

Diffusive Sampling and Analysis of Microbial VOCs Arising From Mold

by

C.R. Manning & S.L. Green, & J. Hearing

Significance of MVOCs

- **MVOCs associated with Toxicity**
 - toxic effects may be attributable to specific chemicals emitted by molds
- **as Indicators of Mold Contamination**
 - mold contamination may be detected by chemical analysis of vapor space

Origin of Microbial VOCs

Arise from Metabolism (Fermentation)

– **Molds (Fungi) consume**

- carbohydrates (e.g. grains)
- cellulose (e.g. wood)

– **Molds (Fungi) produce**

- alcohols, ketones, aldehydes, esters, acids, lactones, terpenes

Effects of Microbial VOCs

Mold Fermentation Products

- **are associated with toxic exposures**
 - irritation, headaches, lethargy
 - lung and kidney toxicity
- **have a chemical profile**
 - alcohols, ketones, terpenes (major)
 - esters, acids, aldehydes (minor)

Nature of Microbial VOCs

Identity of MVOCs

- specific chemicals emitted by fungi
- similar chemicals from many fungi

Amounts of specific MVOCs

- vary with species of fungi
- vary with fungal substrate
 - (i.e. what the fungi consume)

Microbial VOCs

TERPENES & ETHERS

camphor

camphene

limonene

α -terpineol

2-methyl furan

2,5-dimethyl furan

α -pinene

dimethyl sulfide

Microbial VOCs

KETONES

2-hexanone (methyl isobutyl ketone)

2-heptanone (methyl pentyl ketone)

2-octanone (methyl hexyl ketone)

3-octanone (ethyl amyl ketone)

Microbial VOCs

ALCOHOLS

3-methyl-1-butanol (isoamyl alcohol)

3-methyl-2-butanol

2-pentanol (sec-amyl alcohol)

3-octanol

Some Sources of MVOCs

	3-methyl-1-butanol	3-methyl-2-butanol	2-pentanol	2-hexanone	2-heptanone	2-octanone	3-octanone	2-methylfuran	2,5-dimethylfuran	camphor	camphene	α -pinene	limonene
<i>Aspergillus candidus</i>	x	x	x	x	x	x	x	x	x	x	x	x	x
<i>Aspergillus fumigatus</i>		x	x	x	x	x	x	x	x	x	x		
<i>Aspergillus versicolor</i>				x	x	x	x	x		x	x		
<i>Cladosporium cladosporioides</i>			x	x	x	x	x		x		x		
<i>Cladosporium herbarum</i>		x		x		x		x		x			
<i>Penicillium claviguram</i>			x	x	x	x	x	x	x	x	x		
<i>Penicillium polonicum</i>				x	x	x							
<i>Penicillium italicum</i>				x	x	x	x	x	x	x	x		
<i>Penicillium glabrum</i>	x	x					x	x	x	x		x	

Chemosphere, 1999, **39**, 793-810

Int J Hyg & Environ Hlth, 2000, **203**, 97-104

J Environ Monit 1999, **1**, 445-452

Analyst, 1996, **121**, 1949-1953

Analysis of MVOCs

MVOCs can be analyzed

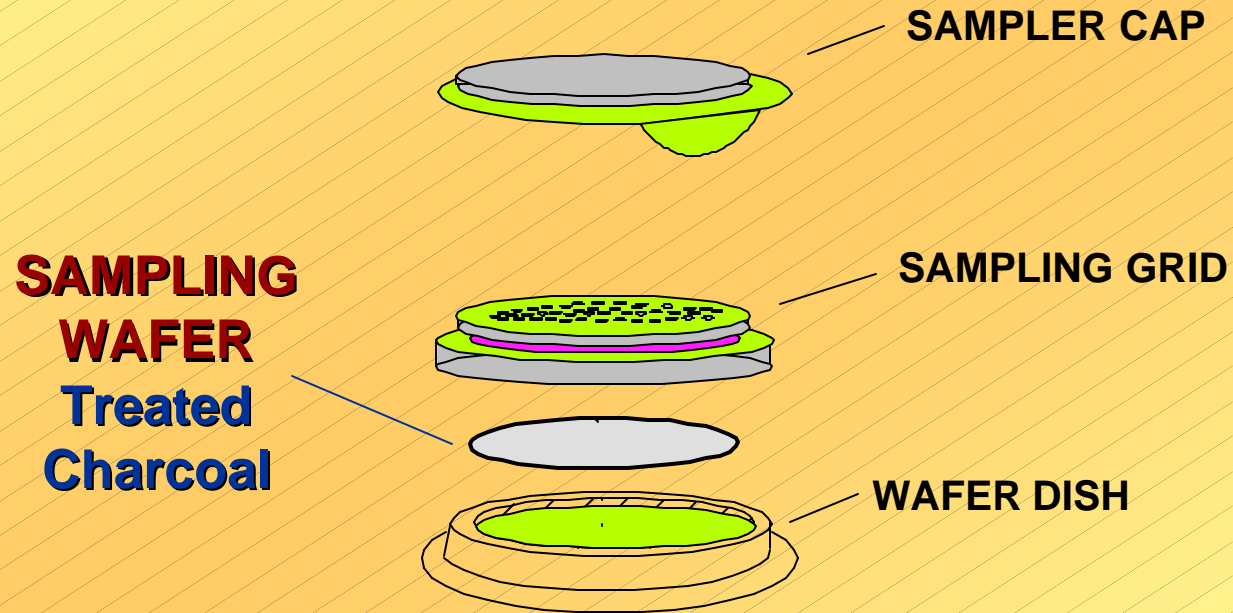
- **Charcoal or Tenax samplers**
 - good recoveries & resolution by GC
- **Diffusive Samplers convenient for Long Term Sampling (1-7 days)**
 - non-intrusive and simple
 - low detection limits (ppb)

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MVOC Sampler (diffusive)



Sampling Parameters

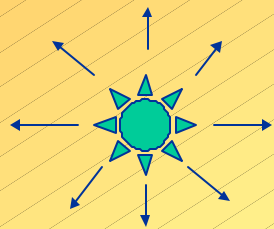
MVOC	SAMPLING RATE (ml/min)	DETECTION LIMIT * (ppm)
3-methyl-1-butanol	3.93	0.01
3-methyl-2-butanol	3.93	0.06
2-pentanol	3.93	0.01
2-hexanone	3.68	0.01
2-heptanone	3.36	0.07
2-octanone	3.09	0.07
3-octanone	3.09	0.07
2,5-dimethylfuran	4.07	0.01
camphor	2.90	0.01
camphene	2.94	0.06
a-pinene	3.05	0.01
limonene	2.95	0.02

* Detection Limit (ppm) based on 72-hour sampling time.

Analytical Parameters

CAS No.	Name of MVOC	GC t _R (min)	DE (%)	Det'n Limit (ug)
123-51-3	3-methyl-1-butanol	8.66	92	0.9
598-75-4	3-methyl-2-butanol	9.76	93	5
6032-29-7	2-pentanol	9.01	94	5
591-78-6	2-hexanone	10.02	95	0.7
110-43-0	2-heptanone	12.7	96	0.7
111-13-7	2-octanone	14.22	94	6
106-68-3	3-octanone	14.11	96	6
625-86-5	2,5-dimethylfuran	9.25	99	6
76-22-2	camphor	17.19	99	0.6
79-92-5	camphene	15.12	99	5
80-56-8	α-pinene	13.41	100	0.8
138-86-3	limonene	14.64	100	2

Validation Scheme

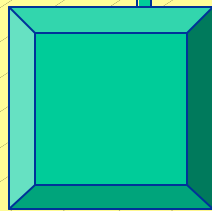


MVOC
Emitter

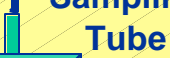


Air Current

Sampling
Pump



Sampling
Tube



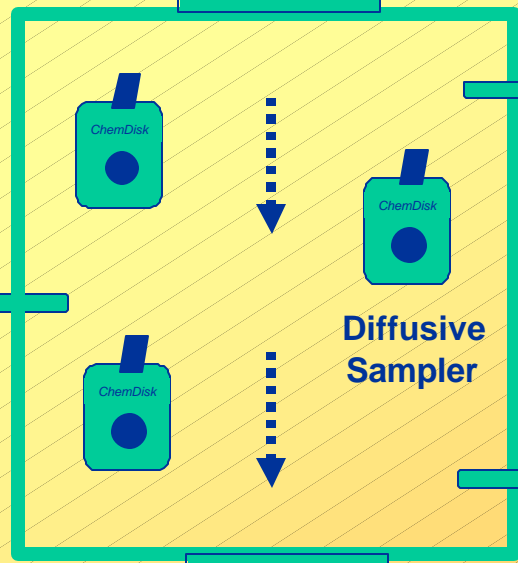
Air Intake



Diffusive
Sampler



Exhaust Fan



Conclusions

- Can you determine by MVOC analysis which fungi may be present in an environment ? **NO**
- Can you determine by MVOC analysis whether fungi are likely to be present ? **PROBABLY**
- Can you estimate the amount of fungi which are likely to be present? **POSSIBLY**

Future Work

- **Field Test - Correlate Response**
 - **MVOC Detection by Personal Sampling Badge with GC Analysis**
 - vs**
 - **Detection by Microbiology Testing**