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Metabolic breath signature of 13C-enriched wheat bran consumption related to gut fermentation in humans: a Fiber-TAG study

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Abstract

Introduction

Dietary fibers (DF) have been classified mainly according to their physico-chemical and fermentability properties but it remains unclear whether such classification is relevant when addressing their health effects. Indeed, the nature of physiological effects induced by DF, particularly through their interaction with gut microbiota, remains poorly known due to their diversity, to gut microbiota inter-subjects variability and to the lack of validated non-invasive biomarkers to characterize DF-gut microbiota interaction. The aim of this pilot study was 1) to follow the metabolic fate of ^{13}C-labeled DF through the assessment of ^{13}C-labelled gut-derived metabolites in excreted breath and 2) to evaluate novel non-invasive breath-derived biomarkers of DF-gut microbiota interactions.

Materials and methods

Six healthy women (29.7 ± 1.7 years old, BMI: 23.2 ± 0.9kg/m^2, fiber intake: 23 ± 1g/d) consumed in research settings a controlled breakfast containing eight ^{13}C-labelled wheat bran biscuits (50 g of labelled wheat bran, 3.0At%^{13}C). ^{13}C-labelled wheat bran was obtained from wheat cultivated under $^{13}CO_2$ enriched atmosphere. Samples of expired gases were collected during 24 h after ingestion in order to measure H_2 and CH_4 by gas chromatography (GC) with piezoelectric detection and $^{13}CO_2$ and $^{13}CH_4$ by gas chromatography coupled with an isotope ratio mass spectrometer (GC-IRMS). Apart test breakfast, subjects only consumed standardized meals without fibers.

Results

The analysis of H_2 and CH_4 24h-kinetic measurements distinguished 2 groups in terms of fermentation related gas excretion: the high-CH_4 producers with high baseline CH_4 concentrations (42.1 ± 13.7ppm) and low baseline H_2 concentrations (7.3 ± 5.8ppm) and the low-CH_4 producers with low baseline CH_4 concentrations (6.5 ± 3.6ppm) and high baseline H_2 concentrations (20.8 ± 16.0ppm). Following the ^{13}C-wheat bran biscuits' ingestion, postprandial H_2 and CH_4 concentrations increased more significantly in the high-CH_4 producer subjects. ^{13}C enrichment was detectable in expired gases in all subjects. $^{13}CO_2$ kinetics were similar for all subjects and correspond to the oxidation of the digestible part of the bran. The appearance of $^{13}CH_4$ was significantly enhanced and prolonged after 180 min in high-CH_4 producers compared to low-CH_4 producers, suggesting distinct fiber fermentation profile.

Discussion

This pilot study allowed to consider novel procedures for development of non-invasive breath biomarkers of fiber-gut microbiota interactions. Assessment of expired gas excretion following ^{13}C-labelled fiber ingestion allowed deciphering distinct fermentation profiles: high-CH_4 producers *vs* low-CH_4 producers and accordingly provide a related non-invasive breath metabolic signature of the fiber fermentation for each profile. Further gut microbiota and ^{13}C-metabolites analysis will permit to relate the gut bacteria composition with breath gas excretion kinetics according to fiber fermentation profile.

Conflict of Interest

The PhD (AE Breyton) is founded by Mondelez International. Sophie Vinoy and Alexandra Meynier are Mondelez International employees