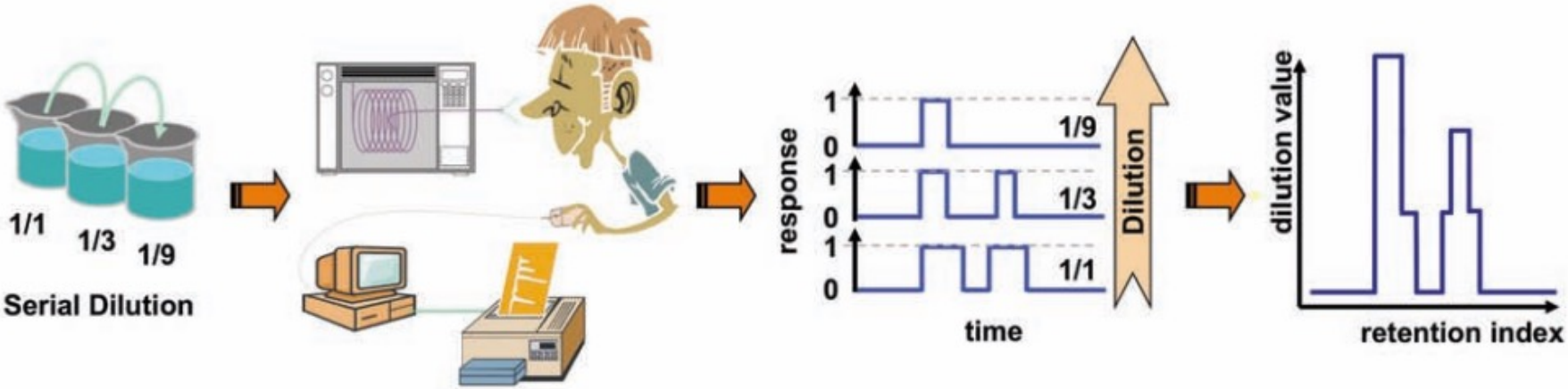


## ROASTED COFFEE

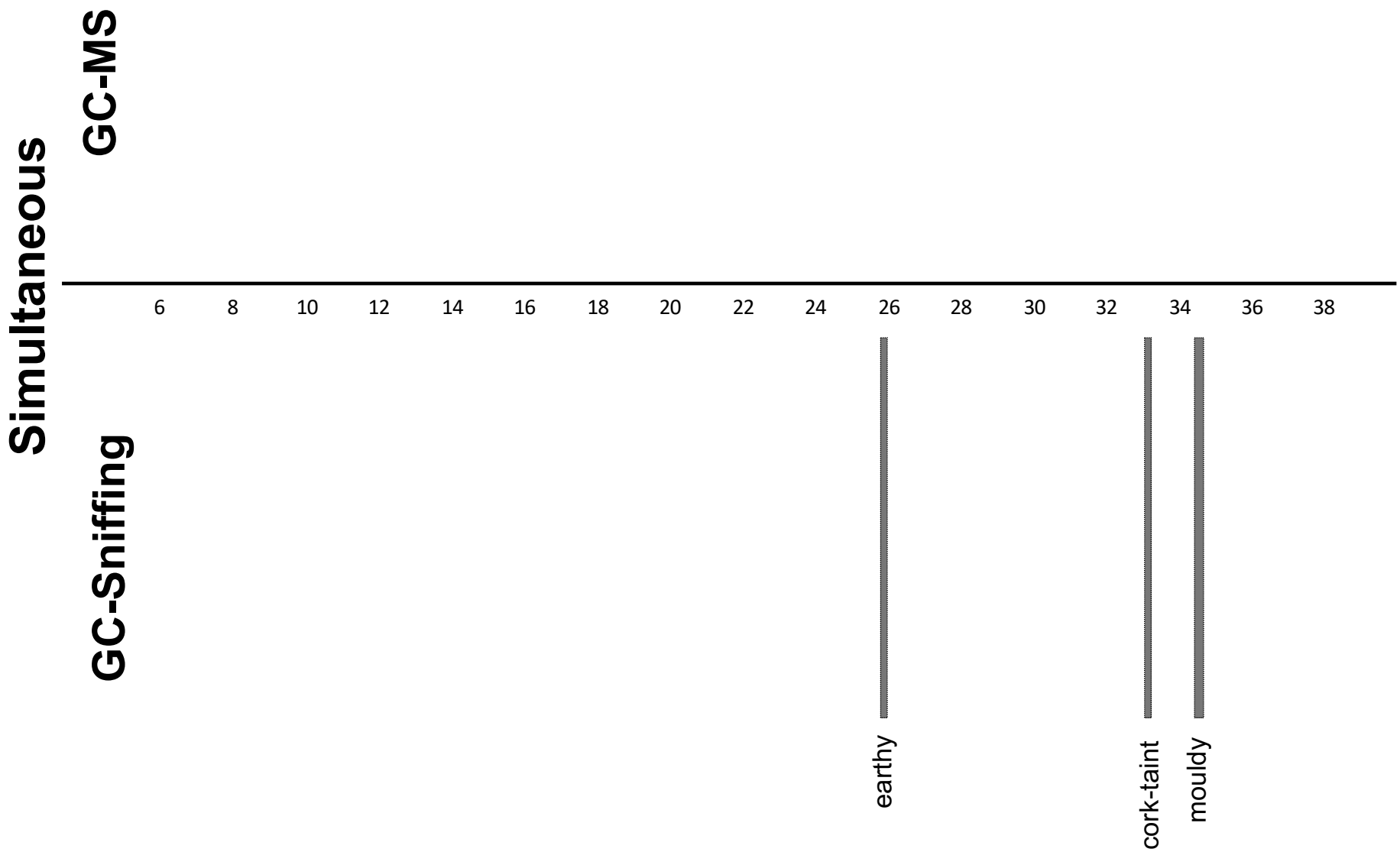
- approx. 900 molecules :
  - aldehydes
  - ketones
  - alcohols
  - Organic acids
  - esters
  - terpenes
  - Nitrogen compounds
  - Sulphur compounds
  - ...

# Gas Chromatography – Olfactometry
# Or GC-O / GC-sniffing

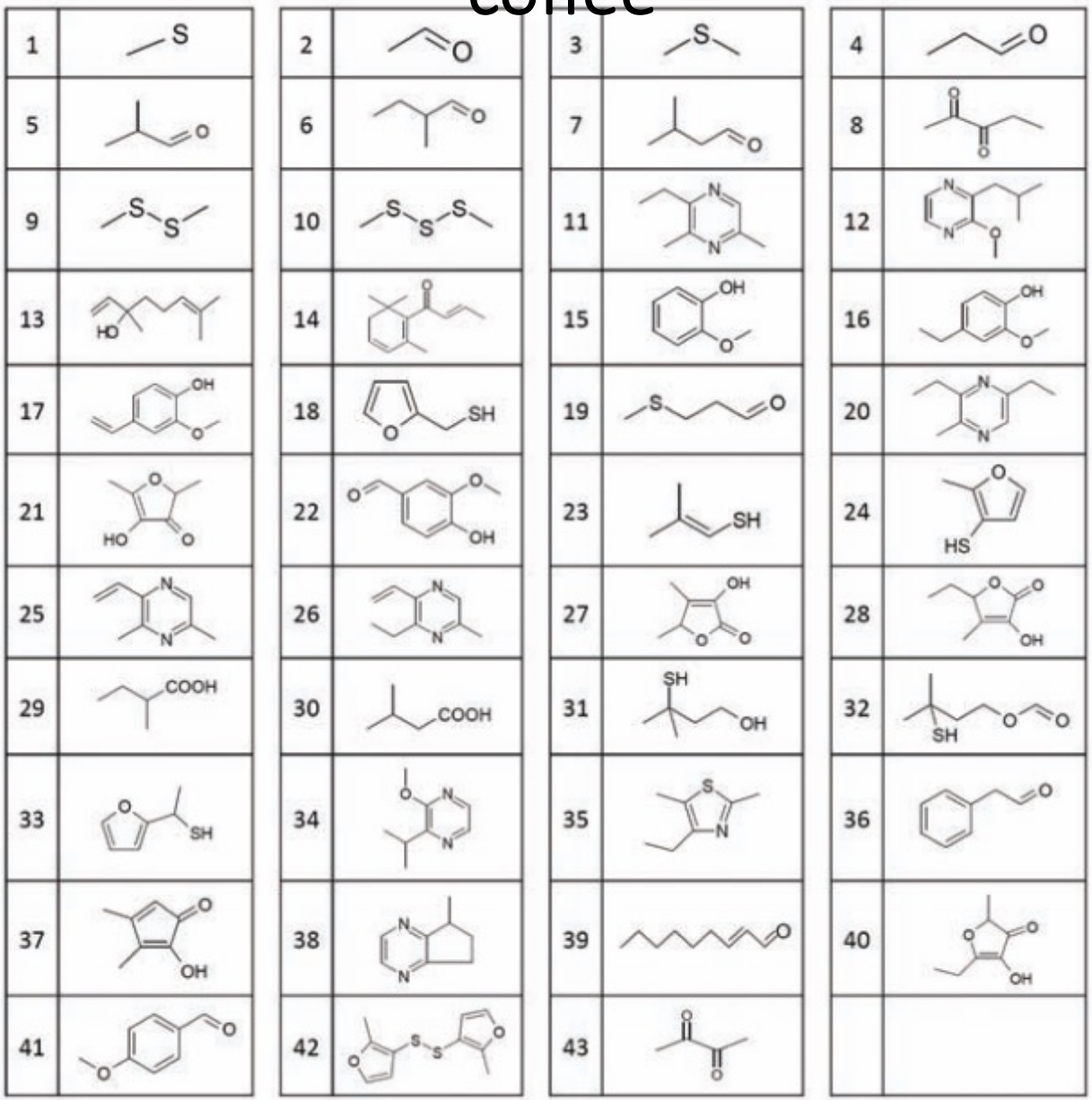


## *Simultaneous GC/sniffing detection on mouldy sample (non-polar)*



# 43 identified potent odorants in roasted coffee




Source: Yeretzian, C., et al.

# Phenolic compounds formation during roasting (degradation of CGA's)

*smocky, woody, spicy, earthy character*

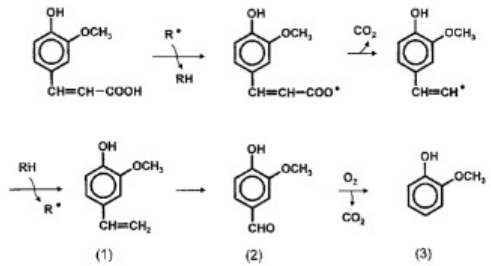
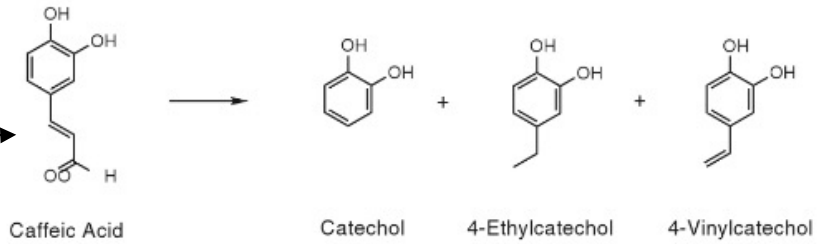



*Fig. 3.10* Thermal degradation of ferulic acid to 4-vinylguaiacol (1), vanillin (2) and guaiacol (3). R: radical.

Degradation from ferulic acid

Degradation from caffeic acid




Degradation from quinic acid

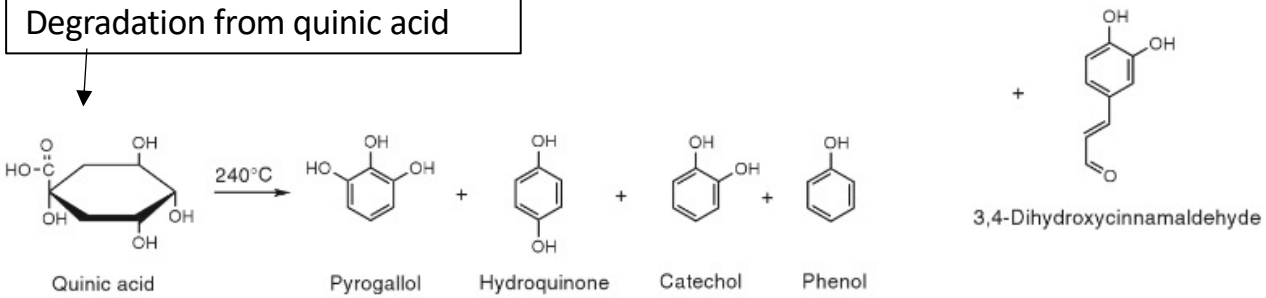


**Table 2.** Odour activity values (by AEDA) and formation mechanisms of volatiles in the aroma of roasted ground Arabica coffee[13]

| Compound | Odour activity value | Formation mechanism |
|---|---|---|
| (*E*)-$\beta$-Damascenone | $2.7 \times 10^5$ | Carotene degradation |
| 2-Furfurylthiol | $1.7 \times 10^5$ | Maillard reaction |
| 3-Mercapto-3-methylbutylformate | $3.7 \times 10^4$ | Maillard reaction |
| 5-Ethyl-4-hydroxy-2-methyl-3(2*H*)-furanone | $1.5 \times 10^4$ | Maillard reaction |
| 4-Hydroxy-2,5-dimethyl-3(2*H*)-furanone | $1.1 \times 10^4$ | Maillard reaction |
| Guaiacol | $1.7 \times 10^3$ | Phenol degradation |
| 4-Vinylguaiacol | $1.1 \times 10^3$ | Phenol degradation |
| Methional | $1.2 \times 10^3$ | Maillard reaction |
| 2-Ethyl-3-dimethylpyrazine | $1.6 \times 10^2$ | Maillard reaction |
| 2,3-Diethyl-5-methylpyrazine | 95 | Maillard reaction |
| 3-Hydroxy-4,5-dimethyl-2(5*H*)-furanone | 74 | Maillard reaction |
| Vanillin | 48 | Phenol degradation |
| 4-Ethylguaiacol | 32 | Phenol degradation |
| 5-Ethyl-3-hydroxy-4-methyl-2(5*H*)-furanone | 21 | Maillard reaction |

**Table 3.** Aroma occurrences resulting from CharmAnalysis[27]

| Compound | OAV (standardized) | Sensorial description |
|---|---|---|
| Sotolon | 81 | Toast |
| $\beta$-Damascenone | 98 | Fruit |
| 2-Furfurylthiol | 100 | Toast |
| 4-Vinylguaiacol | 62 | Cloves |
| 2-Methyl-3-furanthiol | 89 | Nuts |
| Vanillin | 71 | Vanilla |
| Guaiacol | 77 | Plastic |
| Furaneol | 58 | Caramel |
| Methional | 43 | Potato |
| 3-Methoxy-2 isobutyl pyrazine | 38 | Plants |
| 2,4,5-Trimethylthiazole | 38 | Plastic |
| Abhexon | 44 | Honey |
| 4-Ethyl guaiacol | 31 | Spice |
| 5-Methyl-6,7-dihydrocyclopentapirazine | 22 | Cotton candy |
| 2-Ethyl-3,5,-dimethylpyrazine | 25 | Burnt |
| *cis*-2-Nonenal | 27 | Toast |
| 2-Isopropyl-3-methoxypyrazine | 14 | Green |
| 2,3,5-Trimethylpyrazine | 15 | Toast |

# Conclusions

Roasting degree and roasting profile influence a lot the aroma of the brewed coffee

Darker it is, less “Terroir” remains

Aroma alone gives one dimension of coffee quality. Taste, Body play also a role in the overall appreciation

New aromas are coming with some new post-harvest processes making the word “Terroir” more difficult to use. Traceability is then mandatory to avoid any confusion.

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THANK YOU !