

# Understanding food flavour: the interaction of flavour chemistry and sensory science



A joint venture of CSIRO &  
the Victorian Government

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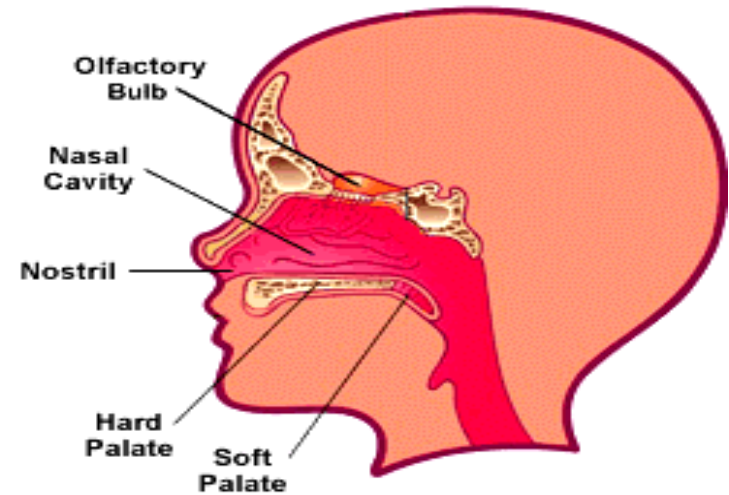
***Centre for Food Quality and Stability***

# Food Flavour: Definition

- Food flavour consists of three sensations:

- Odour (orthonasal perception)
- Aroma (retronasal perception)
- Taste

- Volatile compounds are responsible for the odour and aroma of a food

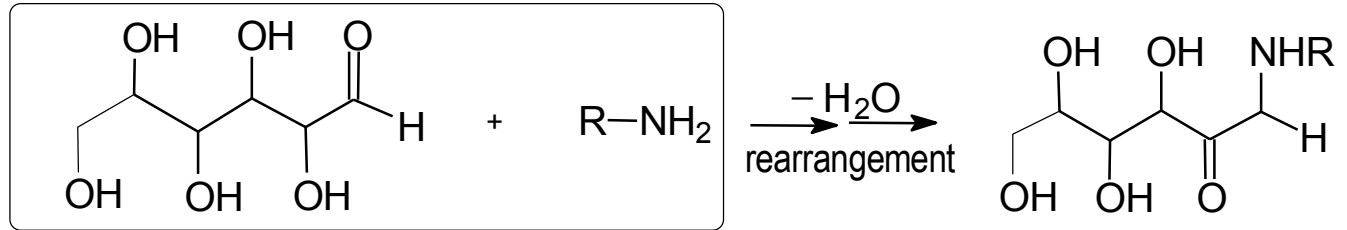


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# Precursors of Volatile Compounds

- Foods contain amino acids, carbohydrates and lipids, carotenoids
- Reactions involving amino acids, sugars and lipids are responsible for the formation of volatile compounds:
  - Maillard reaction
  - Lipid decomposition

# Maillard Reaction + Lipid oxidation



reducing sugar

amino compound

Amadori intermediate

Lipid oxidation  
(e.g PUFA)

aldehydes

Flavour compounds  
**Melanoidins**

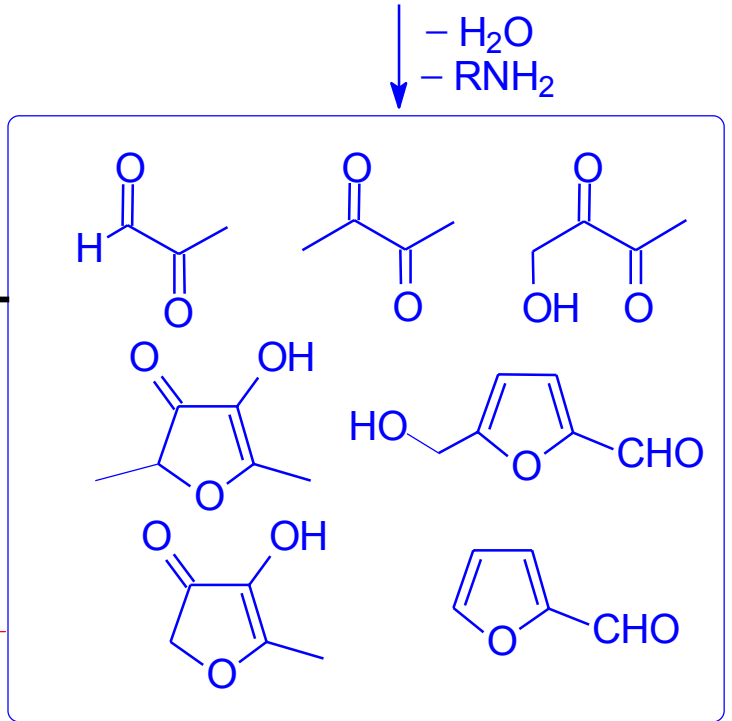
Amino acids

Strecker reaction

H<sub>2</sub>S aldehydes

Acrylamide

**ASPARAGINE**



# Maillard reaction: Aromas generated from various sugars / amino acids

	<u>Glycine</u>	<u>Glutamic Acid</u>	<u>Lysine</u>	<u>Methionine</u>	<u>Phenylalanine</u>
Glucose	Burnt candy	Chicken tray	Burnt fried potatoes	Cabbage	Caramel
Fructose	Beef broth	Chicken	Fried potatoes	Bean soup	Dirty dog
Maltose	Beef broth	Baked ham	Stale potato	Harsh horseradish	Sweet
Sucrose	Beef broth	Charred meat	Boiled meat	Overcooked cabbage	Chocolate

(obtained from various literature sources)

# Food volatiles

- Analytical investigations employed mostly GC and GC/MS.
- An estimated 8000 food volatiles had been reported until 1997.
- Initially it was assumed that all volatiles contribute to food aroma.
- The determination of odour activity values (OAV) showed that not all volatiles were important as flavour compounds

$$\text{OAV} = \text{Odorant concentration} / \text{Odour threshold value}$$

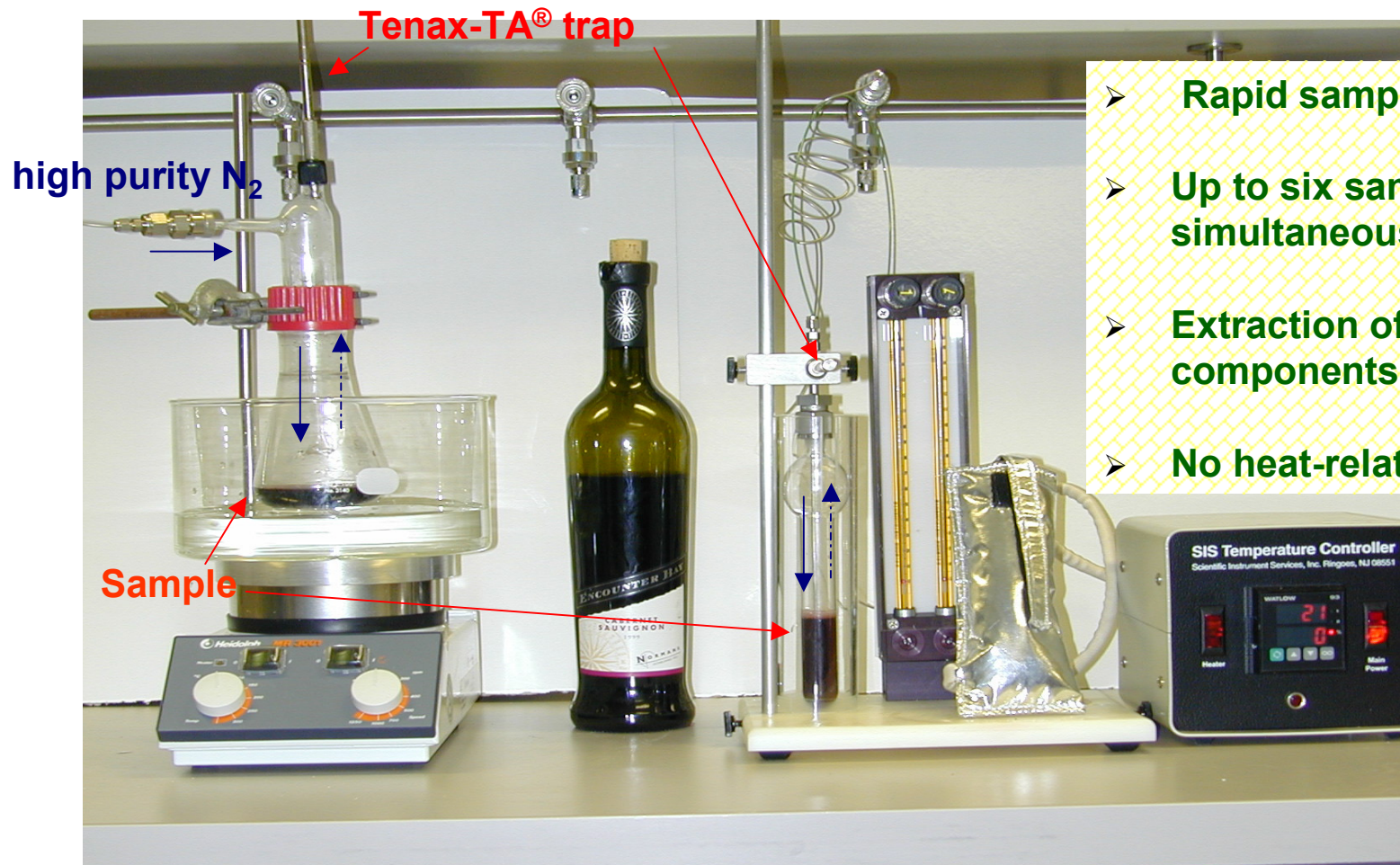
# Odour analysis

- Results in the qualitative and quantitative determination of the important odorants in a food product:
  - *identity of important odorants*
  - *relative concentration in food of interest*
- This information is useful for the prediction, control and re-creation of the flavour of a food product.

# Odour analysis: Steps

1. Extraction of the volatiles from the food matrix
  - *dynamic headspace or purge-and-trap (DHS)*
  - *static headspace (SHS)*
  - *liquid or solvent extraction*
  - *solvent-assisted flavour evaporation (SAFE)*
  - *simultaneous distillation-extraction (SDE)*

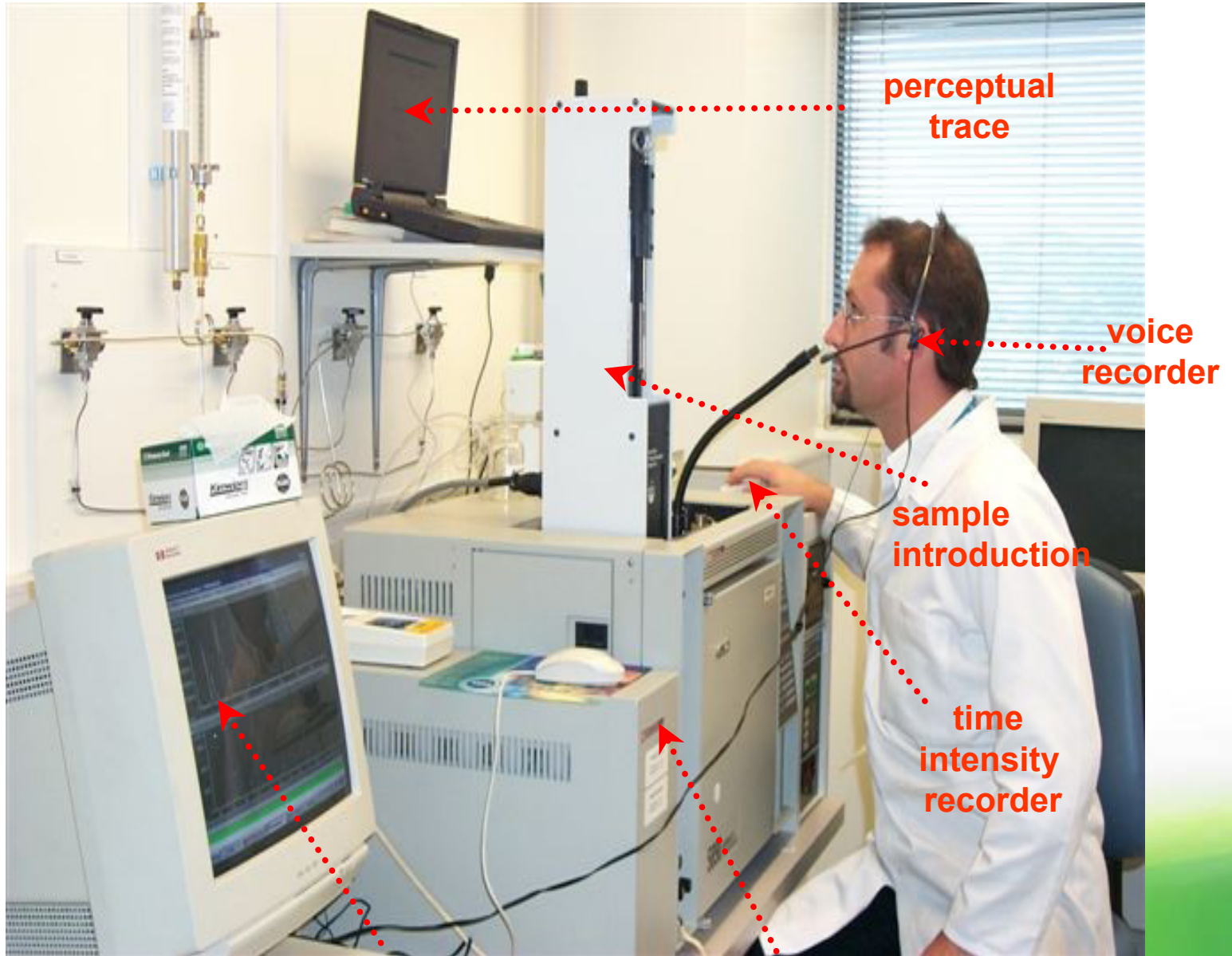
# Odour analysis: purge-and-trap



# Odour analysis: Steps

2. Separation and tentative identification of the volatiles in the extract by GC/MS and localisation of the odorants by olfactometry (GC/MS-O)
  - Commonly employed GC/MS-O approaches:
    - *OSME* (perception measurements of a non-diluted extract by trained panelists averaged)
    - *AEDA* (extract serially diluted and measured until no perception)

# GC-MS-olfactometer and time intensity recorder

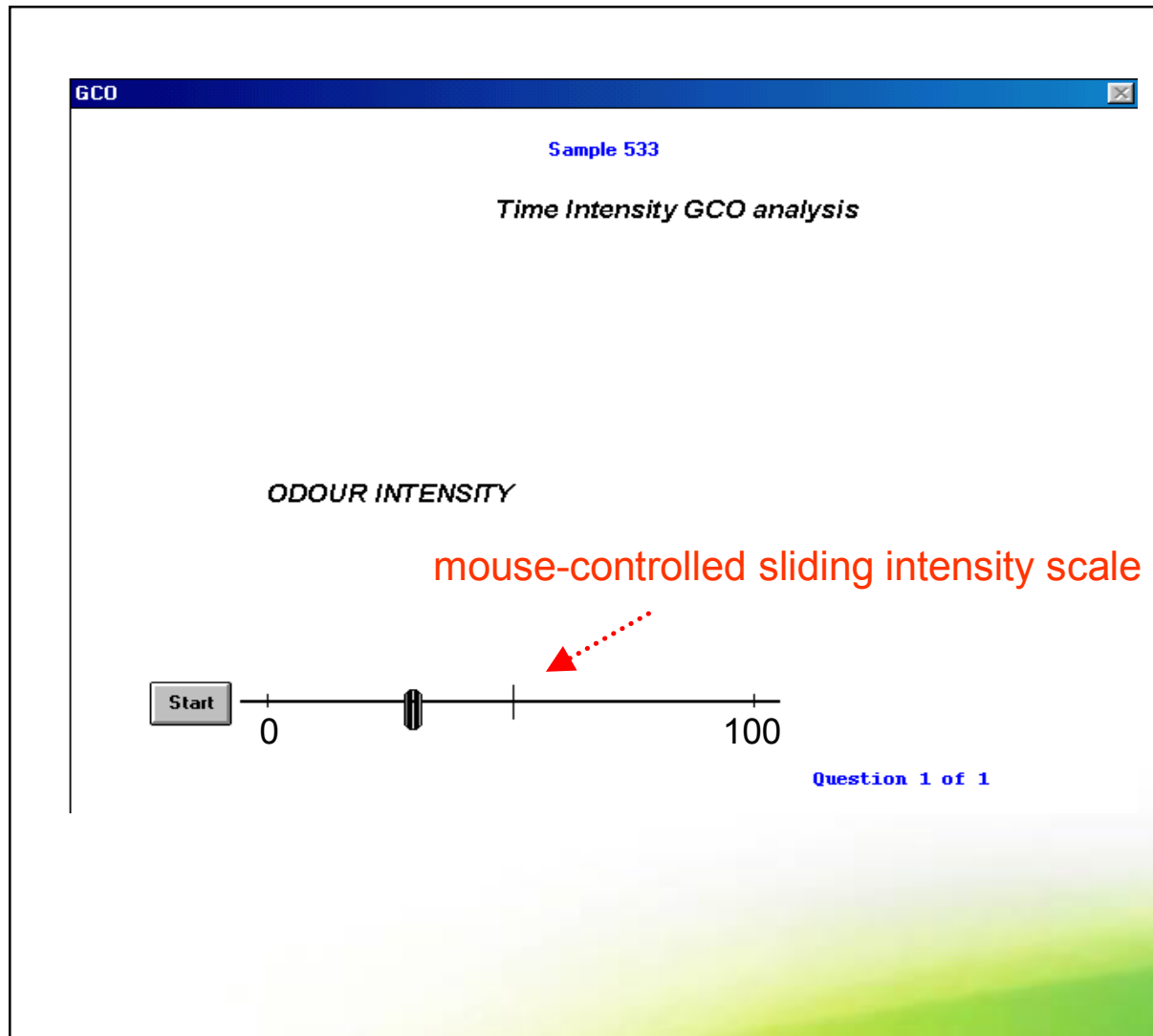


Results for today Ideas for tomorrow

instrumental trace

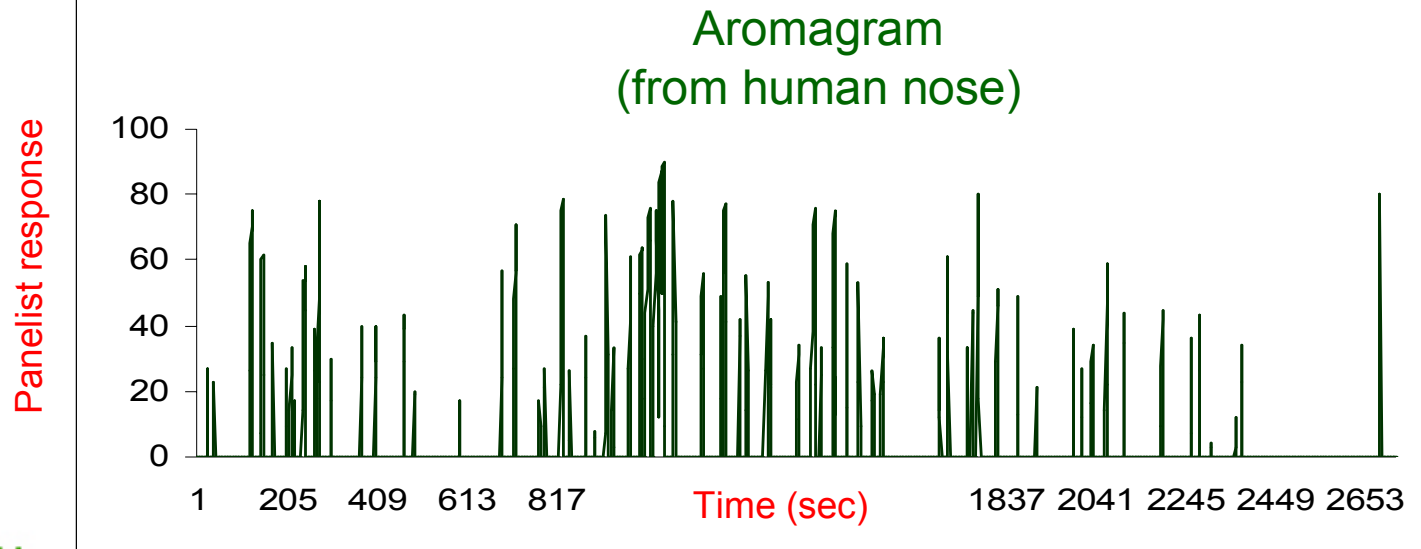
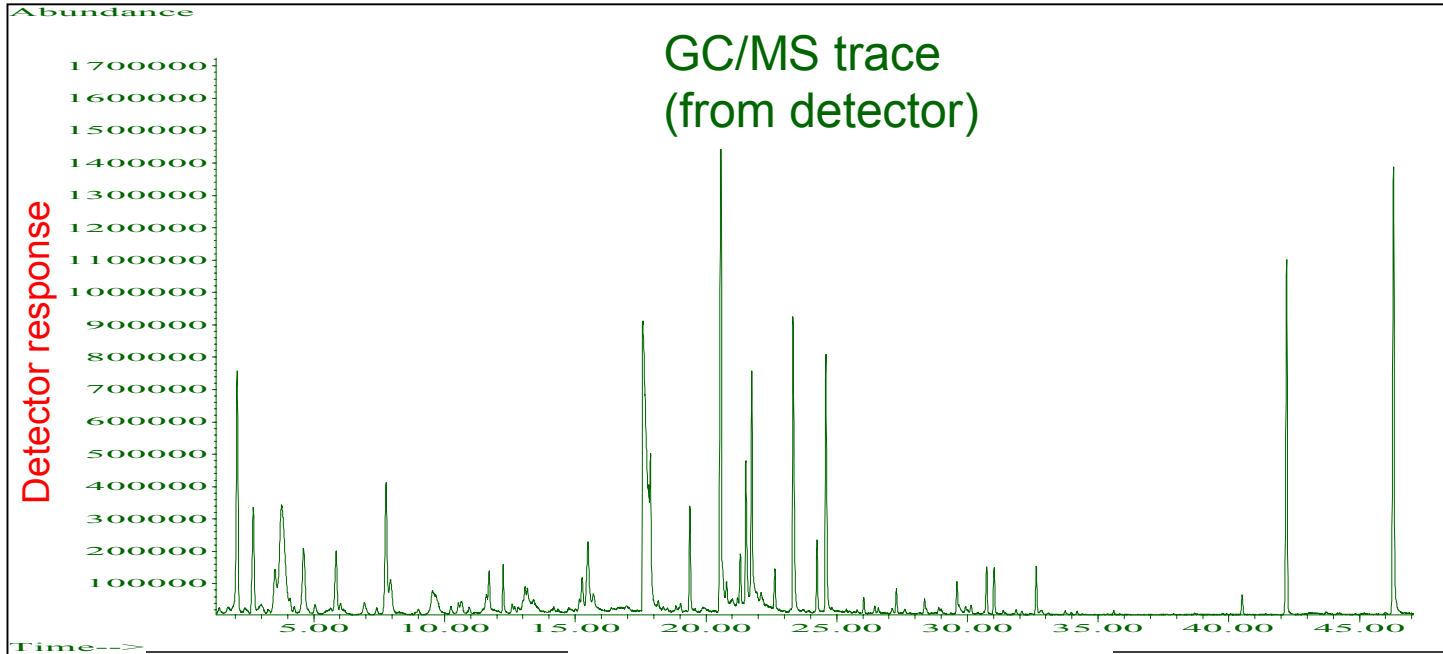
GC/MS

# Time-intensity recorder interface



# Information obtained from GC/MS-O

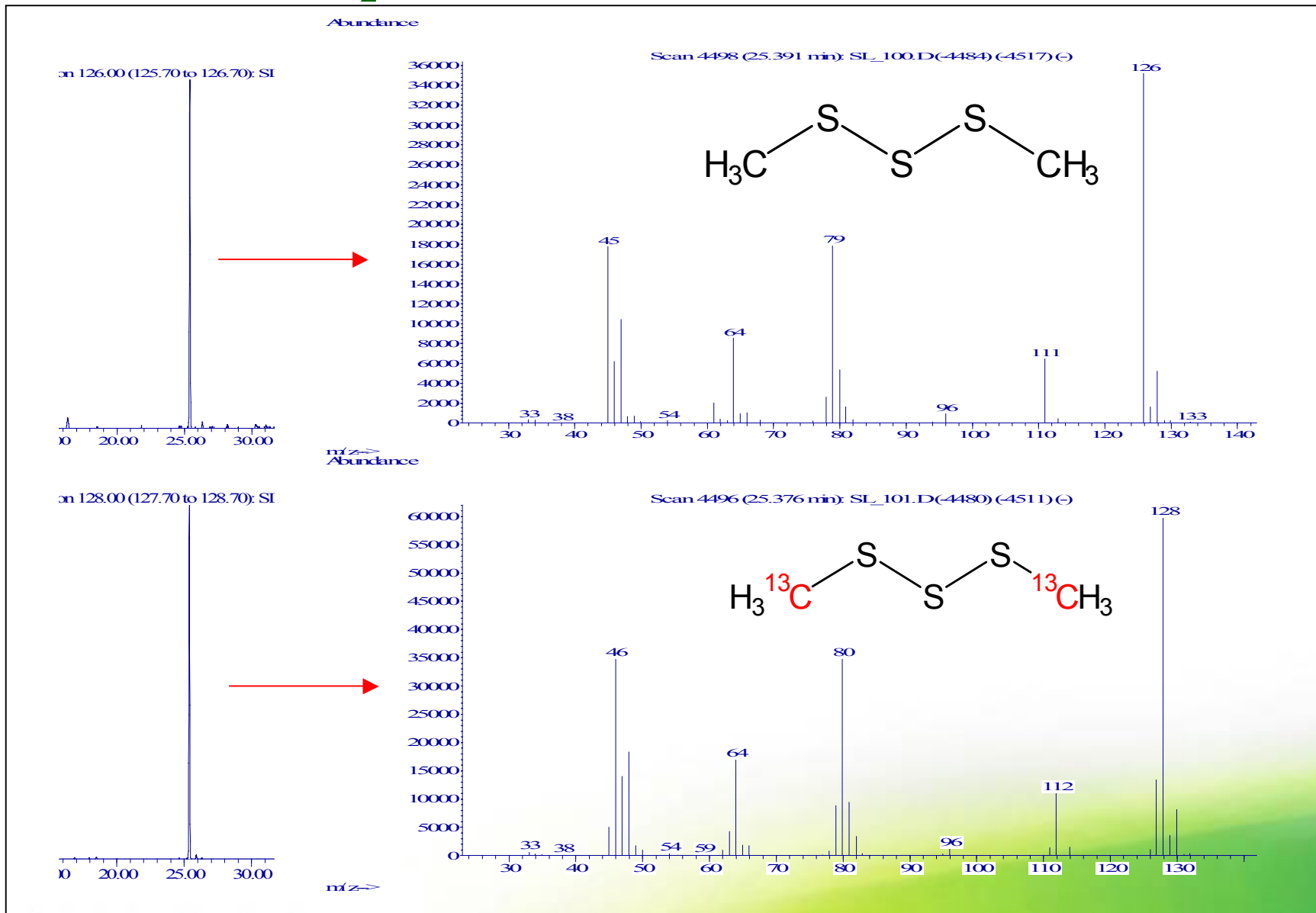
The human nose still remains the most sensitive detector of odour-active volatiles!!



# Odour analysis: Steps

3. Quantification of important odourants using GC/MS
  - Potentially most reliable quantification approach:
    - *SIDA* (stable isotope dilution analysis)

# Example: $^{13}\text{C}_2$ -dimethyl trisulfide



# Odour analysis: Steps

4. Preparation of 'synthetic' blends of odourants in 'blank' matrices using the quantitative data (including omission experiments)
5. Sensory evaluation of the prepared blends by trained panels

Whole process successful when:

Aroma of synthetic blend (usually containing 3-4 odourants) = aroma of original food

# Example: Chocolate aroma

- Chocolate: a matrix of solid particles (cocoa, sugar, milk) set in a continuous fat medium
- Characteristic flavour is a result of several manufacturing steps
- Flavour depends on many parameters including cocoa variety used, bean fermentation, conching process, added ingredients (e.g. vanillin)



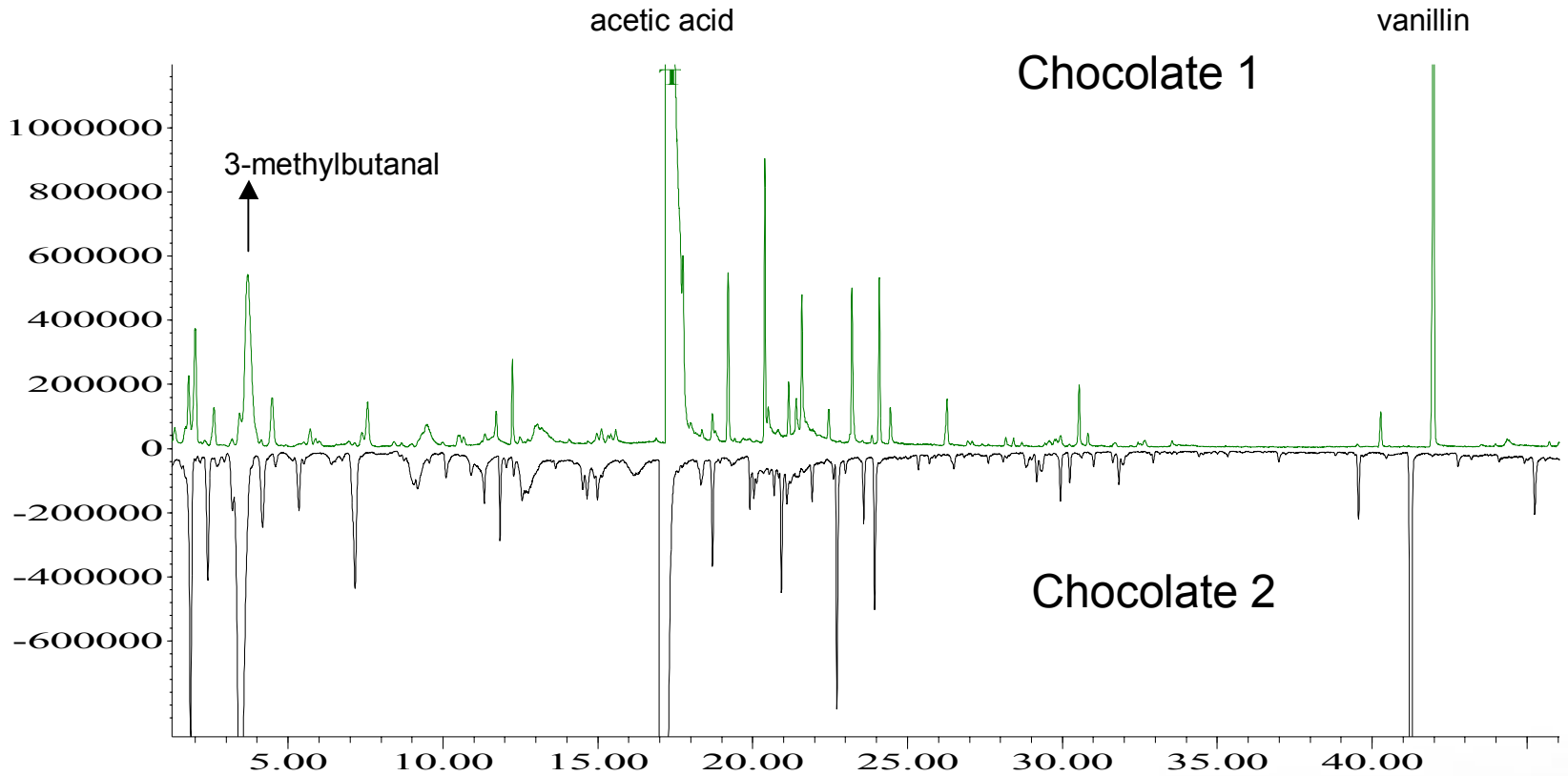
# Example: Chocolate aroma

- Total volatile and aroma profiles of two milk chocolates compared
- Both chocolates contained a similar amount of cocoa and milk solids (approx. Cocoa Solids 26%, Milk Solids 27%, Fat 30%)



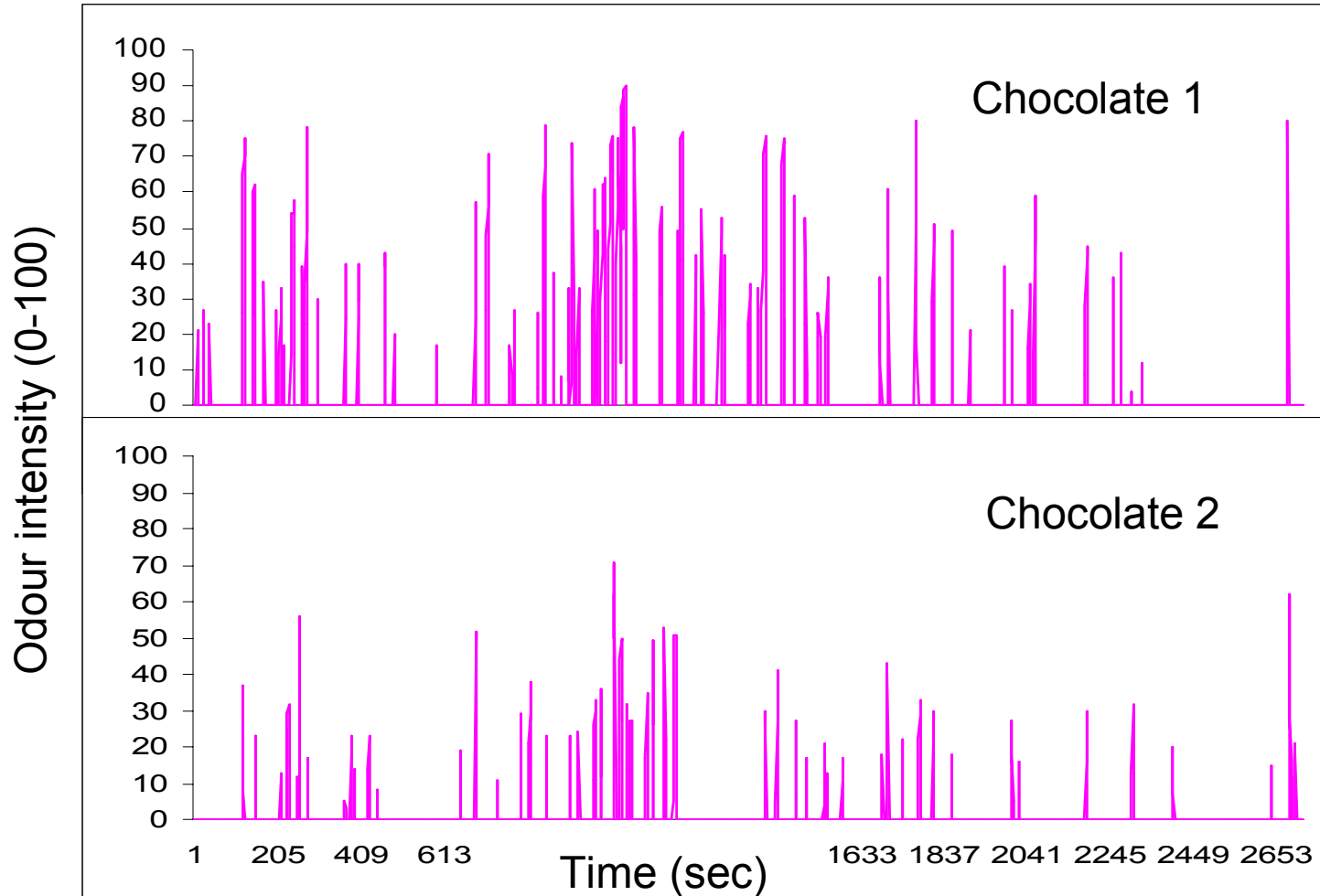
# GC/MS profiles

Abundance



- Traces very similar (> than 90 volatiles detected)

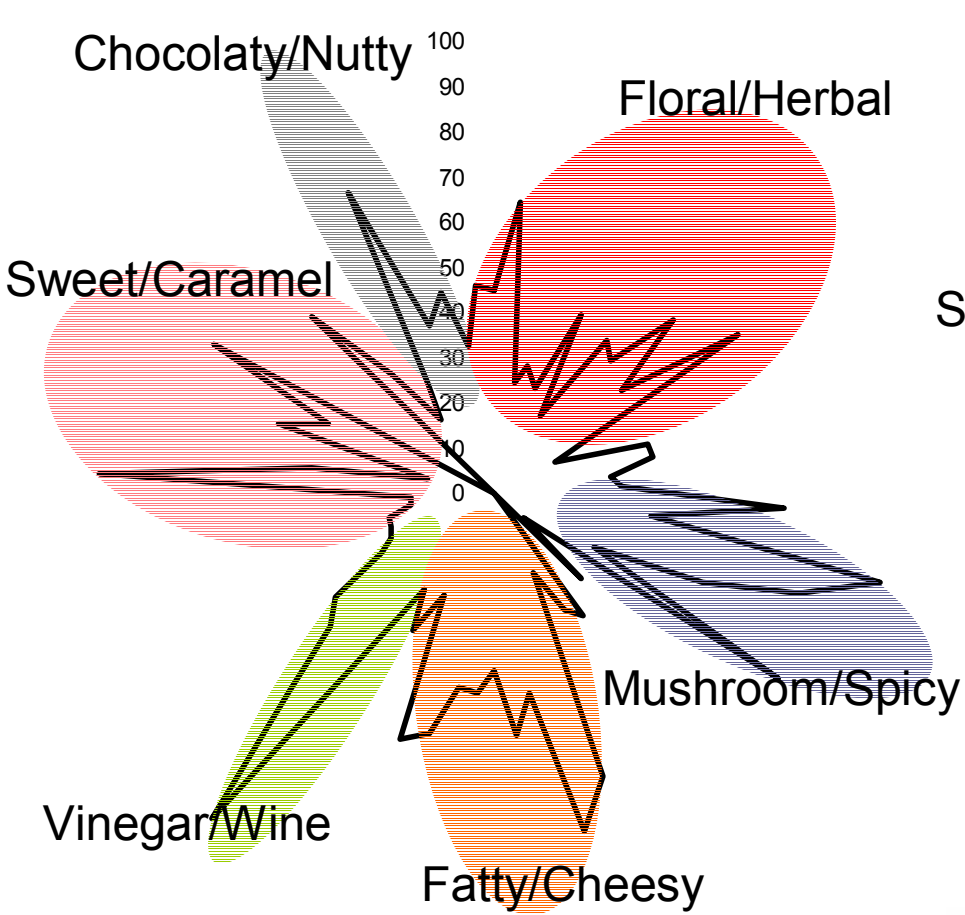
# Aromagrams



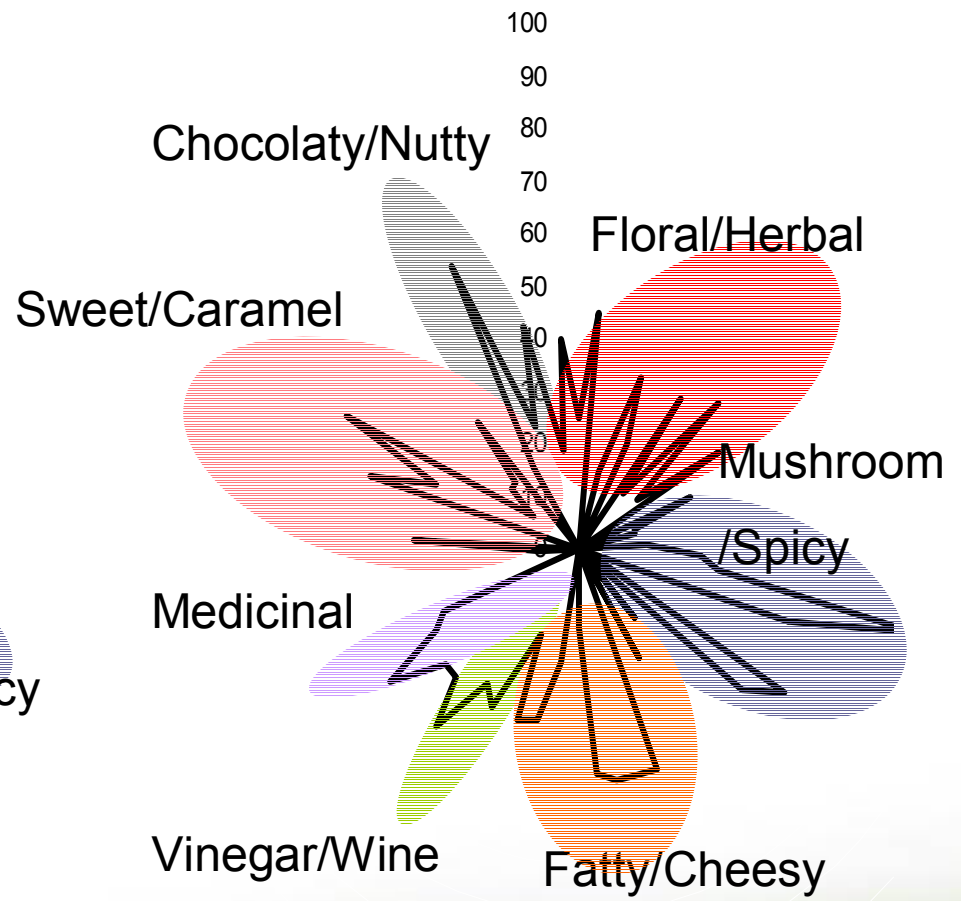
- Traces different (> than 70 odour-active volatiles detected)



# Aroma profile comparison



Chocolate 1



Chocolate 2

## Volatiles contributing most to milk chocolate aroma

- 3-methylbutanal (malty)
  - 2-ethyl-3,5-dimethylpyrazine (potato, green)
  - Z-2-nonenal (green, fatty)
  - acetic acid (vinegar)
  - methional (baked potato)
  - 2-methyl-3-(methylthio)furan (coffee, chocolate)
  - hexanal (crushed leaves)
  - phenylacetaldehyde/butanoic acid (honey/cheesy, rotten)
- These volatiles could be now used (by going through the remaining steps of the process) to re-create chocolate aroma.



This has recently been achieved at FSA with kiwifruit flavour.

# Bibliography

*Belitz, H.D, Grosch, W. Food Chemistry*, 2nd edition, Springer-Verlag, 1999.

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*Sides A, Robards K, Helliwell S. Developments in extraction techniques and their application to analysis of volatiles in foods. TiAC* **2000**,19, 322-329.

*Pillonel L, Bosset J.O, Tabacchi R. Rapid pre-concentration and enrichment techniques for the analysis of food volatile: A review. Lebensm.-Wiss. u-Technol.* **2002**, 35, 1-14.

*Meet me at Food Science Australia's FoodPro stand - Hall 5, Stand 5009.*

*I will be available from 2.30-3.00 pm.*

Thank you for your time!