

Measurement of carbon isotopic compositions of volatile organic compounds in human breath

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Human breath contains a wide range of volatile organic compounds (VOCs), which vary between individuals but are closely linked to metabolic processes [1]. Acetone and isoprene are the two major VOCs commonly found in breath. Acetone is biosynthesized during energy production and excreted via exhalation and urine. The relationship between acetone concentration and glucose metabolism has been studied, but its usefulness as a biomarker for blood glucose levels and disease such as diabetes remains controversial [2]. On the other hand, studies on the mechanism of isoprene production are limited, though King et al. [3] suggested that it originates from muscle tissue, with the synthesis process still unclear.

In this study, we aimed to determine the natural stable carbon isotopic compositions of acetone and isoprene in breath to gain insight into their origins and production pathways. Our study had two main objectives: first, to develop a method for measuring the natural stable carbon isotopic compositions of exhaled acetone and isoprene, and second, to monitor the exhaled breath of subjects in daily life conditions to explore its relationship to glucose metabolism and physical activity.

For the first objective, we developed a method to simultaneously measure the concentrations and carbon isotopic compositions of acetone, isoprene, and CO₂ using HS-SPME-GC-C-IRMS on a sample of 100 cc of breath.

For the second objective, we monitored three subjects over several days, including fasting period and glucose and lipid tolerance tests. For acetone, we observed both periods where concentration and isotopic variations were synchronized and periods where they were not. While we investigated the relationship between acetone and blood glucose levels, no clear correlation was found. For isoprene, synchronous changes in concentration and isotopic composition were observed before and after exercise.

References

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