Fermentation of Fiber in the Gut:
A Mechanism to Explain Fiber's Protective Role in Weight Control

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Introduction

❖ Higher dietary fiber intake is associated with lower body weight. [1] but the average fiber intake in the United States is under the recommendation of Dietary Reference Intakes.
❖ Increased fiber intake promotes satiety and decrease hunger [2].
❖ The colonic fermentation may influence satiety although the mechanism remains unclear [3].
❖ Satiety responses differ among different fibers [4].
❖ The degree of colonic fermentation may vary with type of fiber [5].

Objectives

To examine changes of the breath hydrogen gas level excreted after ingestion of various fibers to measure the degrees of fermentation.

To determine whether difference in type of fiber influences the colonic fermentation patterns, which may differentiate the satiety response.

Definition of Fiber

According to the Dietary Reference Intakes and recommended by the Institute of Medicine, the definition of fiber is as followed;

Dietary Fiber - the non-digestible carbohydrates and lignin that are intrinsic and intact in plants.
Functional Fiber - the isolated or synthetic fibers that are non-digestible and have beneficial physiological effects.
Total Fiber - the sum of dietary fiber and functional fiber.

Colonic Fermentation of Fiber

Figure 1 shows one proposed mechanism of increased breath hydrogen level. When fiber is ingested, microflora ferment undigested fiber and produce hydrogen, methane and carbon dioxide as flatus gases. Some produced gases enter the blood stream. The gases are carried to the lung and excreted as end-alveolar gases.

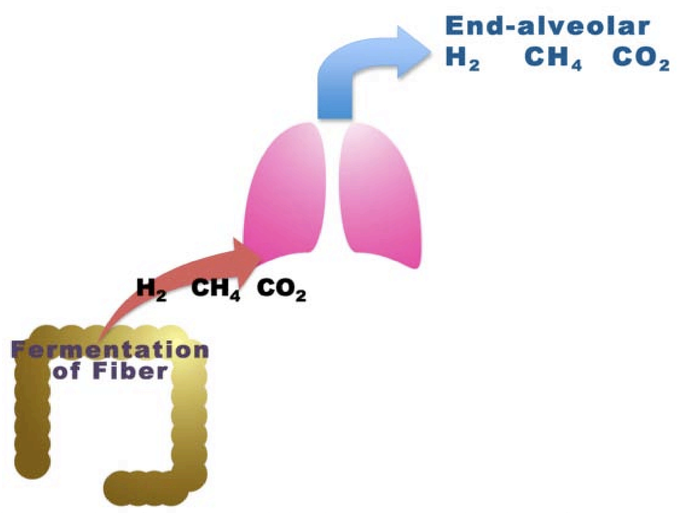

Figure 1. The mechanism of increased end-alveolar gases caused by the gut fermentation of Fiber

Method

❖ 22 healthy female subjects, ages 18 - 40 years consumed snack bars, control and treatments.

❖ During the five test visits, separated by at least 1 week, fasted subjects consumed their breakfast bars.

❖ Breath samples were collected from each subject at baseline and 180 minutes after they consumed snack bars.

❖ Breath samples were analyzed for breath hydrogen levels as a measure of colonic fermentation of fiber. The hydrogen levels at baseline and 180-minute point were compared for each subject and each type of fiber.

Treatments

The total energy of both control and treatment bars was set to 400 kilocalories, balanced in protein, fat and carbohydrate. Each treatment contained 10 grams of different fibers. The fiber content of the control was minimized.

Treatment 1: Inulin
Treatment 2: Soluble Corn Fiber
Treatment 3: Oligofructose
Treatment 4: Resistant Wheat Starch (RS4)
Control: ~ 0 gram fiber

Results

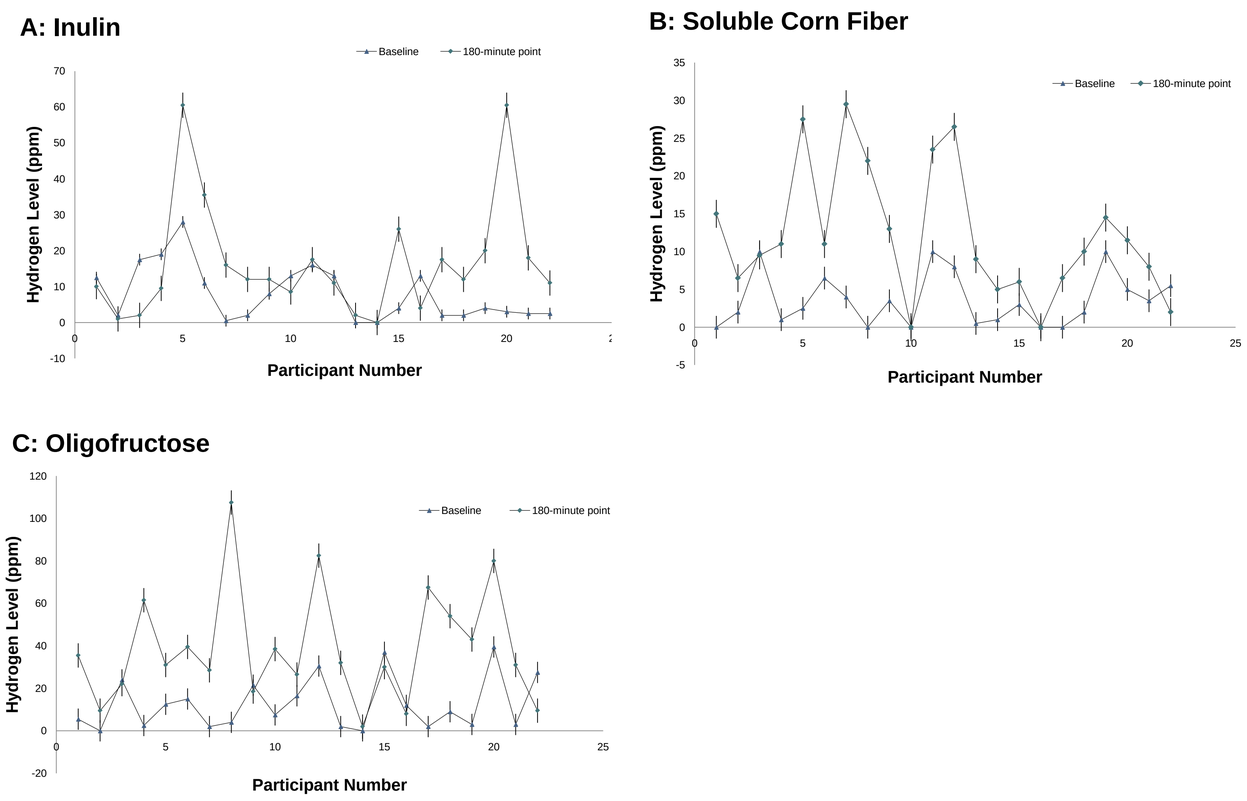

Figure 2. Change in Breath Hydrogen levels 180 minutes after consumption of Inulin, Soluble Corn Fiber and Oligofructose.

The graphs in figure 2 show the changes of breath hydrogen levels for inulin, soluble corn fiber and oligofructose. The breath hydrogen levels for inulin, soluble corn fiber and oligofructose changed significantly (*p=.03, p=.0002, and p=.0001*) between baseline and 180 minutes of ingestion (Figure 2).

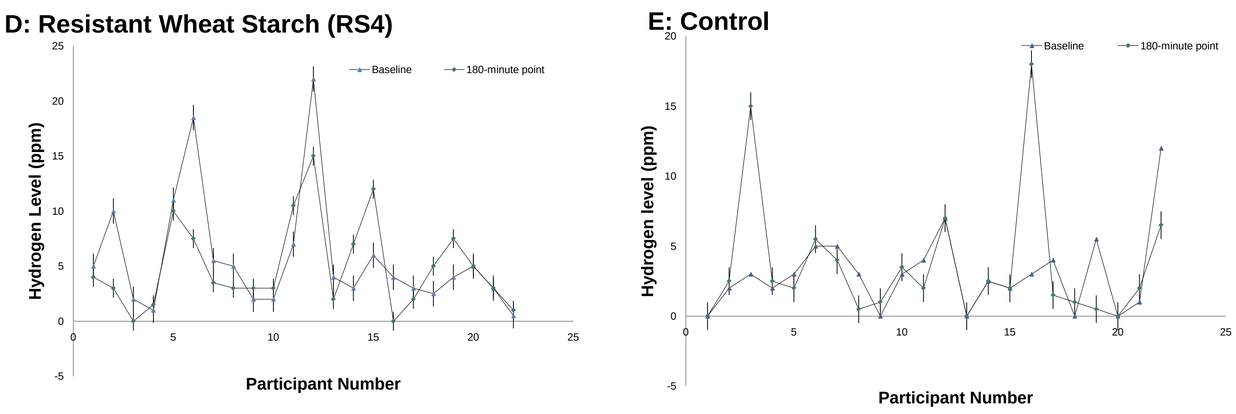

Figure 3. Change in Breath Hydrogen levels 180 minutes after consumption of RS4 and Control.

Figure 3 shows that there were no significant changes found for resistant wheat starch and control between baseline and after 180 minutes of consumption (*p*=.58 and *p*=.57).

Discussion

As hypothesized, the fermentation patterns varied according to types of fiber. The breath hydrogen excretion increased 180 minute after the ingestion of inulin, soluble corn fiber and oligofructose. This result indicates that these fibers are readily fermented in the large intestine. The result of for resistant wheat was almost identical to the control, and showed no significant effect on breath hydrogen level. This result claims that the resistant wheat is poorly fermented in the colon. Thus, not all fibers are equally fermentable in the human colon.

Within the three fibers that showed significant effect on breath hydrogen, the increase rates varied. This might reflects the different rates of gut fermentation in each fiber. Fiber intake is associated with increased satiety, and colonic fermentation may be one of the reasons for the increased satiety [3]. One suggested mechanisms is the influence of the colonic fermentation on gut hormone [5]. Further research is necessary to determine the correlation between different types of fibers and gut fermentations.

Acknowledgments

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Reference

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