

## Detection of Volatile Flavour Compounds in Cheese using SIFT-MS Technology

### Complexity of Cheese Flavour Analysis

The ability to characterise cheese through analysing its volatile flavour compounds is a very powerful tool as it provides cheese manufacturers with valuable information regarding the flavour profile of their cheeses. The task however, is not straight forward given that the headspace above cheese is very complex with over 200 volatile organic compounds (VOCs) identified in cheddar cheese as of 1991<sup>1</sup>.

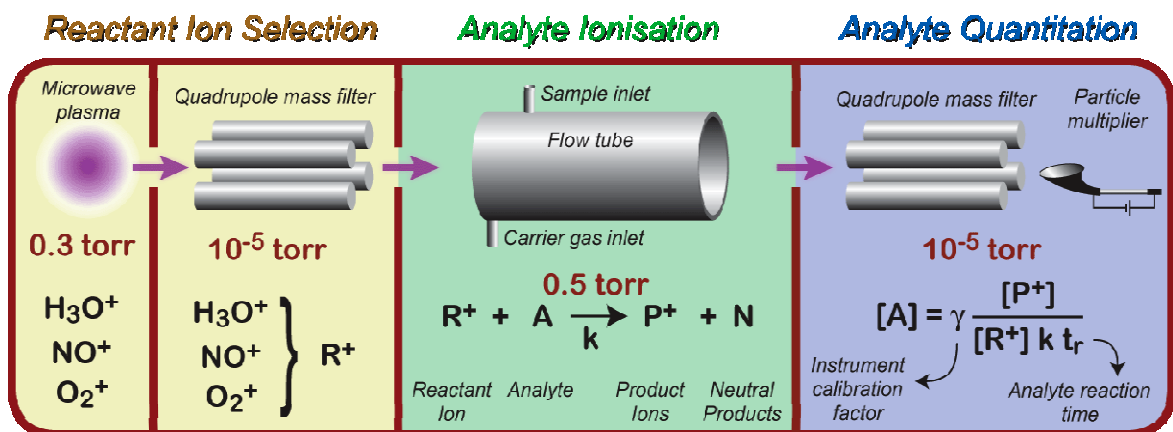
This complexity has limited the effectiveness of traditional real-time chemical ionisation mass spectrometric techniques for cheese analysis. Other techniques available which better resolve interferences do not, however, deliver real-time results meaning users have to wait some time for their flavour analysis profiles.

Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) overcomes both of these issues by providing the ability to analyse highly complex samples, (even differentiating isobaric compounds), whilst delivering real-time quantitative results.

### How does it work?

SIFT-MS uses chemical ionisation for identification and quantitation of desired compounds in gas samples in real-time down to parts per trillion levels. SIFT-MS is unique because it uses a sequence of three reagent ions,  $\text{H}_3\text{O}^+$ ,  $\text{NO}^+$  and  $\text{O}_2^+$  to analyse samples, providing users with the capability to resolve interferences that cannot be resolved using other real-time techniques. This is especially beneficial when analysing complex samples such as the headspace of cheese and chocolate.

### Principles of SIFT-MS



Whilst SIFT-MS may be a relatively new technique in the food and flavour industry, the technology is well established as an analytical technique in other application areas. For example, NASA has been using the technology for some time to model the kinetics of ionospheric and interstellar atmospheres.

It is also recently that commercial SIFT-MS instruments have appeared. These instruments are currently being used in a number of other applications such as detecting levels of fumigants and toxic chemicals in shipping containers and analysing disease signatures in human breath in medical research programmes.

**Commercial SIFT-MS Instrument: The Voice<sup>200</sup>® from Syft Technologies**



## SIFT-MS Detection of Volatile Flavour Compounds

Recently, some studies analysing volatile flavour compounds in cheese have been carried out using SIFT-MS and the Voice instrumentation from Syft Technologies Ltd. These studies examined the flavour profiles of six cheddar and six non-cheddar cheeses as listed in Table 1.

**Table 1:** Cheeses for which headspace measurements were made in this study.

Type	Manufacturer	Country of origin	Name used on graphs	Sample size
Mild Cheddar	Manufacturer A	NZ	MildChed-A	50 grams
Mild Cheddar	Manufacturer B	NZ	MildChed-B	50 grams
Tasty Cheddar	Manufacturer A	NZ	TastyChed-A	50 grams
Tasty Cheddar	Manufacturer B	NZ	TastyChed-B	50 grams
Vintage Cheddar	Manufacturer A	NZ	VintChed-A	50 grams
Vintage Cheddar	Manufacturer C	NZ	VintChed-C	50 grams
Edam	Manufacturer A	NZ	Edam-NZ	50 grams
Edam	Manufacturer D	Netherlands	Edam-NL	45 grams
Blue Brie	Manufacturer E	NZ	BlueBrie-NZ	40 grams
Noble Blue	Manufacturer F	Denmark	BlueNoble-DK	40 grams
Parmesan	Manufacturer G	NZ	Parmesan-NZ	40 grams
Parmigiano Reggiano	Manufacturer H	Italy	ParmRegg-I	40 grams

The compounds monitored in the study are shown in Table 2. The compounds were derived from several published articles<sup>2</sup> and reviews<sup>3</sup> and were short-listed in consultation with cheese industry contacts.

**Table 2:** Target compounds for cheese analysis and the most reliable reagent ion. Compounds are grouped where a total measure of two compounds is obtained.

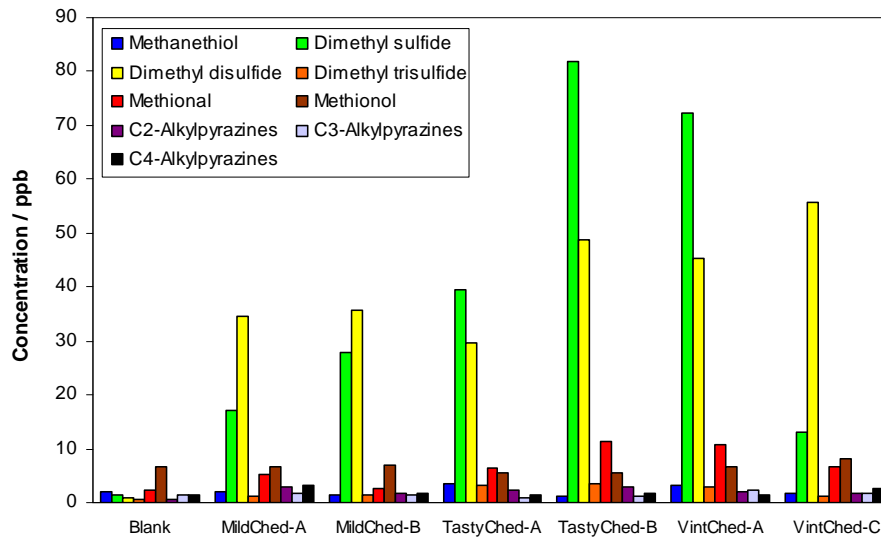
Target compound(s)	Preferred reagent ion	Target compound(s)	Preferred reagent ion
Acetic acid	NO <sup>+</sup>	Acetaldehyde	H <sub>3</sub> O <sup>+</sup>
Butyric acid + Acetoin	H <sub>3</sub> O <sup>+</sup>	3-Methylbutanal	NO <sup>+</sup>
Ethyl butanoate	H <sub>3</sub> O <sup>+</sup> / NO <sup>+</sup>	Decanal	NO <sup>+</sup>
Ethyl hexanoate + Hexanoic acid	NO <sup>+</sup>	Methanethiol	H <sub>3</sub> O <sup>+</sup>
2-Butanone	NO <sup>+</sup>	Dimethyl sulfide	NO <sup>+</sup>
2-Hexanone	NO <sup>+</sup>	Dimethyl disulfide	NO <sup>+</sup>
2-Heptanone	H <sub>3</sub> O <sup>+</sup>	Dimethyl trisulfide	NO <sup>+</sup>
2-Nonanone + $\gamma$ -Octalactone	NO <sup>+</sup>	Methional	NO <sup>+</sup>
2-Undecanone + $\delta$ -Decalactone	NO <sup>+</sup>	Methionol	NO <sup>+</sup>

1-Octen-3-one	NO <sup>+</sup>	C <sub>2</sub> -Alkylpyrazines	O <sub>2</sub> <sup>+</sup>
Diacetyl	NO <sup>+</sup>	C <sub>3</sub> -Alkylpyrazines	O <sub>2</sub> <sup>+</sup>
3-Methyl-1-butanol	NO <sup>+</sup>	C <sub>4</sub> -Alkylpyrazines	O <sub>2</sub> <sup>+</sup>

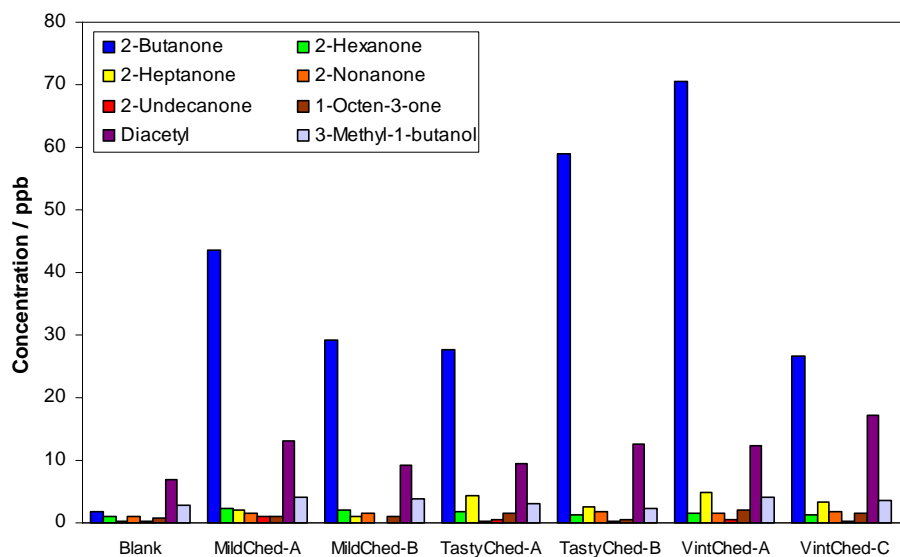
Cheese samples were incubated in one litre Schott bottles for at least one hour at 37°C prior to analysis using the Voice instrument.

The graphs shown below illustrate the concentration measurements at 37°C for each of the 24 compounds in the headspace for the six New Zealand cheddar cheeses. As the graphs show, SIFT-MS can effectively distinguish between each of these cheeses.

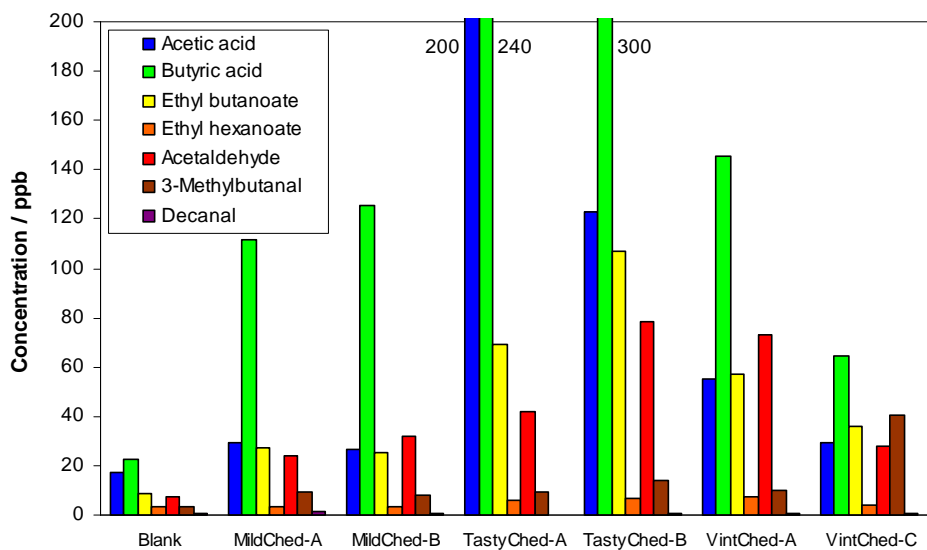
**Figure 1:** Concentrations of sulphur compounds and pyrazines in the headspace of several cheddar cheeses at 37°C, determined using SIFT-MS.



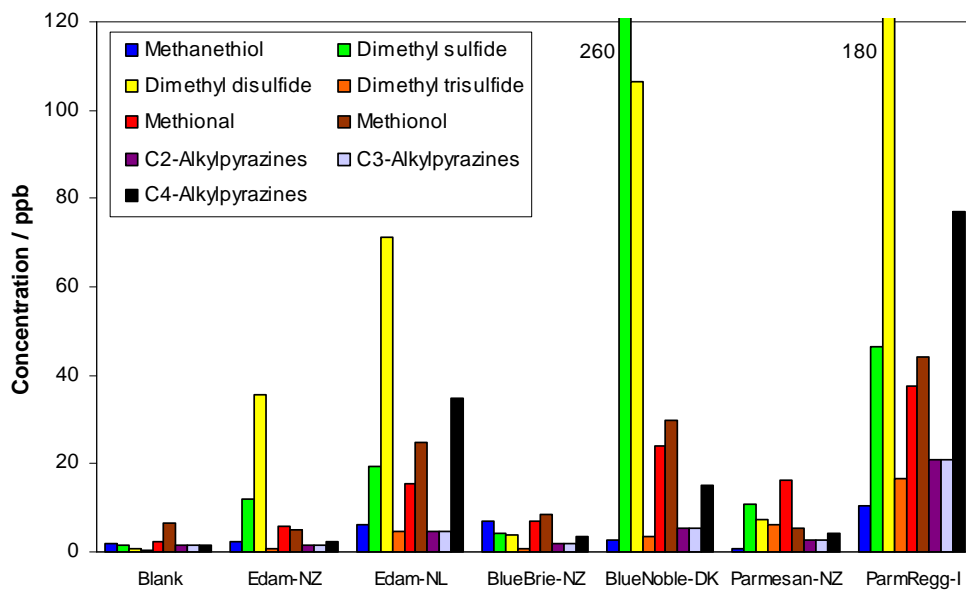
**Figure 2:** Concentrations of ketones, lactones and an alcohol in the headspace of several cheddar cheeses at 37°C, determined using SIFT-MS.



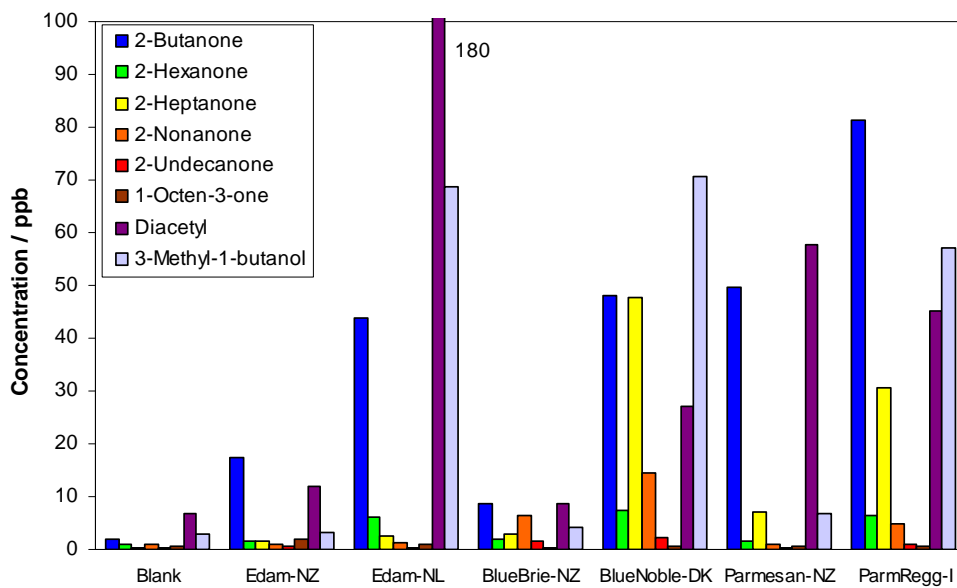
**Figure 3:** Concentrations of various acids, esters and aldehydes in the headspace of several cheddar cheeses at 37°C, determined using SIFT-MS.



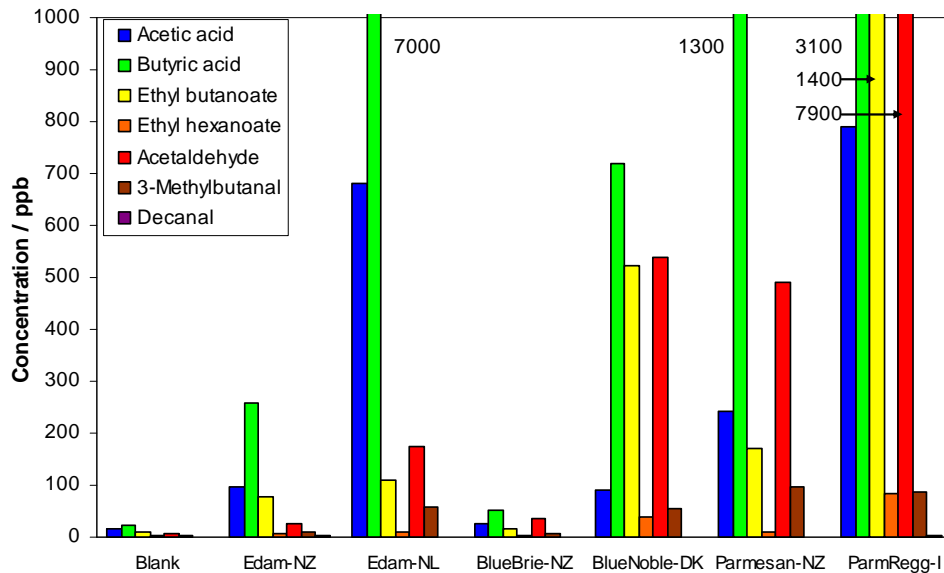
**Figure 4:** Concentrations of sulfur compounds and pyrazines in the headspace of several non-cheddar cheeses at 37°C, determined using SIFT-MS.



**Figure 5:** Concentrations of ketones, lactones and an alcohol in the headspace of several non-cheddar cheeses at 37°C, determined using SIFT-MS.



**Figure 6:** Concentrations of various acids, esters and aldehydes in the headspace of several non-cheddar cheeses at 37°C, determined using SIFT-MS.



### Some Interesting Observations

The New Zealand Edam is a mass produced cheese and is packaged like the cheddars. Its volatile profile reflects this, showing greater similarity to the mild cheddars than to the Dutch Edam.

The New Zealand Parmesan has a very different volatile profile to the Italian Parmesan (Parmigiano Reggiano). These results are confirmed from the aroma and flavour of the two cheeses, with the New Zealand Parmesan dominated by the sharp aroma of butyric acid whereas the Italian is characterised by the pineapple-like aroma of ethyl butanoate.

### Further Food and Flavour Applications

SIFT-MS analysis can easily be applied to other food and flavour applications. By measuring the volatile profiles of ingredients, defective products such as those suffering from unacceptable variations in flavour can be identified, minimising the impact of poor quality ingredients, off-flavours and rancidity.

Manufacturing processes and quality control can also be enhanced through the use of SIFT-MS for determining batch quality and food integrity. With its real-time analysis, critical decisions can be made as and when required and the necessary action taken immediately.

The high-sensitivity and real-time analytical capability of SIFT-MS combined with its suitability for testing humid samples, makes this technology an ideal tool for exploring real-time flavour release. This can be achieved via *in vitro* model systems and also *in vivo* in-mouth and retro-nasal sampling of subjects.

### **Break Out Boxes:**

#### **Benefits of SIFT-MS**

- Identify VOCs in real-time
- Quantify VOCs at part-per-trillion by volume (pptv) levels
- Analyse whole-air samples in seconds
- Analyse high-moisture samples, including direct headspace, in-mouth and retro-nasal
- Analyse static samples, automated batches or continuous production line samples
- Apply multiple chemical ionisation agents to discriminate isobaric compounds

#### **About Voice Instruments**

Syft Technologies has recently launched a second generation commercial SIFT-MS instrument, the Voice<sup>200</sup>®. Based on the flagship product, the Voice<sup>100</sup>™, the Voice<sup>200</sup>® has undergone a number of design improvements including a reduction in weight and size and an increase in sensitivity and performance whilst continuing to deliver the following key features and benefits:

##### **Fast**

Real-time identification and quantitation of VOCs eliminates uncertainties and allows for appropriate actions to be taken quickly.

##### **Accurate**

Analyse an extensive range of trace VOCs down to low pptv level. The Voice<sup>200</sup>® instrument gives true identification of compounds, not just product masses.

##### **Simple**

The Voice<sup>200</sup>® instrument has been designed with push button simplicity and ease of use in mind. With no sample preparation required, the instrument can be operated with minimal training, yet delivers laboratory-quality results. When more detailed and intricate analysis is required, the Voice<sup>200</sup>™ has the flexibility to be configured specifically to the user's application needs.

VOICE200 is a registered trade mark of SYFT Technologies Limited of Christchurch, New Zealand.

## References:

<sup>1</sup> Henk Maarse, Ed. (1991). *Volatile Compounds in Foods and Beverages*, Marcel Dekker, New York (p.30).

<sup>2</sup> D.C.Frank, C.M. Owen and J. Patterson (2004), "Solid phase microextraction (SPME) combined with gas-chromatography and olfactometry-mass spectrometry for characterization of cheese aroma compounds", *Lebensm.-Wiss. u.-Technol.*, 37,139-154. D. Frank, P.O'Riordan, D. Zabararas and P. Varelis (2006), "Cheddar cheese volatile profiling using dynamic headspace and gas chromatography-mass spectrometry olfactometry", *Aust. J. Dairy Tech.*, 61,105-107. P.O'Riordan and C.M. Delahunty (2001), "Comparison of volatile compounds releases during the consumption of Cheddar cheese with compounds extracted by vacuum distillation using gas chromatography olfactometry", *Flavour Fragr.J.*, 16,455-434.

<sup>3</sup> P.M.G. Curioni and J.O. Bosset (2002). "Key odorants in various cheese types as determined by gas chromatography-olfactometry", *Int. Dairy J.*, 12,959-984. T.K. Singh, M.A. Drake and K.R. Cadwallader (2003). "Flavour of Cheddar Cheese: A Chemical and Sensory Perspective", *Comprehensive Reviews in Food Science and Food Safety*, 2,139-162.

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