Food-Matrix Aroma Interactions in Complex Liquid Model System

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Context

In the context of a sensory study of savory bouillons, we determined the importance of each key molecule relatively to specific sensory attributes such as saltiness, body, aroma intensity and quality. In addition to that, we noticed many sensory interactions across the different ingredient compositions.

Objective: Check if the sensory interactions observed had a physico-chemical meaning in addition to physiological and psychological origin.
Most of studies approach are binary relationship, sometimes ternary but in many cases using simplified matrices to extract relevant information (e.g. Guichard, Delgadillo, etc)

More recently PTR-MS and APCI have allowed to see kinetic of aroma release and to correlate on line sensory perception and analytical data (e.g. Taylor, van Ruth, Reineccius, etc)

Although these studies are of capital importance for a general understanding it remains often difficult to apply general tendencies directly into food system.

We consequently focused on our own system in a specific product context
Approach and ingredients

Volatile: 2-methyl butanal, α-pinene, hexanal, heptanal, octanal, 1-octen-3-one, hexanol, nonanal, benzaldehyde

Non-volatile: NaCl, cellulose, chitin, collagen, organic acids, amino acids, nucleotide, fat
Zoom of Headspace-GC Profile

Octen-3-one

Octanal

Blank (without fat)

Hexanol

With fat (base)

With fat (base X2)

Nonanal

Octen-3-one
Headspace analysis
Macromolecules individually

Influence of the ≠ macromolecules on aroma release at the product application concentration

<table>
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<tr>
<th>Compound</th>
<th>Blank</th>
<th>Cellulose</th>
<th>Collagen</th>
<th>Chitin</th>
<th>Fat</th>
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</table>
Headspace analysis
Macromolecules individually

Correlation between aroma retention and their logP value

Hexanal (1.33)
Heptanal (1.75)
Octanal (2.19)
Nonanal (2.59)
Headspace analysis

Macromolecules individually

Influence of macromolecules concentration on aroma release

Chitin
- Blank
- Chitin X2
- Chitin X20

Cellulose
- Blank
- Cellulose X2
- Cellulose X20

Collagen
- Blank
- Collagen X2
- Collagen X20

Ham fat
- Blank
- Ham fat x2
- Ham fat x4

Influence of macromolecules concentration on aroma release

- Isopentanal
- Alpha-pinene
- Hexanal
- Heptanal
- Octanal
- Octen-3-one
- Hexanol
- Nonanal
- Benzaldehyde

Chitin

Cellulose

Collagen

Ham fat
Headspace analysis

Mixture of macromolecules

Inter-influence of macromolecules on aroma release
Headspace analysis

Influence of low molecular weight molecules on aroma release

**IMP-GMP**

- Blanc
- IMP-GMP sple
- IMP-GMP X2
- IMP-GMP X4
- IMP-GMP X8

**Acids**

- Blanc Acide sple
- Acide sple
- Blanc Acides X2
- Acides X2
- Blanc Acides X4
- Acides X4

**Amino-acids**

- Blanc a.a sple
- a.a sple
- Blanc a.a X2
- a.a X2
- Blanc a.a X4
- a.a X4

**Substances:**
- Isopentanal
- alpha-pinene
- hexanal
- heptanal
- octanal
- 1-octen-3-one
- hexanol
- nonanal
- benzaldehyde
Headspace analysis

Influence of low molecular weight molecules on aroma release

![Graph showing the influence of NaCl and MSG on aroma release of various compounds.](image-url)
Effect of amino group on 1-octen-3-one

Electrostatic interaction or chemical reaction?
To summarize

- To our product concentration application, among the macromolecules, only fat influences significantly aroma release, both quantitatively and qualitatively.
  - The decrease of the ‘release’ of aroma in the headspace is proportional to fat quantity
  - Correlation with the hydrophobic properties of the aroma
  - No significant interactions between macromolecules were noticed

- **Nucleotides, acids**
  - No effect at the experimental concentrations

- **NaCl**
  - Increase of the release of aroma in the headspace at the model concentration

- **MSG & Amino-acids**
  - No significant effect on the release of aroma except for 1-octen-3-one
  - Slight effect on aldehydes
  - The overall balance is consequently affected through interactions between aroma and amino acids
Headspace analysis

Total aroma model

Macromolecules

- Isopentanal
- Hexanal
- Heptanal
- Octanal
- 1-octen-3-one
- Hexanol
- Nonanal
- Benzaldehyde

- +NaCl
- +MSG
- +IMP-GMP
- +Acids
- +Amino-acids
- +All low molecular weight molecules
Conclusions

- In complex liquid systems, aroma release is modified both qualitatively and quantitatively by the matrix modulating consequently the overall perception.
- Physico-chemical interactions between components play a role in sensory perception especially in complex mixture.

- Obviously, many other parameters (psychophysic, physiologic, psychologic…) influence the global perception.
Thank you for your attention!

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