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ORIGINAL ARTICLE

Suppressive effect of partially hydrolyzed guar gum on transitory diarrhea induced by ingestion of maltitol and lactitol in healthy humans

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Objectives: To estimate the suppressive effect of partially hydrolyzed guar gum (PHGG) on transitory diarrhea induced by ingestion of a sufficient amount of maltitol or lactitol in female subjects.
Design: The first, the minimal dose level of maltitol and lactitol that would induce transitory diarrhea was estimated separately for each subject. Individual subject was administered a dose that increased by 5 g stepwise from 10 to 45 g until diarrhea was experienced. Thereafter, the suppressive effect on diarrhea was observed after each subject ingested a mixture of 5 g of PHGG and the minimal dose level of maltitol or lactitol.
Setting: Laboratory of Public Health Nutrition, Department of Nutrition and Health Sciences, Siebold University of Nagasaki.
Subjects: Thirty-four normal female subjects (21.3 ± 0.9 years; 49.5 ± 5.3 kg).
Main outcome measurement: Incidence of diarrhea caused by the ingestion of maltitol or lactitol and the ratio of suppression achieved by adding PHGG for diarrhea.
Results: The ingestion of amounts up to 45 g of maltitol, diarrhea caused in 29 of 34 subjects (85.3%), whereas the ingestion of lactitol caused diarrhea in 100%. The diarrhea owing to maltitol was improved in 10 of 28 subjects by the addition of 5 g of PHGG to minimal dose-induced diarrhea, and that owing to lactitol was in seven of 19 subjects. Adding 10 g of PHGG strongly suppressed the diarrhea caused by maltitol, and the cumulative ratio was 82.1% (23/28).
Conclusion: The transitory diarrhea caused by the ingestion of maltitol or lactitol was clearly suppressed by the addition of PHGG. These results strongly suggest that diarrhea caused by the ingestion of a sufficient amount of non-digestible sugar substitute can be suppressed by the addition of dietary fiber.
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Keywords: transitory diarrhea; suppressive effect; maltitol; lactitol; partially hydrolyzed guar gum

Introduction

Sugar alcohols including maltitol and lactitol have been widely used and marketed as bulking sucrose substitutes with beneficial effects on both human health and on the improvement of food quality (Oku, 2005). Maltitol is a typical non-digestible sugar substitute with good sweetness (Oku *et al*., 1991; Oku, 1996a, b, 2005). The metabolic pathway in the human gastrointestinal tract of non-digestible sugar substitutes is as follows: they escape digestion and absorption in the small intestine, and supply energy to the host via fermentation by microbes in the large intestine (Tokunaga *et al*., 1989; Noda and Oku, 1992). The main products of the microbes' fermentation are short chain fatty acids, such as acetate, propionate, and *n*-butyrate, hydrogen, methane and carbon dioxide (Wursch *et al*., 1989; Reaugerie *et al*., 1990; Cummings and Macfarlane, 1991; Natah *et al*., 1997; Oku and Nakamura, 2003). Non-digestible sugar substitutes directly or indirectly bring about beneficial health effects during their passage through the gastrointestinal tract. (Oku and Noda, 1990; Wolfgang *et al*., 2001; Oku and Nakamura, 2002).

However, ingestion of a sufficiently large amount of non-digestible and/or non-absorbable sugar substitutes causes

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overt diarrhea, and minor abdominal symptoms such as distention and flatus in humans (Koizumi *et al*., 1983; Patil *et al*., 1987; Oku and Okazaki, 1996, 1998; Livesey, 2001). The transitory diarrhea is induced by the hyperosmotic retention of fluid in the small and large intestines (Livesey (2001)). The mechanism of diarrhea induction is considered to be similar to that associated with lactose intolerance (Hertzler *et al*., 1997). The onset of diarrhea owing to the ingestion of processed foods containing these sugar substitutes sometimes causes public health problems in terms of nutrition.

On the other hand, soluble dietary fibers are also categorized as non-digestible and/or non-absorbable carbohydrates. These molecular weights are larger than sugar substitutes, which are oligosaccharides and sugar alcohols. Some kinds of dietary fiber, such as guar gum, carboxylmethyl-cellulose, and gum arabic suppress and improve diarrhea. For instance, partially hydrolyzed guar gum (PHGG) improved the diarrhea owing to the mucosal atrophy induced by the feeding of enteral nutrition in the elderly (Nakao *et al*., 2002; Parisi *et al*., 2002) and treated acute diarrhea with oral rehydration solution (ORS) in children (Alam *et al*., 2000). Gum arabic and carboxylmethyl-cellulose also promoted recovery from diarrhea with ORS treatment (Go *et al*., 1994; Teichberg *et al*., 1999). Amylase-resistant starch added to ORS improves diarrhea even in patients with cholera (Ramakrishna *et al*., 2000). The suppressive effect of dietary fiber on diarrhea has been mainly applied in the clinical setting (Joanne and Norman, 2003; Meier *et al*., 2003; Whelan *et al*., 2001).

Recently, non-digestible and/or non-absorbable oligosaccharide and sugar alcohols with beneficial health effects are widely used in functional and processed foods. Therefore, the intake frequency of those foods increases in our daily life, and as a result, the total intake of those sugar substitutes may sometimes exceed the non-effective level for transitory diarrhea. Transitory diarrhea caused by a sufficient amount of non-digestible sugar substitute has been one of the crucial problems in the development of processed foods. If the transitory diarrhea is improved by the coexistence of dietary fiber in processed foods, we can safely ingest those foods. However, no study has been carried out on the suppressive effect of dietary fiber on the transitory hyperosmotic diarrhea induced by the ingestion of non-digestible and/or non-absorbable sugar substitutes in humans.

The objectives of this study are to estimate the suppressive effects of PHGG on transitory diarrhea induced by the ingestion of the large amount of maltitol, and to compare this effect on diarrhea induced by the ingestion of lactitol, which is considered to be non-digestible sugar alcohol.

Subjects and experimental protocol

Subjects

The subjects who applied for public participation in this study were 34 females (age, 21. 3±0.9 years), all of whom were university students. They had no history of gastrointestinal disease and had not been treated with antibiotics or laxatives in the 2-week period before the experiment. The range of body weight was from 40.5 to 59.5 kg (49.5±5.3 kg), and that of height was from 148.0 to 171.6 cm (157.8±4.4 cm). The average body mass index was 19.9±1.7, and no body exhibited obesity or malnutrition. The subjects were asked their daily frequency of defecation and evacuation.

All of these subjects gave informed written consent to participate in this study.

Materials

Maltitol and lactitol (more than 99% purity) are produced by the hydrogenation of maltose and lactose, respectively. They are used as sugar substitutes and categorized as non-digestible and/or non-absorbable sugar alcohols. Maltitol was kindly provided by Towa Chemical Industry Co., Ltd. (Tokyo, Japan), and lactitol was provided by Nikken Chemical Co., Ltd. (Tokyo, Japan). PHGG is a soluble dietary fiber (molecular weight about 20 000), and is enzymatically decomposed from guar gum. It was kindly given by Taiyo Kagaku Co., Ltd. (Mie, Japan). All of the chemicals used were of analytical grade or the highest grade available.

Protocol of administration of test substances

Estimation of the minimal dose levels to cause transitory diarrhea by the ingestion of maltitol or lactitol in individual subjects. In order to estimate the minimal dose level of maltitol or lactitol that would induce transitory hyperosmotic diarrhea for each subject, the subjects were first administered a stepwise-increased dose of maltitol until they experienced diarrhea. Thereafter, 22 out of 34 subjects voluntarily participated in an experiment of lactitol ingestion in order that the results could be compared to those of maltitol.

Subjects ingested several dose levels of maltitol increasing stepwise from 10 to 45 g in 5 g increments. The ingestion order of the test substance progressed from the smallest amount to larger amounts, and the ingestion was stopped at the dose level at which diarrhea was experienced, or at the largest dose level set in this experiment. The interval of ingestion was more than 1 week for each step of the dose to avoid adaptation. The test substance was dissolved in 150 ml of warm tap water and ingested by subjects within 5 min. At least 1 week after the minimal dose level of maltitol was estimated, lactitol was administered by the same method used for maltitol ingestion.

Estimation of the maximal non-effective dose for transitory diarrhea induced by the ingestion of maltitol or lactitol. To evaluate the validity of the ingestion levels that caused subjects to experience diarrhea, the maximal non-effective dosage of maltitol or lactitol that did not induce transitory diarrhea was calculated and compared with the levels that had already been published (Oku, 1996a, b, 2005). Based on

the minimum dose that induced diarrhea for each subject, the ingested dose (g) versus kg of body weight and the cumulative incidence of diarrhea were calculated for each individual subject. Thereafter, the dose value at which the incidence of diarrhea was 0% was calculated using a single linear regression model. The point of intersection with the *x* axis is considered to be the maximal non-effective dose for the transitory diarrhea by the ingestion of maltitol or lactitol.

Evaluation of the suppressive effects of PHGG on the transitory diarrhea induced by the ingestion of maltitol or lactitol. To evaluate the suppressive effect of PHGG on transitory diarrhea induced by the ingestion of maltitol, each subject ingested a mixture of 5 g of PHGG and the minimal dose level of maltitol for the individual. When the diarrhea was not suppressed by the addition of 5 g of PHGG, the amount of PHGG added was increased to 10 g and ingested after more than 1 week. The test substance was dissolved in 150 ml of warmed tap water, was stood for overnight so as to be constantly gel forming, and was ingested within 5 min.

In order to confirm the effect of the added PHGG to improve diarrhea and to observe the repeatability and reliability of inducing diarrhea by the ingestion of maltitol alone, eight subjects were randomly selected. They ingested an equal dose of the minimal level of maltitol at which they had experienced diarrhea.

Then, to compare the suppressive effect of PHGG on transitory diarrhea induced by the ingestion of maltitol and that on diarrhea induced by lactitol, each subject ingested a mixture of 5 g of PHGG and the minimal dose level of lactitol.

Restriction of food intake imposed on the subjects. From the day before the administration, all subjects were required to avoid the ingestion of foods and beverages containing non-digestible sugar substitutes and fermented foods, which might cause diarrhea. On the experimental day, subjects were not permitted to eat or to drink any foods at least 3 h before and after ingestion of the test substance.

Observation of fecal shape and defecation frequency, gastrointestinal symptoms and physical condition. For 24 h immediately after the administration of the test substance, the type and onset time, and frequency of fecal evacuation, diarrhea and abdominal symptoms were recorded by the subjects themselves. The researchers explained the method of self-recording and the classification of stool shape and abdominal symptoms to all of the subjects, and confirmed the recordings. The macroscopic finding of stool shape and color were recorded according to the color photocopy as a standard. The fecal forms were classified according to the following descriptors: stage 1, very hard (ball shaped, like rabbit stool); stage 2, hard; stage 3, normal (banana shaped); stage 4, soft (paste formed); stage 5, very soft (muddy); and stage 6, watery (Nakamura and Oku, 2002). The defecations of muddy or watery stool were defined as diarrhea in this experiment. The abdominal symptoms were measured using the following scale: 1 point, light; 2 points, severe; 3 points, very severe. These categories were used to classify the experience of upper and lower abdominal pain, vomiting, nausea, thirst, flatus, distention and borborygmus for 24 h after ingestion of the test substance.

Statistical analysis and calculation of results
The average minimal dose of maltitol that induced diarrhea was compared to that of lactitol by Student's *t*-test, and the difference of the severity of the abdominal symptoms were compared by Mann–Whitney *U*-test with a significance level of $P<0.05$, using SPSS Ver. 11, for Windows Japan (SPSS Inc., Tokyo, Japan).

Ethical considerations
This study protocol was approved by the Ethical Committee of Siebold University of Nagasaki prefecture, and informed consent was obtained from all subjects. Studies were conducted in the Laboratory of Public Health Nutrition, Siebold University of Nagasaki.

Results

The condition of the subjects
The subjects completely finished the experiments, excluding a subject who could not ingest the mixture of PHGG solution. They were in normal physical condition and did not experience severe side effects. The average frequency of defecation was 4.8 days per week, and none had severe constipation or an irregular evacuation habit.

The minimal dose levels of transitory diarrhea induced by ingestion of maltitol or lactitol
Table 1 shows the dose levels for individual subjects at which transitory diarrhea caused by the ingestion of maltitol alone. Diarrhea was not induced in any subjects by the ingestion of 10 g of maltitol. The ingestion of 15 g of maltitol caused diarrhea in two out of 34 subjects. In the ingestion of up to 45 g of maltitol, which was the maximal dose in this study, 29 out of 34 subjects (85.3%) experienced diarrhea, whereas five out of 34 subjects (18.5%) did not experience diarrhea even at the ingestion level of 45 g of maltitol. The minimal dose level for diarrhea caused by maltitol varied from 0.32 to 1.11 g/kg of body weight, and the average was 0.70 ± 0.20 g/kg of body weight.

In the case of the ingestion of lactitol alone, no one experienced diarrhea at a dose of 15 g (Table 2). After the ingestion of 20 g of lactitol, three out of 22 subjects experienced diarrhea. The ingestion of up to 45 g of lactitol caused diarrhea in all of the subjects. The minimal dose level for diarrhea, which was caused by lactitol, varied from

Table 1 Minimal dose that induced transitory diarrhea by ingestion of maltitol in female subject individual

Sample no.	*Dose levels of maltitol (g)*							
	10	*15*	*20*	*25*	*30*	*35*	*40*	*45*
1	×	■						
2	×	■						
3	×	×	■					
4	×	×	■					
5	×	×	■					
6	×	×	×	■				
7	×	×	×	×	■			
8	×	×	×	×	■			
9	×	×	×	×	■			
10	×	×	×	×	■			
11	×	×	×	×	■			
12	×	×	×	×	×	■		
13	×	×	×	×	×	■		
14	×	×	×	×	×	■		
15	×	×	×	×	×	×	■	
16	×	×	×	×	×	×	■	
17	×	×	×	×	×	×	■	
18	×	×	×	×	×	×	■	
19	×	×	×	×	×	×	■	
20	×	×	×	×	×	×	■	
21	×	×	×	×	×	×	×	■
22	×	×	×	×	×	×	×	■
23	×	×	×	×	×	×	×	■
24	×	×	×	×	×	×	×	■
25	×	×	×	×	×	×	×	■
26	×	×	×	×	×	×	×	■
27	×	×	×	×	×	×	×	■
28	×	×	×	×	×	×	×	■
29	×	×	×	×	×	×	×	■
30	×	×	×	×	×	×	×	×
31	×	×	×	×	×	×	×	×
32	×	×	×	×	×	×	×	×
33	×	×	×	×	×	×	×	×
34	×	×	×	×	×	×	×	×
Number of trial	34	34	32	29	28	23	20	14
Number of diarrhea	0	2	3	1	5	3	6	9
Cumulative diarrhea (n)	0	2	5	6	11	14	20	29
Cumulative diarrhea(%)	0	5.9	14.7	17.6	32.4	41.2	58.8	85.3

$n = 34$, Five subjects did not experience diarrhea in 45 g of ingestion.
■, diarrhea; ×, no diarrhea.

0.35 to 0.96 g/kg of body weight, and the average was 0.70 ± 0.16 g/kg of body weight. The average minimal dose level of lactitol was not significantly different from that of maltitol.

Estimation of maximal non-effective dose of maltitol and lactitol that did not induce transitory diarrhea based on the minimal dose that caused diarrhea

After the calculation of the minimal dose level of maltitol or lactitol that induced diarrhea versus body weight for each subject, the cumulative incidence (%) of diarrhea among all subjects (maltitol $n = 34$, lactitol $n = 22$) was calculated as shown in Figures 1 and 2. The point at which the linear regression intersects the x axis was considered to be the maximal non-effective dose at which the ingestion of the test substance does not induce transitory diarrhea. The maximal non-effective doses of maltitol and lactitol were estimated to be 0.34 and 0.40 g/kg of body weight, respectively. The 50% effective doses (ED_{50}) of maltitol and lactitol, at which transitory diarrhea was induced in 50% of the subjects, were 0.76 and 0.70 g/kg of body weight, respectively. These results are very close to the levels clarified by Oku (1996a, b, 2005).

Suppressive effects of the addition of PHGG on transitory diarrhea that induced by the ingestion of maltitol or lactitol

The summary of suppressive effect of PHGG on diarrhea induced by the ingestion of maltitol or lactitol is shown in Table 3. The suppressive effect was brought about by the addition of 5 g of PHGG to the minimal dose level of maltitol

Table 2 Minimal dose that induced transitory diarrhea by ingestion of lactitol in each female subject

Sample no.	*Dose levels of lactitol (g)*							
	10	*15*	*20*	*25*	*30*	*35*	*40*	*45*
1	×	×	■					
2	×	×	■					
3	×	×	■					
4	×	×	×	■				
5	×	×	×	×	■			
6	×	×	×	×	×	■		
7	×	×	×	×	×	■		
8	×	×	×	×	×	■		
9	×	×	×	×	×	■		
10	×	×	×	×	×	■		
11	×	×	×	×	×	■		
12	×	×	×	×	×	■		
13	×	×	×	×	×	■		
14	×	×	×	×	×	■		
15	×	×	×	×	×	■		
16	×	×	×	×	×	×	■	
17	×	×	×	×	×	×	■	
18	×	×	×	×	×	×	■	
19	×	×	×	×	×	×	■	
20	×	×	×	×	×	×	■	
21	×	×	×	×	×	×	×	■
22	×	×	×	×	×	×	×	■
Number of trial		22	22	19	18	17	7	2
Number of diarrhea		0	3	1	1	10	5	2
Cumulative diarrhea (*n*)		0	3	4	5	15	20	22
Cumulative diarrhea(%)		0	13.6	18.2	22.7	68.2	90.9	100

$n = 22$. ■, diarrhea; ×, no diarrhea.

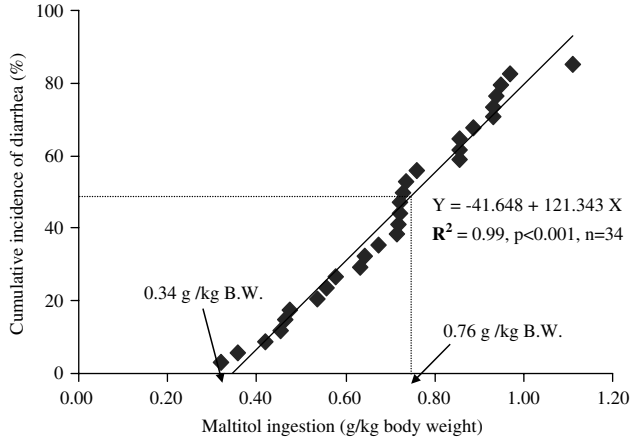

Figure 1 Relationship between the amounts of maltitol ingestion and cumulative incidence of diarrhea in normal subjects. The minimal dosage that caused transitory diarrhea and cumulative percentage of diarrhea were calculated. ED 50 of maltitol was 0.76 g/kg body weight (BW).

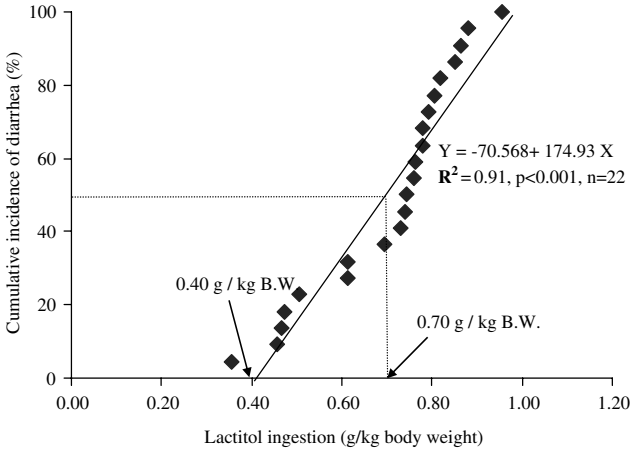

Figure 2 Relationship between the amounts of lactitol ingestion and cumulative incidence of diarrhea in normal subjects. The minimal dosage that caused transitory diarrhea and cumulative percentage of diarrhea were calculated. ED_{50} of laltitol was 0.70 g/kg body weight (BW).

that induced diarrhea was judged in terms of the ratio of suppression of diarrhea. It was 10 out of 28 subjects (35.7%) who suffered from diarrhea caused by the ingestion of maltitol alone, and seven out of 19 subjects (36.8%) who had ingested lactitol. More than 60% of the cases of diarrhea were not suppressed by the addition of 5 g of PHGG. When the added PHGG was increased to 10 g for subjects who experienced diarrhea owing to maltitol ingestion, 13 out of 18 subjects (72.2%) whose diarrhea persisted experienced an improvement in the diarrhea, and cumulatively 82.1% (23/28) of cases of diarrhea caused by maltitol ingestion disappeared.

Table 3 Suppressive effect of adding PHGG on diarrhea incidence by ingestion of maltitol or lactitol

	Maltitol	*Lactitol*
Incidence of diarrhea	85.3(29/34)	100(22/22)
Suppressed diarrhea		
Added PHGG 5g	35.7(10/28)	36.8(7/19)
Added PHGG 10g	72.2(13/18)	—
Cumulative suppressed diarrhea	82.1(23/28)	—

Abbreviation: PHGG, partially hydrolyzed guar gum.
The data were expressed as percentage that transitory diarrhea was suppressed and in the parenthesis were expressed number of subjects.

Association between the amount of dose level at which caused transitory diarrhea and suppression of diarrhea

The amount of maltitol or lactitol ingested in cases in which diarrhea was suppressed by the addition of PHGG varied from 15 to 45 g, and these ingested doses (g) versus kg of body weight also varied for both maltitol and lactitol. Figure 3 shows the association between the suppression of diarrhea and the minimal dose that caused diarrhea, expressed as g per kg of body weight. The suppressive effect on transitory diarrhea was independent of the minimal dose levels that induced diarrhea.

More than 1 week after the end of the experiment in which the suppressive effect of PHGG on transitory diarrhea was evaluated, eight subjects, who had been randomly selected, ingested equal amounts of maltitol, which had caused transitory diarrhea. All of them experienced diarrhea.

Severity of abdominal symptoms induced by the ingestion of maltitol, lactitol, and the mixture of PHGG and maltitol or lactitol

The observed abdominal symptoms were few and not severe. Therefore, there was no significant difference in the average severity score of abdominal symptoms among subjects who ingested maltitol, lactitol, and the mixture of PHGG and maltitol or lactitol.

Discussion

The suppressive effect of the addition of PHGG on transitory diarrhea induced by the ingestion of maltitol and lactitol was evaluated using healthy subjects. First, we estimated the minimal dose of maltitol or lactitol that induced hyperosmotic diarrhea. The minimal dose of maltitol varied from 0.32 to 1.11 g/kg of body weight, and that of lactitol varied from 0.35 to 0.96 g/kg of body weight. The average doses that caused diarrhea were not significantly different between maltitol and lactitol. Both sugar alcohols are disaccharides, and their structures are very similar. Although five out of 34 subjects were resistant to diarrhea even after the ingestion of 45 g of maltitol, all of the subjects experienced diarrhea after the ingestion of the same dose of lactitol. This finding seems

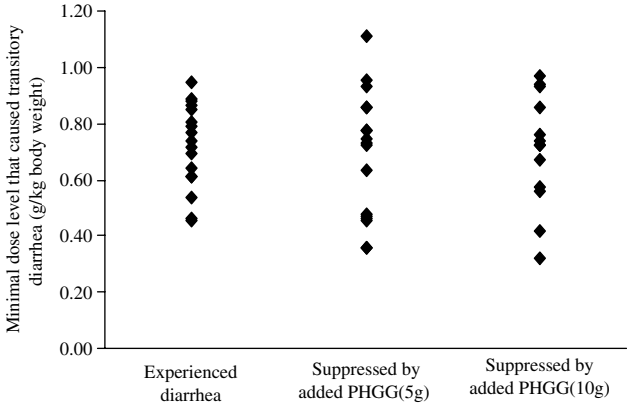

Figure 3 Relationship between the minimal dose that caused transitory diarrhea and suppressive effect of added PHGG on diarrhea. Minimal dose level at which induced diarrhea by the ingestion of maltitol and lactitol were expressed as g per kg of body weight. The minimal dose that caused diarrhea did not significantly effect on suppressing diarrhea.

to relate to the difference in digestibility between maltitol and lactitol. Maltitol is merely digested by intestinal maltase (Yoshizawa *et al*., 1975), but lactitol is not.

The estimated maximal non-effective doses of maltitol and lactitol were 0.34 and 0.40 g/kg of body weight, respectively. These doses are almost equal to those obtained in another experiment (Oku, 1996a, b, 2005), and thus support the earlier findings.

Thirty-five percent of the transitory diarrhea induced by the ingestion of maltitol alone was suppressed by the addition of 5 g of PHGG to the minimal dose of maltitol, and when the added PHGG was increased to 10 g, the ratio of suppressing diarrhea increased to 72.2%, and cumulatively the diarrhea was suppressed in more than 80% of subjects who had experienced diarrhea. In the case of lactitol, the ratio of suppressed diarrhea was very similar to that of maltitol. Interestingly, this suppression did not depend on the dose levels at which transitory diarrhea had been induced. When the ingestion dose of maltitol or lactitol is increased, the retention of water in the intestinal lumen tends to be isotonic. The flux including indigested maltitol or lactitol is much more excreted. In this study, the suppressive effect of PHGG on transitory diarrhea was observed notwithstanding the dispersion of minimal dose-induced diarrhea. This result seems to support the report that even in patients with cholera, the frequency and duration of diarrhea can be improved by adding dietary fiber to ORS (Ramakrishna *et al*., 2000). These results suggest that adding dietary fiber can suppress not only the diarrhea induced by hyperosmotic retention owing to the ingestion of non-digestible sugar substitutes, but also severe diarrhea encountered in the clinic.

PHGG and some kinds of dietary fibers improve the diarrhea that is observed in elderly patients using enteral nutrition as well as acute diarrhea in children. Nakao *et al*., (2002) and, Joanne and Norman (2003) suggest that one of

the mechanisms of the suppressive effect of dietary fiber on diarrhea relates to the recovery of mucosal atrophy or damage. And in the patients with irritable bowel syndrome the mechanism of that PHGG provides the improvement of symptoms, depends on the property of PHGG, which is water soluble and non-gelling (Giannini *et al*., 2006). However, the mechanism of that hyperosmotic transitory diarrhea that caused by the ingestion of non-digestible sugar substitutes, was suppressed by the addition of PHGG, has not been sufficiently explained. In the present study, we have tried to compare the osmotic pressure and viscosity among the solution of maltitol or lactitol alone and the mixture of PHGG and maltitol or lactitol, that were used in the experiments. However, we could not conclude that the suppressive effect on diarrhea depends on the change of osmotic pressure or viscosity. Hence, the factors involved in suppressing the diarrhea may be composite, and more investigation will be required. Furthermore, with regard to the application of the PHGG to the production of processed foods, the optimal dose of PHGG that should be added to sugar alcohol has to be estimated in the near future.

In conclusion, the transitory diarrhea caused by the ingestion of a sufficient amount of maltitol or lactitol was significantly suppressed by the addition of PHGG to the minimal dose that had caused diarrhea. The effect of PHGG was cumulatively observed in more than 80% of the subjects who experienced diarrhea that had induced by the ingestion of maltitol. Also, the ratio of suppression increased depending on the increase in the amount of PHGG added from 5 to 10 g. These results strongly demonstrate that the addition of dietary fiber with sugar alcohol in processed foods should improve the incidence of transitory diarrhea that would be caused by the sufficient amount of ingestion of non-digestible sugar alcohol.

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