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BRIEF ARTICLE

Effect of composite yogurt enriched with acacia fiber and *Bifidobacterium lactis*

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Abstract

AIM: To investigate whether composite yogurt with acacia dietary fiber and *Bifidobacterium lactis* (*B. lactis*) has additive effects in irritable bowel syndrome (IBS).

METHODS: A total of 130 patients were randomly allocated to consume, twice daily for 8 wk, either the composite yogurt or the control product. The composite yogurt contained acacia dietary fiber and high-dose *B. lactis* together with two classic yogurt starter cultures. Patients were evaluated using the visual analog scale *via* a structured questionnaire administered at baseline and after treatment.

RESULTS: Improvements in bowel habit satisfaction and overall IBS symptoms from baseline were significantly higher in the test group than in the control group (27.16 *vs* 15.51, $P = 0.010$, 64.2 ± 17.0 *vs* 50.4 ± 20.5, $P < 0.001$; respectively). In constipation-predominant IBS, improvement in overall IBS symptoms was significantly higher in the test group than in the control group (72.4 ± 18.4 *vs* 50.0 ± 21.8, $P < 0.001$). In patients with diarrhea-predominant IBS, improvement in bowel habit satisfaction from baseline was significantly higher in the test group than in the control group (32.90 *vs* 7.81, $P = 0.006$).

CONCLUSION: Our data suggest that composite yogurt enriched with acacia fiber and *B. lactis* has greater therapeutic effects in patients with IBS than standard yogurt.

Key words: Acacia dietary fiber; *Bifidobacterium lactis*; Irritable bowel syndrome; Probiotics; Yogurt

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INTRODUCTION

Irritable bowel syndrome (IBS) is a functional bowel disorder characterized by symptoms of abdominal pain or discomfort associated with disturbed defecation, and is one of the most common gastrointestinal problems[1-3]. The pathogenesis of IBS is incompletely understood but over the past few years, there has been an emergence of new etiological hypotheses. These include gastrointestinal infection, low-grade infiltration and activation of mast cells in the intestinal mucosa with consequent release of bioactive substances, modification of small bowel and colonic microflora, changes related to the brain-gut axis, and altered serotonin metabolism[4-8]. These new views of the pathogenesis of IBS have changed the approach to IBS treatment[9]. Among several treatment options, the use of probiotics seems to be promising[10].

Probiotics are live microorganisms with a vast array of therapeutic potential for gastrointestinal disease[11,12]. They have been studied and used in many gastrointestinal disorders, with growing evidence for use in pouchitis, *Clostridium difficile* colitis, antibiotic-associated diarrhea, inflammatory bowel disease, and IBS. The emerging multifactorial pathophysiological paradigm of IBS may create adjunctive probiotic therapeutic opportunities[10,13,14]. The most widely studied organisms are *Bifidobacterium lactis* (*B. lactis*) and *Lactobacillus spp.*[15]. *B. lactis* survives complete transit through the digestive tract and is recovered live in stools in large quantities relative to the quantity initially ingested[16,17]. Daily consumption of fermented milk containing *B. lactis* was reported to improve gastrointestinal transit and digestive comfort, alleviate bloating, and increase stool frequency[18,19].

Acacia gum is extensively used as a food additive. It is a complex polysaccharide, that is primarily indigestible, not degraded in the intestine, but fermented in the colon[20]. Acacia fiber is made from acacia gum. Recently, its prebiotic properties, meaning it selectively stimulates the intestinal flora, were described and a synergy for bifidogenicity was observed with the combination of other prebiotics (fructo-oligosaccharide) and acacia gum. In addition, because acacia fiber is slowly fermented, it may attenuate the side effects of fermentation. Intestinal gas production resulting from fermentation can induce abdominal symptoms[21]. Dietary fiber is also commonly used in the treatment of patients with IBS[22]. Although dietary fiber does not appear to be useful as a sole treatment of IBS, it may have a limited role in empiric therapy, especially if constipation is the most significant symptom[23,24].

The aim of this study was to investigate whether a composite yogurt enriched with acacia dietary fiber and *B. lactis* had additive therapeutic effects in patients with IBS when compared with standard yogurt.

MATERIALS AND METHODS

Study population

A total of 130 patients were recruited at Samsung Medical Center, Seoul, South Korea. They were male and female patients between 18 and 70 years of age who met the Rome Ⅲ criteria[25] for the diagnosis of IBS.

Exclusion criteria were as follow: (1) endocrine disorders, neurological disorders, cardiovascular disorders, inherited neuromuscular disorders, malignant tumors, renal failure (serum creatinine ≥ 3.0 mg/dL), and liver cirrhosis (child class B and C); (2) current use of medications that potentially influence bowel habits such as medications for constipation, antidiarrheal drugs, and medications that can cause constipation, including anticholinergic drugs (e.g., anticonvulsants, antihistamines, antipsychotic and neuroleptic agents, anti-Parkinson agents, and antidepressants), narcotic pain medications (e.g., codeine), resins (e.g., cholestyramine), and metal ions and inorganic compounds (e.g., aluminum-, calcium-, and iron-containing antacids); (3) age > 55 years without a history of a sigmoidoscopy or colonoscopy performed in the previous 5 years; (4) abnormal results on a sigmoidoscopy or colonoscopy and abdominal radiological tests performed in the previous 2 years; and (5) any previous abdominal surgery.

Study protocol

This was a randomized, double-blind, controlled trial. Simple randomization was performed using a random number table. Potentially eligible patients answered a structured questionnaire at baseline. At that time, they were provided with a standardized explanation of questions and symptom definitions. In addition, patients were evaluated *via* a full review of their clinical history including complete blood count, serum chemistry, and thyroid function test. Clinically significant abnormalities in any of the latter tests resulted in exclusion from the study. Thereafter, eligible patients were randomly allocated to consume two bottles daily (one at breakfast, one at dinner) for 8 wk of either the composite yogurt (test product) or the control product. At the end of the study, patients were again administered a questionnaire. The use of any medication that potentially influences bowel habits was prohibited for 7 d prior to consumption of the products.

The study protocol was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board at Samsung Medical Center, Seoul, South Korea (No. 2010-07-223). All subjects provided written informed consent before inclusion in the study.

Study products

The test product was a yogurt containing high-dose *Bifidobacterium animalis subsp. lactis Bb-12* (*B. animalis subsp. lactis Bb-12*) (≥ 10^{11} cfu/bottle), *Bifidobacterium* enhancer, and acacia dietary fiber, together with the two classic yogurt starter cultures, *Streptococcus thermophilus* (≥ 3×10^9 cfu/bottle) and *Lactobacillus acidophilus* (*L. acidophilus*) (≥ 10^9 cfu/bottle).

The control product was a traditional yogurt contain-

ing *B. animalis subsp. lactis Bb-12* ($\geq 10^{10}$ cfu/bottle), no extra-functional ingredients (*Bifidobacterium* enhancer and acacia dietary fiber), and two yogurt starter cultures, *Streptococcus thermophilus* ($\geq 3 \times 10^{9}$ cfu/bottle) and *L. acidophilus* ($\geq 1 \times 10^{9}$ cfu/bottle). Both the test and control products were without added flavor and had similar appearance, color, texture, and taste. Each bottle contained either 150 mL of test or control product and was provided by the Namyang Dairy Products Co. Ltd. (Seoul, South Korea).

Assessments

Each patient was evaluated using a structured questionnaire at baseline and after 8 wk treatment. At baseline, the questionnaire assessed age, sex, height, body weight, IBS subtype[26], abdominal symptoms (abdominal pain/discomfort, abdominal distension/bloating, and flatulence), and bowel habits (frequency and duration of defecation, urgency, straining, feeling of incomplete defecation, stool consistency, bowel habit satisfaction, and discomfort related to daily life). Abdominal pain/discomfort, abdominal distension/bloating, bowel habit satisfaction, and discomfort related to daily life were evaluated using the visual analog scale (VAS, 0 = no symptoms, 25 = mild, 50 = moderate, 75 = severe, and 100 = very severe). Abdominal pain/discomfort, flatulence, and defecation were assessed by frequency. The stool consistency was determined using the Bristol stool scale[27].

At the end of the treatment, abdominal symptoms and bowel habits were assessed by the self-administration of the questionnaire that had the same questions as the one at baseline. In addition, the improvement of overall IBS symptoms was evaluated using the VAS (0 = aggravated, 25 = no change, 50 = slightly improved, 75 = much improved, 100 = very much improved).

Statistical analysis

It was determined that 50 patients per group were required for a power of 85% and two-sided significance at 5% in detecting a between-group effect of 0.2 in the improvement of overall IBS symptoms. To ensure the inclusion of at least 50 patients per group, 65 per group were ultimately recruited in order to account for a potential withdrawal rate of 25%.

Baseline demographic data were compared between groups using Student's *t* test, Pearson's χ^2 test, or Fisher's exact test, as appropriate. Changes in the symptom scores after treatment for each group were assessed using a paired *t* test, McNemar's test, and a generalized estimating equation. A two-sided *P* value < 0.05 was considered statistically significant. Statistical analysis was performed using PASW Statistics 18 for Windows (SPSS, Inc, Chicago, IL, United States).

RESULTS

Baseline characteristics and response to treatment

A total of 130 patients were enrolled and randomized either to the test group ($n = 65$) or the control group ($n = 65$). Thirteen patients discontinued the study and were lost to follow-up, and 117 (58 in the test group and 59 in the control group) completed the study. Using the Rome Ⅲ criteria, 35.0% of patients were classified as constipation-predominant IBS (IBS-C), 29.9% as diarrhea-predominant IBS (IBS-D), 8.5% as mixed IBS (IBS-M), and 26.5% as unsubtyped IBS. Table 1 shows baseline characteristics and symptom scores of patients in the test and control groups. At baseline, the distributions of age, sex, body mass index, and IBS subtype were similar between the groups, and the baseline scores for abdominal symptoms and bowel habits did not differ.

Table 2 summarizes the changes in the study parameters after 8 wk treatment in both the test and control groups and differences between the groups. Bowel habit satisfaction improved more in the test group than in the control group (change from baseline of 27.16 *vs* 15.51, $P = 0.010$), and the improvement in overall IBS symptoms was significantly higher in the test group than in the control group (64.2 ± 17.0 *vs* 50.4 ± 20.5, $P < 0.001$). The scores for abdominal pain/discomfort, abdominal distension/bloating, and discomfort related to daily life also improved more in the test group than in the control group, but the improvements did not significantly differ between the groups. The improvements in straining and feeling of incomplete evacuation did not differ between the groups. Defecation duration and frequency, flatulence, and urgency did not improve after treatment. The change in stool consistency was different in the two groups. Stool consistency did not change in the test group but became softer in the control group. There were no significant adverse events reported throughout the study.

Analysis by IBS subtype

A subgroup analysis was performed to determine the effects of the test product on each IBS subtype. In the IBS-C group (Table 3), the improvement in overall IBS symptoms was significantly higher in the test group than in the control group (72.4 ± 18.4 *vs* 50.0 ± 21.8, $P < 0.001$), and the difference between the two groups was greater than that between the test and control groups including all of the study patients (64.2 ± 17.0 *vs* 50.4 ± 20.5, $P < 0.001$). However, bowel habit satisfaction did not differ between the two groups. Defecation frequency and feeling of incomplete evacuation, which did not improve in the study patients overall, improved in the test and control groups (change from baseline of 1.79, $P = 0.002$ and 1.96, $P = 0.032$; change from baseline -42.1%, $P = 0.021$ and -31.8%, $P = 0.016$, respectively) although the improvements did not significantly differ between the groups. Stool consistency became softer in both groups without a significant difference between the test and control groups (change from baseline of 0.789 *vs* 1.09, $P = 0.386$). In the IBS-D group (Table 4), bowel habit satisfaction improved more in the test group than in the control group (change from baseline of 32.90 *vs*

Table 1 Baseline characteristics and symptom scores (mean ± SD)

	Test group (n = 58)	Control group (n = 59)	P value
Age (yr)	37.43 ± 10.27	34.24 ± 8.67	0.720
Male:female n (%)	17 (29.3):41 (70.7)	18 (30.5):41 (69.5)	0.887
BMI (kg/m^2)	21.96 ± 3.01	21.28 ± 2.50	0.184
Subtype of IBS n (%)			0.919
Constipation	19 (32.8)	22 (37.3)	
Diarrhea	19 (32.8)	16 (27.1)	
Mixed	5 (8.6)	5 (8.5)	
Unsubtyped	15 (25.9)	16 (27.1)	
Abdominal symptoms			
Abdominal pain or discomfort (VAS)	34.05 ± 18.55	33.05 ± 19.94	0.779
Frequency of abdominal pain or discomfort/d	1.73 ± 2.03	1.21 ± 1.17	0.089
Abdominal distension or bloating (VAS)	44.40 ± 21.99	39.83 ± 20.82	0.281
Flatulence/d	5.19 ± 4.01	4.98 ± 2.88	0.749
Bowel habit			
Defecation frequency/wk	6.38 ± 5.98	5.69 ± 3.87	0.458
Defecation duration (min)	8.68 ± 6.35	8.85 ± 5.59	0.881
Urgency n (%)	23 (39.7)	22 (37.3)	0.792
Straining n (%)	39 (67.2)	37 (62.7)	0.608
Feeling of incomplete defecation n (%)	39 (67.2)	44 (74.6)	0.382
Stool consistency (BSS)	3.95 ± 1.64	3.54 ± 1.59	0.159
Bowel habit satisfaction (VAS)	32.33 ± 17.53	31.95 ± 18.22	0.909
Discomfort related to daily life (VAS)	36.21 ± 22.54	30.93 ± 17.58	0.160

BMI: Body mass index; IBS: Irritable bowel syndrome; VAS: Visual analog scale; BSS: Bristol stool scale.

Table 2 Study parameters at week 8 and changes from baseline in all patients (mean ± SD)

	Test group (n = 58)				Control group (n = 59)				P value[1]
	Baseline	wk 8	Δ wk 8	P value	Baseline	wk 8	Δ wk 8	P value	
Abdominal symptoms									
Abdominal pain or discomfort (VAS)	34.05 ± 18.55	12.93 ± 14.99	-21.12	0	33.05 ± 19.94	16.5 ± 17.7	-16.53	< 0.001	0.26
Frequency of abdominal pain or discomfort/d	1.73 ± 2.03	0.84 ± 0.83	-0.89	0.004	1.21 ± 1.17	0.7 ± 0.8	-0.48	0.001	0.214
Abdominal distension or bloating (VAS)	44.40 ± 21.99	25.86 ± 18.1	-18.53	0	39.83 ± 20.82	28.8 ± 21.2	-11.02	< 0.001	0.096
Flatulence/d	5.19 ± 4.01	5.69 ± 5.08	0.5	0.391	4.98 ± 2.88	5.5 ± 4.0	0.51	0.266	0.991
Bowel habits									
Defecation frequency/wk	6.38 ± 5.98	7.23 ± 4.28	0.85	0.289	5.69 ± 3.87	6.7 ± 4.2	1.04	0.052	0.843
Defecation duration (min)	8.68 ± 6.35	7.47 ± 4.95	-1.22	0.07	8.85 ± 5.59	6.7 ± 3.9	-2.12	< 0.001	0.301
Urgency	23 (39.7%)	16 (27.6%)	-7	0.118	22 (37.3%)	22 (37.3%)	0	1	0.146
Straining	39 (67.2%)	22 (37.9%)	-17	0	37 (62.7%)	20 (33.9%)	-17	0.002	0.959
Feeling of incomplete evacuation	39 (67.2%)	19 (32.8%)	-20	0	44 (74.6%)	23 (39.0%)	-21	< 0.001	0.815
Stool consistency (BSS)	3.95 ± 1.64	3.72 ± 1.02	-0.22	0.274	3.53 ± 1.59	3.88 ± 1.15	0.36	0.047	0.118
Bowel habit satisfaction (VAS)	32.33 ± 17.53	59.48 ± 19.21	27.16	0	31.95 ± 18.22	47.5 ± 20.1	15.51	< 0.001	0.01
Discomfort related to daily life (VAS)	36.21 ± 22.54	21.98 ± 19.91	-14.22	0	30.93 ± 17.58	22.9 ± 17.5	-8.05	0.007	0.199
Improvement in overall IBS symptoms (VAS)		64.2 ± 17.0				50.4 ± 20.5			< 0.001

[1]Comparison between both groups. IBS: Irritable bowel syndrome; VAS: Visual analog scale; BSS: Bristol stool scale.

7.81, P = 0.006), and the difference between the two groups was greater than the difference between patients in the overall analysis (change from baseline of 27.16 *vs* 15.51, P = 0.010). However, the improvement in overall IBS symptoms did not differ between the two groups. Abdominal pain/discomfort scores improved more in the test group than in the control group, and the improvement was nearly significant (change from baseline of -23.68 *vs* -9.38, P = 0.050). Stool consistency became harder in both groups without a significant difference between the test and control groups (change from baseline of -1.26 *vs* -0.63, P = 0.738). In the IBS-M group, the improvements in abdominal symptoms, bowel habits, and overall IBS symptoms did not significantly differ between the test and control groups.

DISCUSSION

Several clinical studies have demonstrated the efficacy of probiotics for the treatment of patients with IBS. Some studies have also been performed in populations of certain IBS subtypes. A study by Kim *et al*[28] evaluated the effect of VSL#3, a combination of probiotics that contains live bacteria including *Bifidobacterium*, *Lactobacillus*, and *Streptococcus salivarius ssp. thermophilus,* on gastrointestinal transit and symptoms in IBS-D. With VSL#3 treatment, the decrease in bloating was of borderline significance, but there was no effect on gastrointestinal transit

Table 3 Study parameters at week 8 and changes from baseline in constipation-predominant irritable bowel syndrome patients (mean ± SD)

	Test group (n = 19)				Control group (n = 22)				P value[1]
	Baseline	wk 8	Δ wk 8	P value	Baseline	wk 8	Δ wk 8	P value	
Abdominal symptoms									
Abdominal pain or discomfort (VAS)	28.95 ± 20.90	9.21 ± 12.39	-19.74	0.001	37.50 ± 25.30	15.91 ± 18.17	-21.59	0.001	0.8
Frequency of abdominal pain of discomfort/d	1.50 ± 1.17	0.89 ± 0.88	-0.61	0.032	1.27 ± 1.56	0.68 ± 0.78	-0.6	0.029	0.979
Abdominal distension or bloating (VAS)	44.74 ± 21.38	25.00 ± 16.67	-19.74	0.007	38.64 ± 22.79	26.14 ± 16.33	-12.5	0.031	0.393
Flatulence/wk	6.05 ± 5.03	6.13 ± 4.35	0.08	0.952	5.52 ± 3.34	6.02 ± 4.95	0.5	0.577	0.785
Bowel habit									
Defecation frequency/wk	3.82 ± 2.08	5.61 ± 3.54	1.79	0.002	3.43 ± 1.55	5.39 ± 3.97	1.96	0.032	0.872
Defecation duration (min)	12.26 ± 7.33	9.66 ± 5.28	-2.61	0.106	10.84 ± 6.49	6.59 ± 4.07	-4.25	< 0.001	0.358
Urgency	4 (21.1%)	4 (21.1%)	0	1	3 (13.6%)	6 (27.3%)	3	0.375	0.336
Straining	18 (94.7%)	11 (57.9%)	-7	0.016	18 (81.8%)	12 (54.5%)	-6	0.146	0.321
Feeling of incomplete evacuation	15 (78.9%)	7 (36.8%)	-8	0.021	16 (72.7%)	9 (40.9%)	-7	0.016	0.776
Stool consistency (BSS)	2.26 ± 0.45	3.05 ± 0.85	0.789	0	2.18 ± 0.66	3.27 ± 1.08	1.09	0.001	0.386
Bowel habit satisfaction	30.26 ± 19.68	56.58 ± 20.14	26.32	0	27.27 ± 18.76	44.32 ± 21.73	17.05	0.004	0.21
Discomfort related to daily life (VAS)	34.21 ± 22.38	18.42 ± 16.33	-15.79	0.014	36.36 ± 21.45	27.73 ± 15.25	-13.64	0.015	0.782
Improvement in overall IBS symptoms (VAS)		72.4 ± 18.4				50.0 ± 21.8			< 0.001

[1]Comparison between both groups. IBS: Irritable bowel syndrome; VAS: Visual analog scale; BSS: Bristol stool scale.

Table 4 Study parameters at week 8 and changes from baseline in diarrhea-predominant irritable bowel syndrome patients (mean ± SD)

	Test group (n = 19)				Control group (n = 16)				P value[1]
	Baseline	wk 8	Δ wk 8	P value	Baseline	wk 8	Δ wk 8	P value	
Abdominal symptoms									
Abdominal pain or discomfort (VAS)	32.89 ± 14.56	9.21 ± 14.93	-23.68	0	29.69 ± 10.08	20.3 ± 18.8	-9.38	0.083	0.05
Frequency of abdominal pain or discomfort/d	2.45 ± 3.18	0.63 ± 0.83	-1.82	0.036	1.25 ± 0.71	0.91 ± 0.94	-0.34	0.245	0.117
Abdominal distension or bloating (VAS)	43.42 ± 23.34	25.00 ± 20.41	-18.42	0.012	35.94 ± 15.73	29.69 ± 20.85	-6.25	0.164	0.146
Flatulence/wk	4.63 ± 2.36	4.08 ± 2.67	-0.55	0.503	4.66 ± 2.15	5.50 ± 3.38	0.84	0.255	0.212
Bowel habit									
Defecation frequency/wk	10.55 ± 8.18	8.79 ± 4.46	-1.76	0.381	9.09 ± 4.19	9.09 ± 4.12	0	1	0.451
Defecation duration (min)	6.66 ± 5.57	6.58 ± 4.98	-0.08	0.938	8.00 ± 4.75	7.03 ± 3.81	-0.97	0.3	0.52
Urgency	10 (52.6%)	8 (42.1%)	-2	0.625	12 (75.0%)	11 (68.8%)	-1	1	0.867
Straining	8 (42.1%)	3 (15.8%)	-5	0.063	7 (43.8%)	2 (12.5%)	-5	0.063	0.707
Feeling of incomplete evacuation	13 (68.4%)	6 (31.6%)	-7	0.039	12 (75.0%)	5 (31.3%)	-7	0.016	0.826
Stool consistency (BSS)	5.42 ± 1.17	4.16 ± 0.38	-1.26	0.001	5.50 ± 1.10	4.88 ± 1.09	-0.63	0.036	0.738
Bowel habit satisfaction	31.58 ± 18.34	64.47 ± 19.21	32.9	0	40.63 ± 15.48	48.44 ± 17.00	7.81	0.173	0.006
Discomfort related to daily life (VAS)	36.84 ± 24.11	23.68 ± 25.65	-13.16	0.163	29.69 ± 13.60	28.13 ± 17.97	-1.56	0.751	0.292
Improvement in overall IBS symptoms (VAS)		61.8 ± 17.4				51.6 ± 14.3			0.07

[1]Comparison between both groups. IBS: Irritable bowel syndrome; VAS: Visual analog scale; BSS: Bristol stool scale.

or other individual IBS symptoms. A study by Guyonnet *et al*[19] assessed the effects of fermented milk containing *B. animalis* DN-173 010 in IBS-C and reported improvements in the health-related quality-of-life discomfort score and bloating symptoms, as well as increased stool frequency. Another study demonstrated the effects of a fermented milk product containing *B. lactis* DN-173-010 on abdominal distension and gastrointestinal transit in IBS-C[29]. In the present study, the therapeutic effect of the composite yogurt differed according to IBS subtype; in IBS-C, overall IBS symptoms were improved, and in IBS-D, the improvement in bowel habit satisfaction was prominent. However, irrespective of IBS subtype, the new composite yogurt had additive therapeutic effects on bowel habit satisfaction and overall IBS symptoms among the entire IBS study sample when compared with standard yogurt.

Lactobacilli and *bifidobacteria*, alone or in combination, have been used for the treatment of IBS in many clinical studies. A study by Sinn *et al*[14] reported that 4 wk treatment with *L. acidophilus*-SDC 2012, 2013 was associated with a reduced score for abdominal pain or discomfort compared to baseline. O'Mahony *et al*[30] performed a study in patients with IBS and grouped them into three different treatment arms. The patients received *Lactobacillus salivarius* UCC4331, *Bifidobacterium infantis* (*B. infantis*) 35624, or placebo, but only *B. infantis* alleviated IBS symptoms. This was associated with a normalization of the anti-inflammatory to proinflammatory cytokine ratio (interleukin-10/interleukin-12), suggesting an immune-modulating role for *B. infantis*. A larger study by Whorwell *et al*[31] evaluating different doses of *B. infantis* 35624 was performed in 362 women with IBS. The participants were randomized to receive either the placebo or encapsulated *B. infantis* at a dose of 10^6, 10^8 or 10^{10} cfu for 4 wk. *B. infantis* at a dose of 10^8 cfu was significantly superior to placebo and all other doses in improving IBS symptoms. However, the 10^{10} dose was associated

with significant formulation problems. From only these two studies, it is not possible to determine which strain is most effective and the optimal dose. Nevertheless, to date, *Bifidobacterium* seems to be one of the most important probiotics, and a *B. infantis* dose of at least 10^8 cfu may be appropriate for the treatment of IBS. Given this fact, it can be deduced that at a *Bifidobacterium* dose > 10^8 cfu, the therapeutic effects would increase in proportion to the dose up to a certain point. In this study, we used *B. lactis*, which has been shown to have therapeutic effects in IBS in several studies[18,19,29,32]. Our results also showed that the new composite yogurt (containing > 10 times the *B. lactis* of the control product and *Bifidobacterium* enhancer) was associated with a significant improvement in bowel habit satisfaction and overall IBS symptoms, although acacia fiber was also added to the test product and it was difficult to attribute the results to one or the other component. To determine the optimal dosage, another trial evaluating the effects of yogurt containing *B. lactis* at different dosages is necessary.

Dietary fiber accelerates whole gut transit time and increases daily stool weight and the proportion of unformed stool, and its efficacy in alleviating constipation has been confirmed in patients with IBS[33]. Therefore, dietary fiber is frequently recommended for IBS[22]. A study by Choi *et al*[24] evaluated the additive effects of probiotic fermented milk containing dietary fiber in IBS-C patients, compared to plain probiotic fermented milk, and dietary fiber had additive benefits for the symptoms of constipation, especially in IBS-C. However, in a study by Francis *et al*[34], fiber was found to exacerbate all symptoms of IBS. Dietary fiber is classified into soluble and insoluble fiber, which have different effects on global IBS-related symptoms[35]. Soluble fiber delays gastric emptying and nutrient absorption from the small bowel; it is used to delay gastric emptying and improve glycemic control in diabetes, as well as to alleviate constipation. Insoluble fiber has little effect on gastric emptying and small bowel transit; it markedly accelerates colonic transit and is frequently used as a laxative[36]. For our study, we used acacia fiber, which is soluble, and that is thought to be the reason the composite yogurt containing acacia fiber was associated with improvement in IBS symptoms among IBS-C patients.

The present study had some limitations. First, the follow-up period was relatively short. It would have been useful to know how participants were faring after using the composite yogurt for 6 and 12 mo. Next, this study was limited by the lack of a placebo group because the control product was not a placebo. Finally, we did not investigate participants' dietary factors, which may be more prevalent in IBS-D. Nevertheless, this was a well-designed trial with an appropriate number of patients. Furthermore, additive effects of high-dose *B. lactis* and acacia dietary fiber were clearly noted with respect to bowel habit satisfaction and overall IBS symptoms. Among IBS subtypes, overall IBS symptoms were more improved in IBS-C; in IBS-D, bowel habit satisfaction was more improved. In conclusion, a new composite yogurt had greater therapeutic effects in patients with IBS than standard yogurt had. Further studies are needed to determine the most effective probiotic strain, dosage, and duration of therapy.

COMMENTS

Background

Irritable bowel syndrome (IBS) is one of the most common gastrointestinal problems. The new views of the pathogenesis of IBS have changed the approach to IBS treatment. Among several treatment options, the use of probiotics seems to be promising. Dietary fiber is also commonly used in the treatment of patients with IBS.

Research frontiers

The authors investigated whether a composite yogurt enriched with acacia dietary fiber and *Bifidobacterium lactis* (*B. lactis*) had additive therapeutic effects in patients with IBS when compared with standard yogurt.

Innovations and breakthroughs

This study was a well-designed prospective clinical trial with an appropriate number of patients. Additive effects of acacia dietary fiber and high-dose *B. lactis* were clearly noted with respect to bowel habit satisfaction and overall IBS symptoms.

Applications

The study results suggest that composite yogurt enriched with acacia fiber and *B. lactis* has greater therapeutic effects in patients with IBS than standard yogurt has.

Terminology

Probiotics are live microorganisms with a vast array of therapeutic potential for gastrointestinal disease.

Peer review

This study is very informative for clinicians because IBS is one of the most common gastrointestinal problems and clinicians frequently encounter problems with treating IBS patients. In addition, the results have scientific relevance for understanding the pathogenesis of the disease.

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