Original Article

Effect of Rice Carbohydrate Ingestion on Intestinal Hydrogen Gas Production and Symptoms in Non-Constipation Irritable Bowel Syndrome Patients Compared with Carbohydrate from Wheat or Mungbean

Linlawan S
Patcharatrakul T
Gonlachanvit S

ABSTRACT

Background: Diet plays an important role in the management of the irritable bowel syndrome (IBS). Previous studies have suggested that, compared to wheat, rice is more completely absorbed in the small bowel and is associated with less intestinal gas and gastrointestinal (GI) symptoms. The benefit of rice carbohydrate in IBS, however, has not been clearly demonstrated.

Objective: To determine the effect of rice flour on intestinal hydrogen gas production and IBS symptoms, compared to wheat or mungbean flour.

Method: Twenty non-constipation IBS patients (13 females, age 46±11 yrs) underwent H_2 breath test study and GI symptom evaluation after ingestion of standard rice, wheat or mungbean meals (90 gm-dry weight). Subjects were randomized in a double-blind crossover study, with a 1-week washout period. After an overnight fast, intestinal gas production and GI symptom scores in response to the standard meals (given at 8 AM and 12 PM) were evaluated at baseline and every 15-minute for 8 hours after the first standard meal. GI symptoms were evaluated using the visual analog scales.

Results: All subjects completed the study without any adverse events. The hydrogen (H_2) and methane (CH_4) concentrations in the breath samples were similar at baseline (p>0.05). Beginning at hour-5 after breakfast, the H_2 and CH_4 productions were significantly increased after wheat noodle ingestion compared to rice noodle ingestion (p<0.05). The area under curves (AUC) of H_2 and CH_4 were greater after wheat noodle ingestion compared to rice and mungbean noodle ingestion (H_2: 4,120.5 ± 45.5 vs. 2,267.3 ± 14.6 and 2,356.1±13.9 ppm-min, p<0.001 and CH_2 : 1,616.0 ± 15.8 vs. 946.5 ± 6.0 and 943.1±5.2 ppm-min, p<0.05). The mean symptom scores for bloating and satiety symptoms were significantly increased after wheat ingestion compared to rice ingestion (3.0 ± 0.6 vs. 2.2 ± 0.6 and 3.4 ± 0.5 vs. 2.5 ± 0.5, respectively, p<0.05). Other GI symptoms including abdominal pain, abdominal burning, nausea, urgency of stool, heartburn, belching and regurgitation were not significantly different between after rice and wheat ingestion.

Conclusion: Rice flour ingestion produces significantly less intestinal gas production, bloating and satiety symptom compared to wheat flour ingestion. The results suggested that rice is a better source of carbohydrate for non-constipation IBS compared to wheat or mungbean carbohydrate.

Key words : Carbohydrate, irritable bowel syndrome, rice, wheat, mungbean, breath test

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Division of Gastroenterology, Department of Internal Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.

Address for Correspondence: *Prof. Sutep Gonlachanvit, M.D., Department of Internal Medicine, Faculty of Medicine, Chulalongkorn University, Bangkok 10330, Thailand.*

INTRODUCTION

Irritable bowel syndrome (IBS) is defined as a group of functional gastrointestinal disorders (FGID) that has chronicity of natural history and disturbed quality of the patients' life. Many IBS patients observe and are concerned that certain food items can trigger their GI symptoms[1]. Complaints of GI symptoms after food ingestion are common for patients with functional gastrointestinal disorders (FGID), and have been reported in 25-64% of IBS patients[2-4]. Previous data suggested that modification of the composition of meals (avoiding specific food items) and the eating habits (reducing meal size and/or the time of meals) may benefit patients with IBS[5]. The effects of food ingestion on GI symptoms in IBS patients have been studied mostly in Western populations[6-8]. Recent studies also suggested that diet low in fermentable oligosaccharides, disaccharides, monosaccharides, and polyols (FODMAPs) plays a major role in the management of IBS[9, 10]. However, the effect of complex carbohydrate on GI symptoms or intestinal gas production has not been sufficiently investigated especially in Asia[11]. Moreover, information is quite limited regarding the effects of typical Asian foods on GI symptoms of (FGID). Rice is completely absorbed in the small bowel and produces less intestinal gas after ingestion compared to wheat and other sources of carbohydrate[12]. In this study, we aimed to evaluate the effect of rice flour on intestinal gas production and IBS symptoms, compared to wheat or mungbean flour, all of which are major sources of carbohydrate in Thailand and other Asian countries.

MATERIALS AND METHODS

Study subjects

Twenty patients diagnosed as non-constipation IBS based on the fulfilling Rome III criteria were recruited for the study[13]. Subjects were at least 18 years old, were not pregnant, and had not taken probiotic supplements, prokinetics, laxatives or antibiotics for at least 4 weeks prior to the study. All were non-smokers, and none had a history of abdominal surgery. The protocol was approved by the Institutional Review Board of the Faculty of Medicine, Chulalongkorn University, Bangkok, Thailand.

Chemicals

Study diet was made from 90 grams dried weight of rice, wheat or mungbean flour as carbohydrate source with pork and fish ball as protein source, and was prepared and cooked as noodles. No vegetables or other poorly-absorbed ingredients were added in order to avoid intestinal gas production.

Study design

Participants were randomly assigned with block randomization to ingest the study diet (rice, wheat, or mungbean flour). After overnight fasting, intestinal gas production, GI symptom scores and Bristol stool form scale were evaluated at baseline. Then the standard meal was then given at 8 AM (breakfast) and at 12 PM (lunch), in a blinded manner to both the research assistance and the patient[14]. The subjects were also asked to maintain good oral hygiene during the breath testing phase by brushing teeth before taking the first breath sample and refraining from smoking and vigorous physical activity[15]. Exhaled breath specimen and questionnaire after the first standard meal were collected every 15 minutes for 8 hours. GI symptoms were evaluated using the 100 mm visual analog scale (100 mm-VAS). A 7-day washout period was implemented before crossing over to the next alternative diet until completion of all three types of the study diet.

Breath test

Breath samples collected every 15-minute for 14 hours into 250 mL sample holding bags (Quintron Instrument Co, Inc., Milwaukee, WI, USA). The first sample of the day was a fasting sample taken before breakfast. The samples were analyzed within 24 hours bay an experienced technician for hydrogen and methane using a Quintron Microlyzer Model DP Plus (Quintron Instrument Co., Milwaukee, WI, USA). Results of all the breath tests were reported in parts per million (ppm).

Statistical analysis

All data were presented as mean ± standard deviation (SD). Comparisons involving more than 2 groups were analyzed by repeated-measured ANOVA. In all statistical comparisons, a *p*-value less than 0.05 was considered statistically significant. The data were analyzed using the SPSS software version 17.0 for windows.

RESULTS

Twenty non-constipation predominated irritable bowel syndrome (IBS non-C) patients participated and underwent breath test studies and GI symptoms evaluation. Most participants were female with a Bristol stool scale of 5 (Table 1).

All subjects completed the study without adverse events. The hydrogen (H_2) and methane (CH_4) concentrations in breath samples were similar at baseline (p>0.05). Beginning at hour 5 after breakfast, the H_2 and CH_4 production was significantly increased after wheat noodle ingestion compared to rice noodle ingestion (p<0.05)(Figure 1 and 2).

Table 1. Baseline characteristics of IBS non-C patients (n=20).

Baseline characteristics	
Male : Female (n)	7:13
Mean Age ± SD (year)(mean±SD)	46.0 ±11.1
BMI (kg/m^2)(mean±SD)	23.3 ±4.0
Duration of IBS(months)(mean±SD)	2.6±0.9
Bristol stool scale (median)	5

The AUCs of H_2 and CH_4 were greater after wheat noodle ingestion compared to rice and mungbean noodle ingestion (H_2: 4,120.5 ± 45.5 vs. 2,267.3 ± 14.6 and 2,356.1±13.9 ppm-min, p<0.001 and CH_4 : 1,616.0 ± 15.8 vs. 946.5 ± 6.0 and 943.1±5.2, p<0.05, respectively) (Table 2).

The mean symptom scores for bloating and satiety symptoms were significantly increased after wheat ingestion compared to rice ingestion (3.0 ± 0.6 vs. 2.2 ± 0.6 and 3.4 ± 0.5 vs. 2.5 ± 0.5, respectively, p<0.05). Other GI symptoms, including abdominal pain, abdominal burning, nausea, urgency of defecation, heartburn, belching and regurgitation, were not significantly different after rice or wheat ingestion (Figure 3).

DISCUSSION

Our study investigated the effects of common diet in any sources of carbohydrate on intestinal gas production and gastrointestinal (GI) symptoms in Thai IBS patients. That diet is a challenging problem in the man-

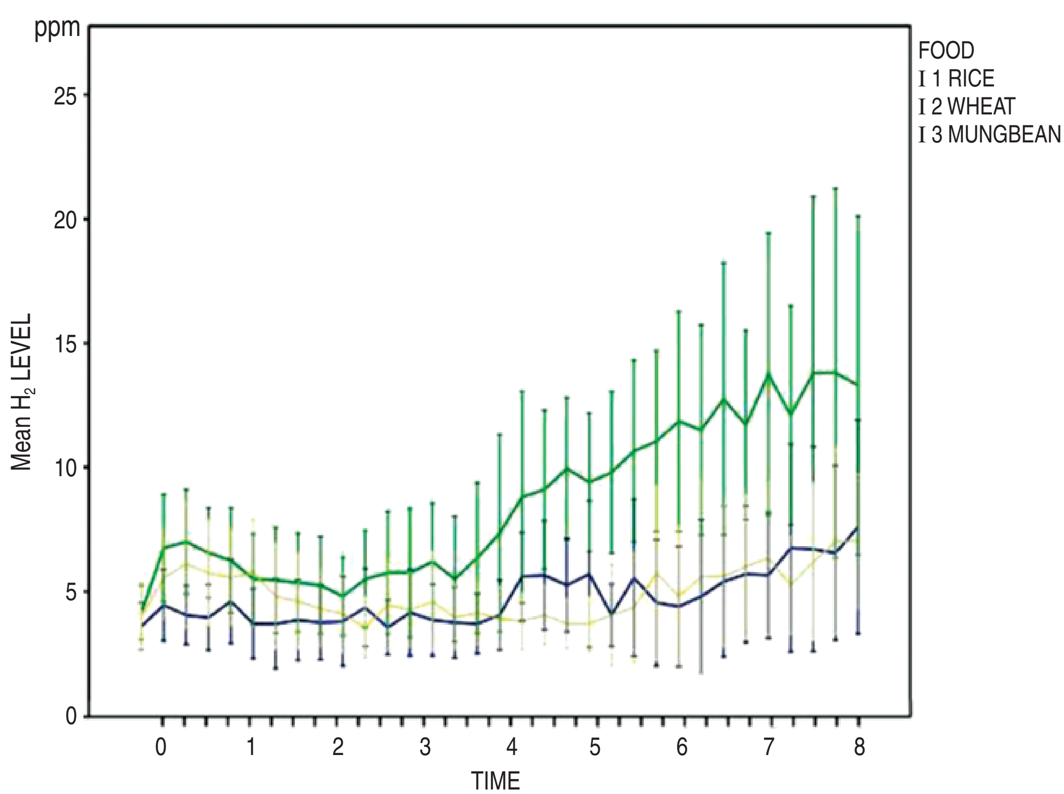

Figure 1. Mean intestinal hydrogen (H_2) gas production as measured from breath test in IBS non-C patients (p < 0.05 after 5th hour of ingestion of the study diet).

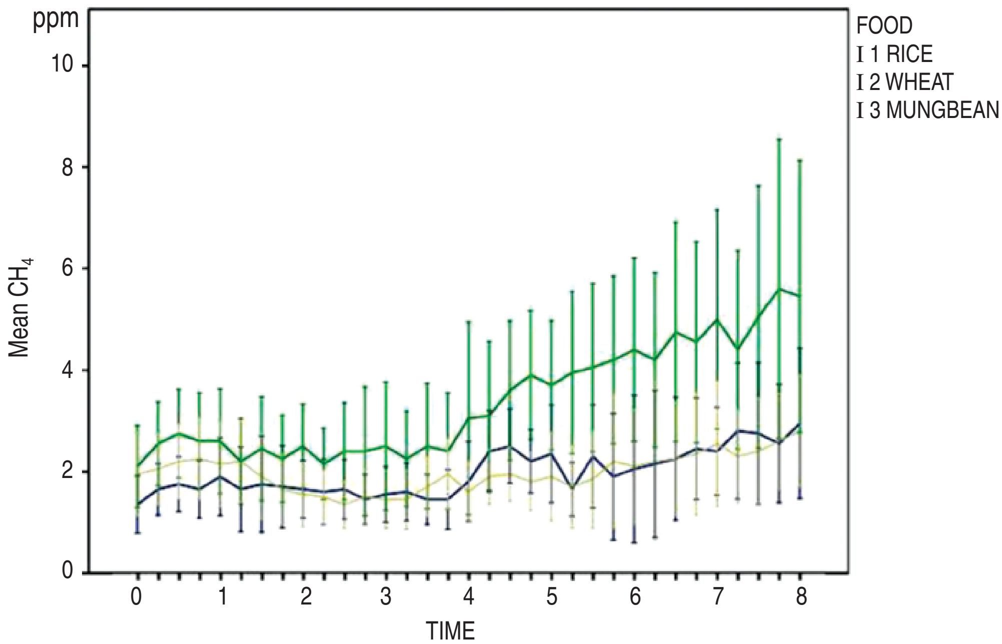

Figure 2. Mean intestinal methane (CH_4) gas production as measured from breath test in IBS non-C-patients ($p < 0.05$ after 5^{th} hour of ingestion of the study.

Table 2. Intestinal gas production after ingestion of the study diets (rice, wheat, and mungbean flour) (mean±SD).

Intestinal gas	Rice	Wheat	Mungbean
Hydrogen (ppm)	4.75±2.64	21.50±5.13*	4.92±2.67
Methane (ppm)	1.97±1.19	3.38±2.11*	1.97±1.31
AUC Hydrogen (ppm-min)	2,267.3±14.6	4,120.5±45.5*	2,356.1±13.9
AUC Methane (ppm-min)	946.5±6.0	1,616.0±15.8*	943.1±5.2

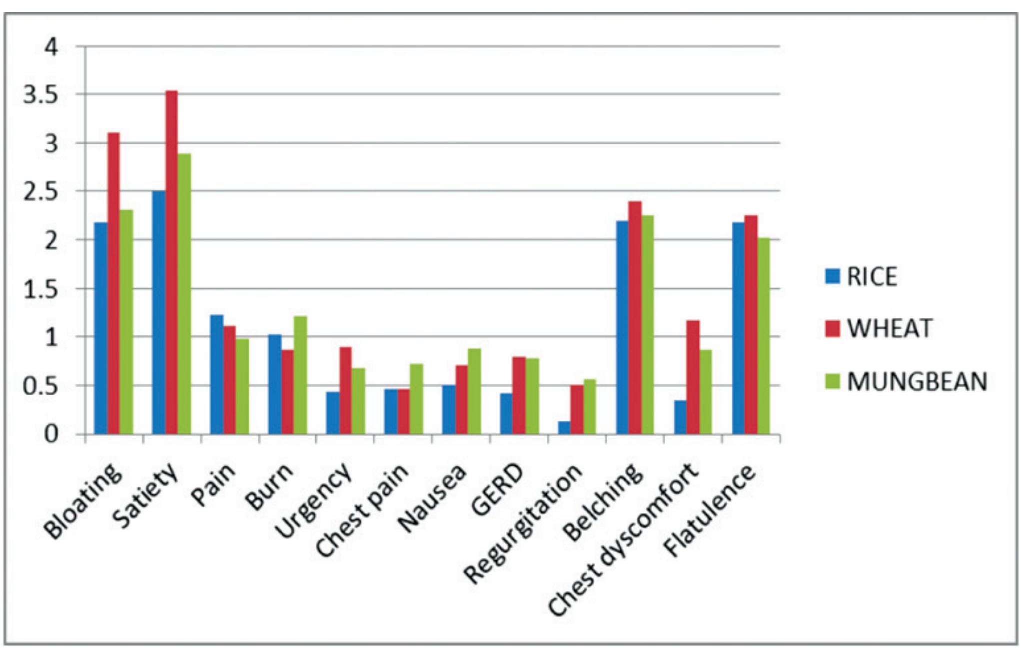

Figure 3. Gastrointestinal (GI) symptoms scores (100 mm-VAS) in IBS non-C patients after ingestion of different study diets.

agement of IBS. Rice and mungbean flour, which are the major sources of carbohydrate in Asia are categorized as low FODMAPs diet, while wheat is defined as high FODMAPs diet and is mostly consumed in Western countries[16-18].

The breath test is a useful non-invasive test for evaluating small intestinal bacterial overgrowth (SIBO) and incomplete absorption[19]. There is no strong evidence that shows a significant correlation between lactulose breath test-positive IBS patient and occurrence of GI symptoms (bloating, abdominal pain or satiety)[20]. Meta-analysis has demonstrated only abnormality of this breath test in IBS patients compared with in healthy volunteers (OR=4.46, 95% CI= 1.69-11.80), with a sensitivity and a specificity of 43.6% and 83.6% respectively[21].

Previous studies have shown that not only GI symptoms, after wheat ingestion especially bloating and early satiety, can result from incomplete intestinal absorption, but the osmotic load and luminal distention in the small or the large intestine also can trigger symptoms by increasing small bowel water content as confirmed with abdominal MRI[22]. By contrast, improvements of stool frequency, consistency or stool urgency, may result from diminished terminal ileal fluid content, reabsorption of colonic water, or change in short-chain fatty acids (SCFA) production in the large intestine[23]. Small bowel transit, which is rapid in IBS patients with bloating and wheat ingestion, may trigger this GI symptom via the same mechanism[24].

Most of our patients were satisfied with their improved symptoms after the breath test and dietary intervention. This observation was similar to the 4-week randomized controlled trial published by Staudacher et al, which demonstrated the effects of fermentable carbohydrate restriction on luminal microbiota, SCFA, and GI symptoms in patients with IBS, with a reduction in the concentration and the proportion of luminal bifidobacteria after four weeks of fermentable carbohydrate restriction[23].

Limitations in our study were 1) impossibility of designing different sources of carbohydrate into very similar-looking dishes, 2) difficulty in controlling confounding factors at home (diet, medication, activity, etc.), and 3) our small sample size. However, we tried to reduce these problems by using a double-blinded crossover design with 1-week washout period. We also employed a dietary sheet, a routine screening history with the use of the Bristol stool scale for evaluation of intestinal transit time before the study, as well as recording the amount of study diet ingested by each subject.

Our study confirmed that rice as the low FODMAPs diet can optimize the outcome of treatment in IBS patients compared with other sources of carbohydrate and leads to a significant improvement for most patients. Our finding was similar to in previous studies worldwide. Lifestyle modification and dietary education are helpful for controlling GI symptoms, in addition to IBS medications, and a more intensive program for healthcare providers to better inform patients is needed.

CONCLUSIONS

In conclusion, this study suggested that rice was a better source of carbohydrate for non-constipation IBS patients compared to wheat or mungbean carbohydrate. Price and produced significantly less intestinal gas production, bloating and satiety symptoms than wheat flour ingestion.

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