

Real-Time Analysis of Exhaled Breath Using SIFT-MS for Biomarker & Disease Identification



Kseniya Dryahina, David Smith, Veronika Pospíšilová, Kristýna Sovová, Violetta Shestivska, Martin Bortlík, Naděžda Machková, Milan Lukáš, Jiří Kubišta, Anatolii Spesyvyi, František Pehal, Jarmila Turžíková, Jiří Votruba, Rohit Sinha, Khalida A. Lockman, Natalie Z.M. Homer, Edward Bower, Paul Brinkman, Hugo H. Knobel, Jonathan A. Fallowfield, Alan J. Jaap, Peter C. Hayes, John N. Plevris, R. Fernández del Río, M.E. O'Hara, A. Holt, P. Pemberton, T. Shah, T.Whitehouse, C.A.Mayhewa, and Patrik Španěl

ABSTRACT / INTRO

SIFT-MS was used to identify and quantify potential biomarkers in exhaled breath for two different diseases as well as a range of liver damage conditions. The Tracer i3 (Syft Technologies, NZ) was used to evaluate pentane levels from individuals with inflammatory bowel disease, acetic acid levels from individuals with Gastro-Esophageal Reflux Disease (GERD), and limonene levels following ingestion of oral supplements for patients with liver damage.

INFLAMMATORY BOWEL DISEASE (CROHN'S DISEASE & ULCERATIVE COLITIS)

Patients suffering from Crohn's Disease and Ulcerative Colitis breathed into nalophan bags which were subsequently analyzed by SIFT-MS. Pentane levels were quantitatively measured using Selected Ion Monitoring (SIM) acquisition providing real time concentration levels.

GASTRO-ESOPHAGEAL REFLUX DISEASE (GERD)

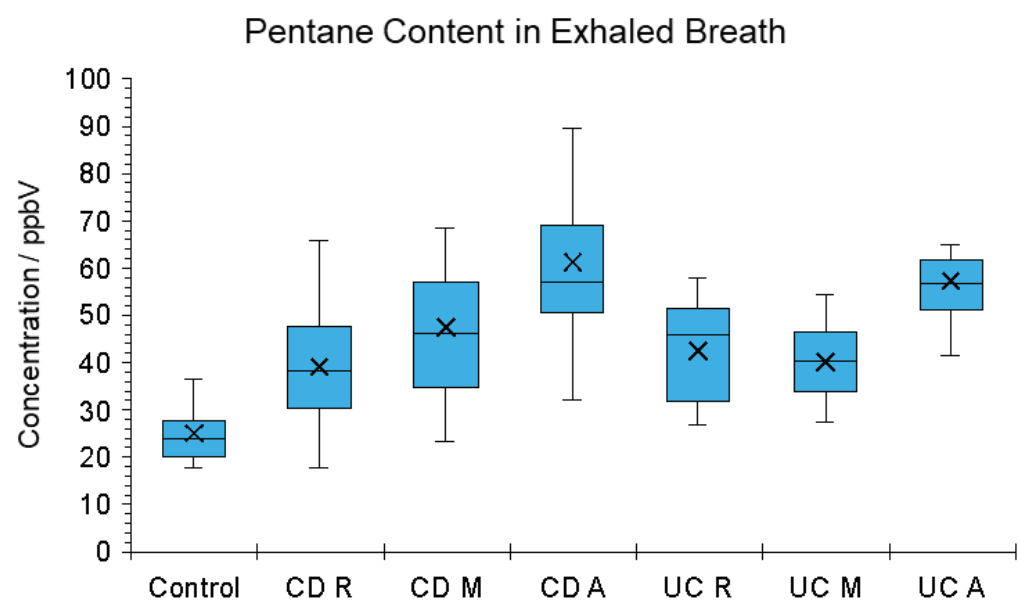
Direct breath from 22 patients suffering from GERD was analyzed for Acetic Acid levels using SIFT-MS against a healthy control group.

METABOLIC DYSFUNCTION-ASSOCIATED STEATOTIC LIVER DISEASE (MASLD), LIVER FIBROSIS, LIVER CIRRHOSIS

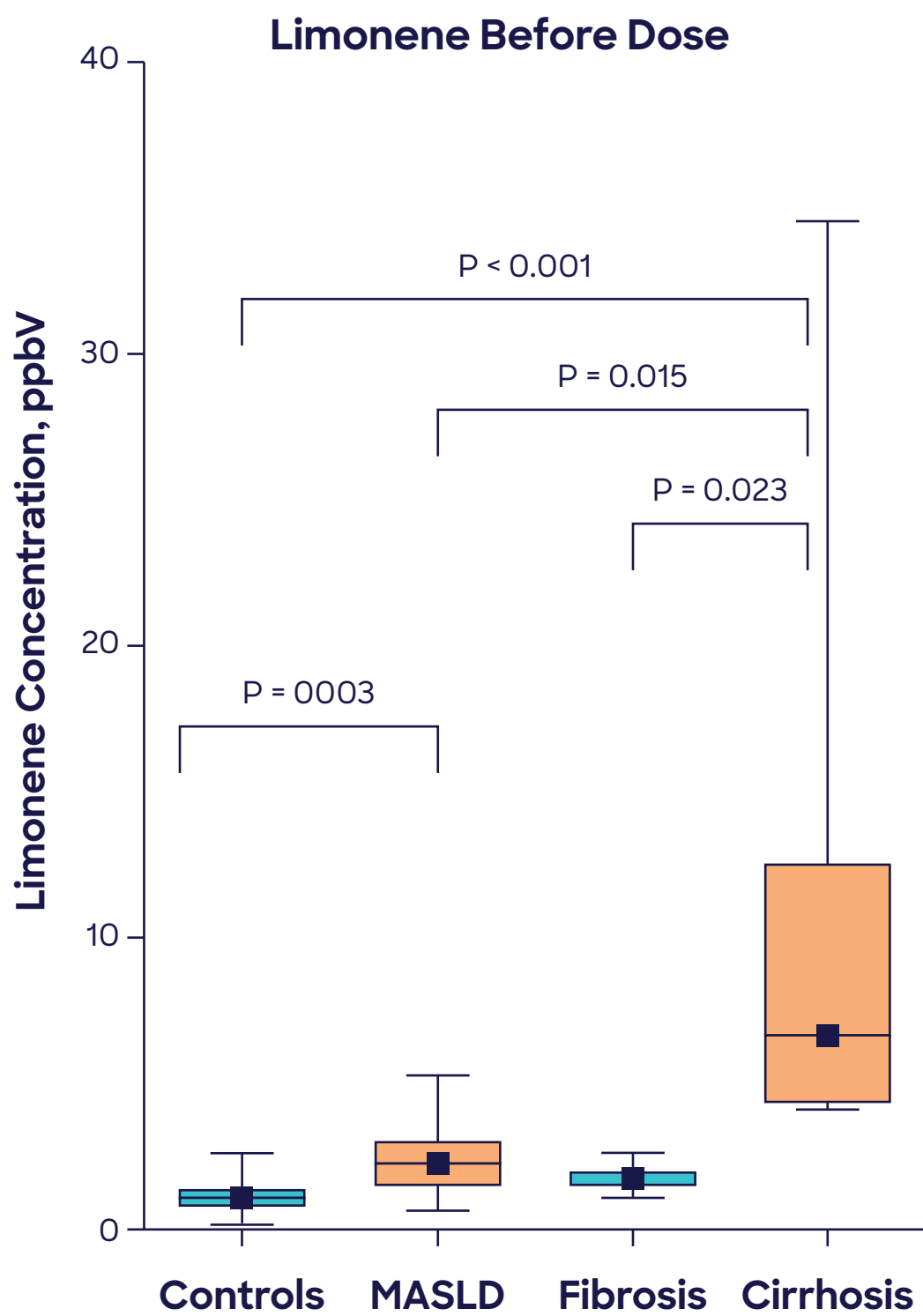
Direct breath analysis from individuals suffering from the above liver diseases was analyzed for limonene content before and after dosage with a limonene oral supplement.

INFLAMMATORY BOWEL DISEASE

- Pentane levels were measured from bagged samples originating from healthy individuals, patients in remission (R), patients with mild to moderate active disease (M), and patients with severe active disease (A).
- Both Crohn's Disease (CD) & Ulcerative Colitis (UC) patients were included in the study.
- Median values showed elevated levels of pentane in diseased patients compared to the control, as well as further elevated levels for those in the severe active disease category.



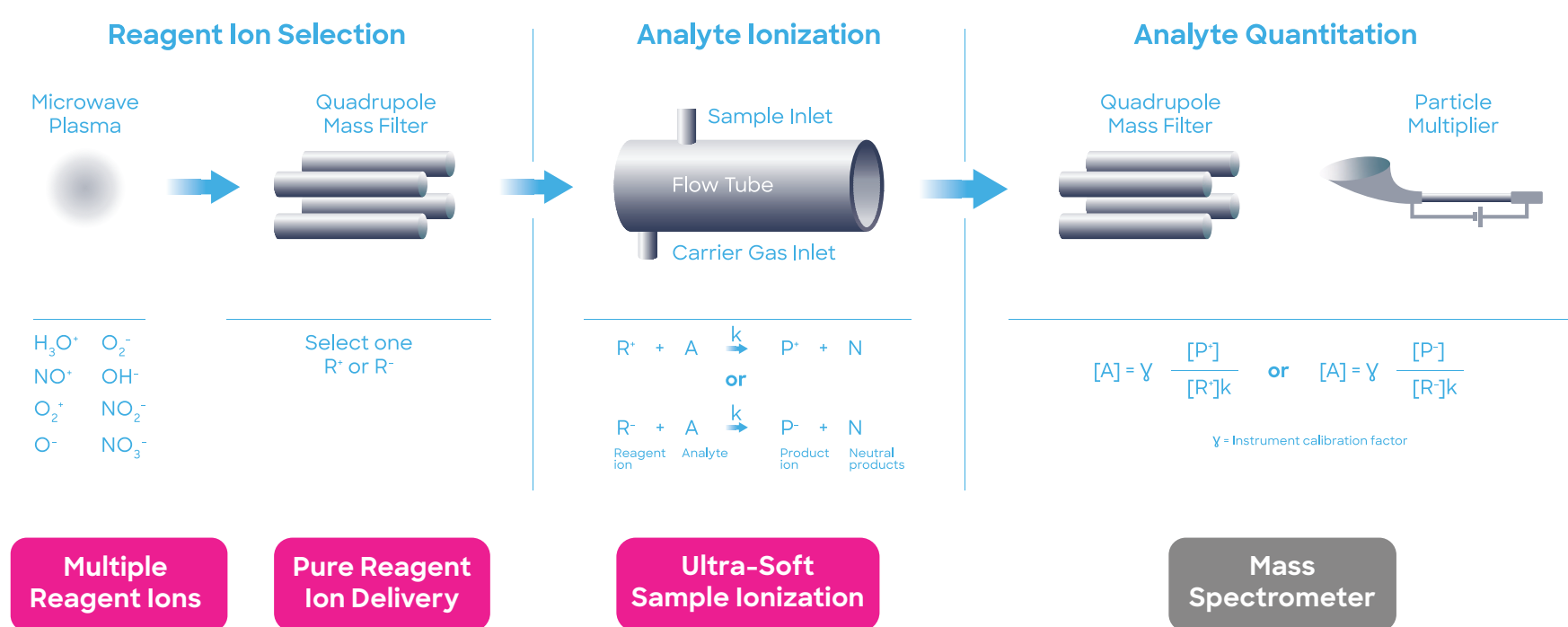
Pentane levels for control, crohn's disease, and ulcerative colitis groups in Remission (R), with Mild (M) and Active (A) symptoms



Limonene concentrations prior to supplement dosing

HOW SIFT-MS WORKS

Syft Tracer i8 mass spectrometer with a high throughput inlet (HTP)

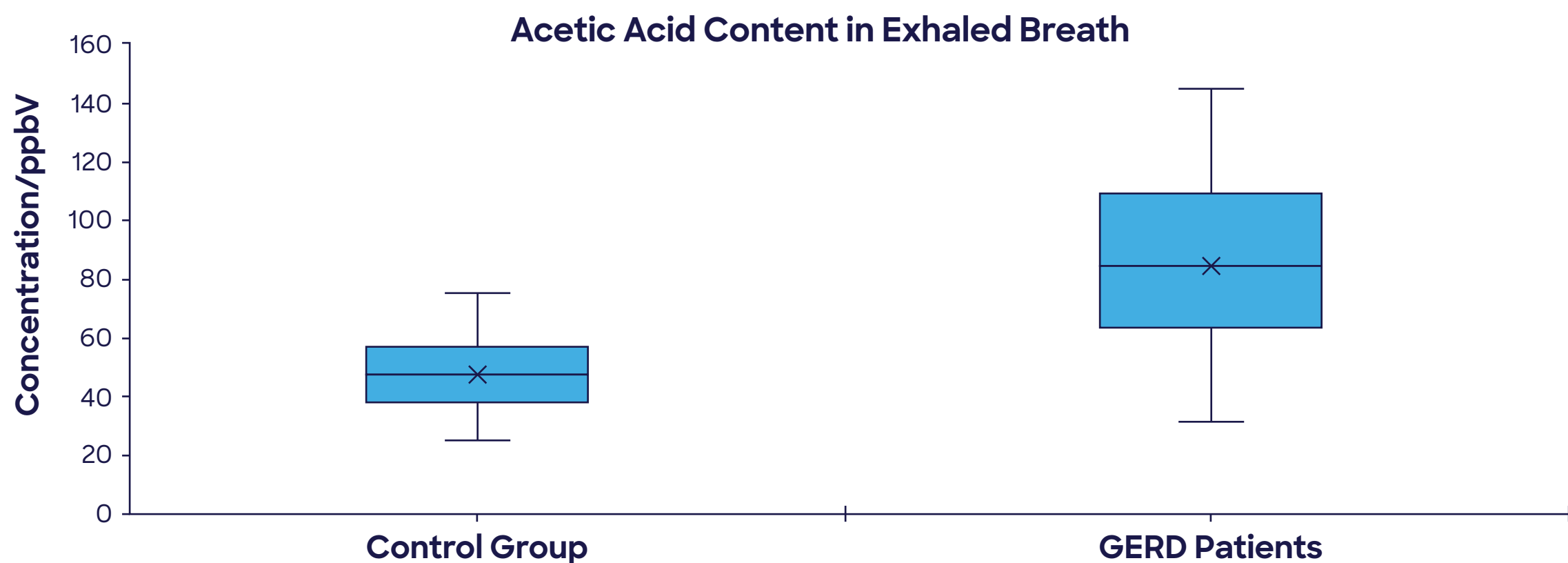


Selected Ion Flow Tube Mass Spectrometry (SIFT-MS) is a direct injection MS technique for volatile analysis. Compound detection and separation in SIFT-MS is achieved using ions that ionize the sample in unique ways coupled with MS detection. SIFT-MS is comprised of three parts: formation and detection of ionizing species, analyte ionization and ion detection. Reagent ions are selected on a millisecond timescale. Analytes react with these reagent ions in a flow tube, where soft chemical ionization occurs. Product ions are then detected and quantified using a ratio of the product ion to reagent ion and uses a rate constant found in Syft's chemical library.

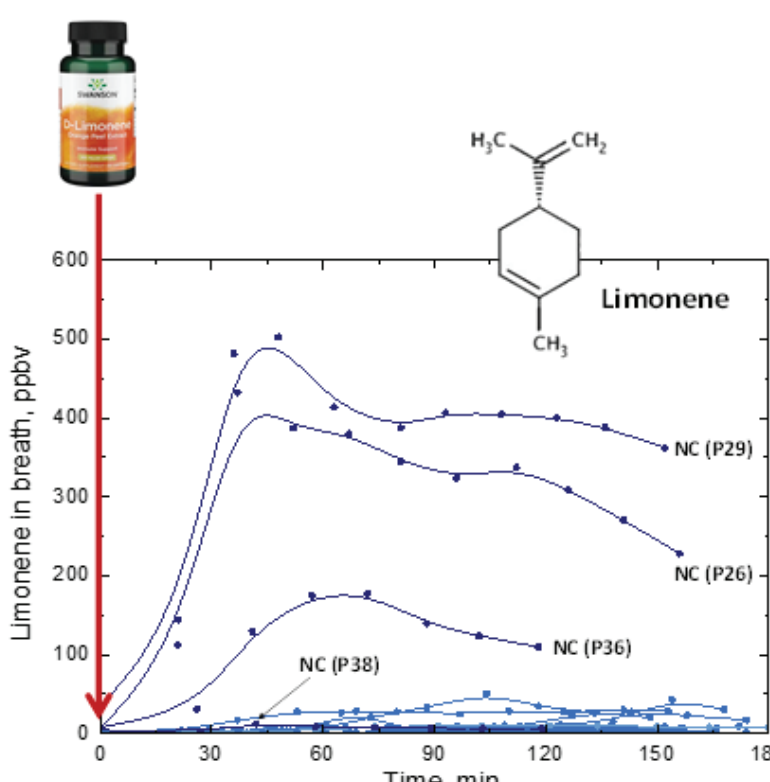
GASTRO-ESOPHAGEAL REFLUX DISEASE

Median exhaled breath acetic acid content of 22 GERD patients (85 ppbv) was found to be significantly higher than that in the breath of a control group (48 ppbv).

Breath acetic acid may be useful for non-invasive diagnostics of GERD and other conditions resulting in the lowering of pH of the lining of the airways.



Acetic acid levels for control & GERD patient groups



Elevated limonene concentrations for cirrhosis patients following oral supplement dosing

EVALUATING LIMONENE AS A BIOMARKER FOR LIVER DISEASE

Limonene concentration was measured before oral supplement dosage showing an increase in concentration for patients suffering from cirrhosis of the liver.

Oral supplement was administered to the groups and limonene concentration was measured over a 180-minute period.

Patients with cirrhosis (NC) showed elevated levels compared to the other groups