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ORIGINAL ARTICLE

Therapeutic effect of lyophilized, Kefir-fermented milk on constipation among persons with mental and physical disabilities

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Abstract

Aim: Constipation is a serious problem for persons with mental and physical disabilities in Japan. However, prophylaxis is extremely difficult because the major causes of constipation in these individuals are related to their mental and physical disabilities. Constipation can be successfully treated with glycerol enemas (GEs) and other aperients. As constipation is a lifetime issue for these persons, dietary regimens to prevent constipation can be important.

Methods: This study evaluated the probiotic effects of kefir-fermented milk for preventing constipation in 42 persons with mental and physical disabilities. The participants were administered 2 g of lyophilized kefir with each meal for 12 weeks and their bowel movements, the administration of GE and other aperients, and stool shape were recorded.

Results: The intake of kefir significantly reduced constipation, compared with the baseline status. Some individuals showed complete relief of constipation, whereas others showed no effect.

Conclusion: Despite individual variations, consuming kefir daily could prevent constipation.

Key words: laxative agents, nursing of persons with mental and physical disabilities, probiotics, relief of constipation.

INTRODUCTION

The relief of constipation is a daily activity for nurses who work in nursing homes for mentally and physically disabled persons in Japan. Many disabled persons experience constipation that is directly caused by their disabilities (Booth, Roberts, & Laye, 2012; Mazlyn, Nagarajah, Fatimah, Norimah, & Goh, 2013b). For example, many are unable to exercise sufficiently to regulate their gastrointestinal (GI) systems, whereas others can experience GI system dysplasia and/or dysfunction (Chong, 2001). Most disabled persons in Beppu Developmental Medical Center have eating disabilities, requiring that their food be processed to a paste or a soft diet. Individuals with more severe eating disabilities might experience gastric or intestinal fistulae, enabling them to eat only soft diets, which could cause constipation. Constipation also can be a side-effect of medicines that are administered to treat epilepsy and other illnesses. The multiple causes of constipation in individuals with disabilities therefore can result in severe constipation.

Constipation can be relieved by administering aperients and/or glycerol enemas (GEs). However, the administration of these agents to individuals with disabilities can give rise to other problems from a nursing point of view. Administering a GE requires nurses to hold and carry each person individually and the nurses in Beppu Developmental Medical Center spend several hours daily administering GEs to all the patients. This task is physically demanding, often

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causing supporting nurses to injure their backs and knees (Fujimura, Yasuda, & Ohara, 1995; Yassi & Lockhart, 2013). In addition, the hospital's policy requires at least two nurses to safely administer GEs to each person, which is managerially inefficient. Furthermore, constipation is a lifelong issue for many of these patients. Once started on an aperient and/or GE, many individuals must continue this treatment for the rest of their life. However, habituation to laxative agents often necessitates further strengthening of the stimulus, such as an increased amount of medicine or the use of multiple combined laxatives (Day & Monsma, 1995). Depending on the cognitive characteristics of the disabled person, GE administration might be a sign that the bowel movements are affected by cognitive aspects, which could affect patients' lives (Niv, Grinberg, Dickman, Wasserberg, & Niv, 2013).

To overcome these problems, many efforts have been made to reduce or prevent constipation; for example, by dietary regimens, including dietary fiber and herbal teas. One of the most effective regimens to date has been the oral intake of kefir-fermented milk (Ino, Matsukawa, Yamaoka, Hanada, & Fujii, 2014). The merit of this scheme is in its reduction of the administration of laxatives and GEs. In the case of severely disabled persons, several nurses need to watch over all excretion assistance for safety management purposes, resulting in less efficient nursing work. The authors previously reported that the oral intake of kefir-fermented milk, part of the traditional diet in the northern Caucasus Mountains in the Republic of Georgia, reduced severe constipation in some disabled persons (Ino *et al.*). That study investigated the therapeutic "probiotic" effect of kefir in 11 individuals with disabilities who also had severe constipation. It was found that GE administration could be reduced in three participants owing to kefir's probiotic effect (Ino *et al.*). Similar findings also were observed among patients in Turkey (Turan, Dedeli, Bor, & Ilter, 2014). The current study investigated the effects of kefir on constipation among all the individuals who were hospitalized in Beppu Developmental Medical Center in order to determine whether including kefir in dietary regimens could reduce the administration of aperients to some individuals with constipation.

METHODS

Therapeutic effect of lyophilized, kefir-fermented milk

This double-blind study included individuals who were hospitalized at Beppu Developmental Medical Center, Beppu, Japan, with the cooperation of nutritionists. The study protocol was approved by the ethics committees of Oita University (approval no. 802), Yufu, Japan, and Beppu Developmental Medical Center (approval no. 27-11), Beppu, Japan. Informed consent was obtained from all the participants in the presence of their family members and/or legal guardians. The powdered milk and lyophilized, kefir-fermented milk were provided by Nippon Kefir Company, Ltd. (Fujisawa, Japan). To isolate the effects of kefir, powdered milk and lyophilized, kefir-fermented milk were prepared from the same milk. As we asked Nippon Kefir Company, Ltd. to package the samples of powdered milk and lyophilized, kefir-fermented milk individually in aluminum wrap, the researchers could not judge the contents by their appearance. The nutritionists in the hospital provided those materials with each meal; therefore, neither the feeding nurses nor the participants knew the meals' contents during the examination. An overview of the study protocol is shown in Figure 1a. Initially, the participants were monitored for 12 weeks and administration of the GEs and bisacodyl was recorded. During the placebo (control) period, all the participants were orally administered 2 g of powdered milk with each meal (three times daily; total: 6 g daily) for 12 weeks and the administration of GEs and aperients was recorded. The patients then were administered a normal diet for 4 weeks to remove any effects of the powdered milk. Then, during the study period, all the participants were orally administered 2 g of lyophilized, kefir-fermented milk with each meal (three times daily; total: 6 g daily) for 12 weeks and administration of the GEs and aperients was recorded. This was followed by another 4 week resting phase. Administration of the GEs and bisacodyl during the pretrial, powdered milk, and kefir phases were statistically analyzed by the paired *t*-test (Table 1). The number of individuals who received GEs and bisacodyl was compared among the pretrial, powdered milk, and kefir phases. Those results were analyzed with Fisher's exact test (Table 2). During each period, the shape of each stool was classified according to the Bristol scale (Heaton *et al.*, 1992; Lewis & Heaton, 1997). The size of each stool was visually classified. Stool volumes that were <1 egg (<50 cm^3), 1–2 eggs (50–100 cm^3), and >2 eggs (>100 cm^3) in size were classified as "small," "medium," and "large," respectively.

RESULTS

Effect of the oral intake of lyophilized kefir on the prevention of constipation

Forty-two individuals who were hospitalized in Beppu Developmental Medical Center were enrolled in this

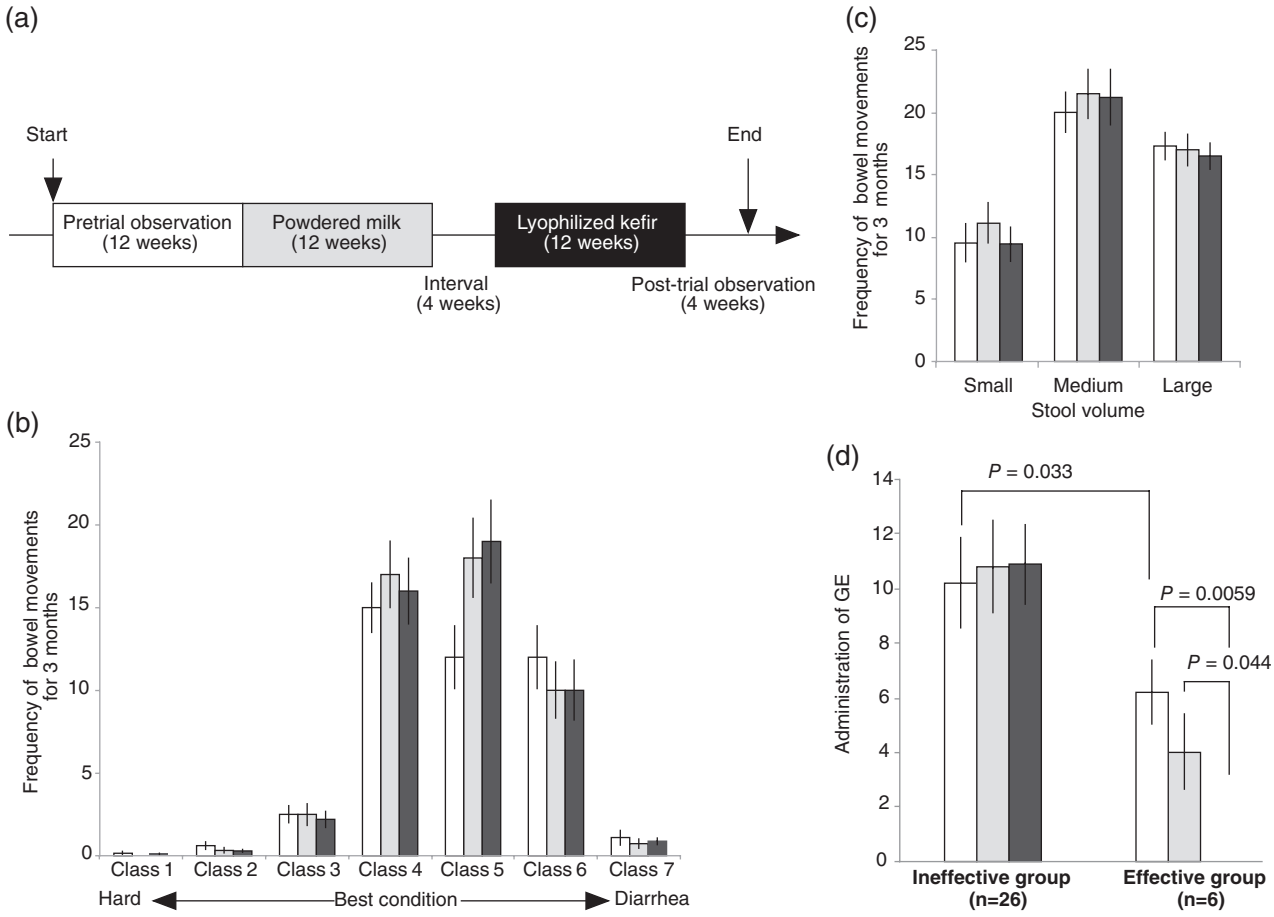

Figure 1 Probiotic effects of lyophilized kefir on constipation. (a) Trial design. The participants were evaluated for 12 weeks to establish a baseline and subsequently administered 2 g/meal of powdered milk for 12 weeks. Following a washout period of 4 weeks, the participants were administered 2 g/meal of lyophilized kefir for 12 weeks, followed by an additional 4 week monitoring period. The numbers of glycerol enemas (GEs) and aperient administrations were recorded during each treatment period. (b) Distribution of the stool shapes. Each stool was classified according to the Bristol scale and group distributions were compared. The error bars represent standard errors. SD, standard deviation. (□) Pretrial, Mean = 4.7, SD = 0.65, (▫) powdered milk, Mean = 4.7, SD = 0.61, and (■) Kerif, Mean = 4.7, SD = 0.60. (c) Distribution of the stool volume per bowel movement. Stool volumes: <1 egg (<50 cm^3), 1–2 eggs (50–100 cm^3), and >2 eggs (>100 cm^3) in size were classified as "small," "medium," and "large," respectively. The error bars represent standard errors. (□) Pretrial, (▫) powdered milk, and (■) Kerif. (d) Effects of lyophilized kefir on constipation in the effective and ineffective groups. The number of GEs was counted and the numbers of individuals who required GEs during each treatment period were compared. The individuals who did not require GE administration were classified as "effective." The individuals who required GE administration were classified as the "ineffective" group. The mean reductions in treatments were compared by the Student's *t*-test, with the error bars representing standard errors. (□) Pretrial, (▫) powdered milk, and (■) Kerif.

study. During the trial, only four individuals did not experience constipation, whereas 38 individuals required the administration of aperients. The number of administrations of GE or bisacodyl is represented in Table 1. The total consumption rate of laxative agents during the pretrial period was 7.7 times per 3 months; the corresponding rate during the powdered milk period (placebo control) was 8.1 times per 3 months. The consumption rates during the pretrial, placebo control, and kefir periods were statistically comparable (Table 1).

The number of participants who experienced a relief in constipation was increased by the kefir intake (Table 2). Eight individuals who previously had constipation did not require GEs or bisacodyl during the kefir period (column 8, Table 2). The difference between the Kefir and pretrial periods was statistically significant ($P = 0.014$). However, the difference between the kefir and powdered milk periods was not statistically significant ($P = 0.17$; column 9, Table 2), indicating that, for some individuals, even the intake of powdered milk was

Table 1 Effect of the oral intake of lyophilized, kefir-fermented milk

Participant identification number	Treatment	Number of administrations during the pretrial period	Number of administrations during the test period of powdered milk	Number of administrations during the test period of kefir
1	GE	29	28	25
2†	GE	1	0	0
3	Bisacodyl	5	11	6
4	GE	15	21	20
5	GE	16	12	12
6‡	Bisacodyl	7	5	0
7	GE	21	22	13
	Bisacodyl	0	1	0
8	GE	7	1	1
9§	None	0	0	0
10	GE	11	8	4
11	GE	3	9	9
12	Bisacodyl	2	6	11
13	GE	10	17	18
14¶	GE	3	0	3
15	GE	28	26	24
16	GE	16	13	19
17	GE	3	5	13
18‡	Bisacodyl	2	1	0
19‡	GE	4	3	0
20¶	GE	1	0	1
21	GE	8	11	18
22	GE	0	18	12
23	Bisacodyl	3	9	6
24	Bisacodyl	4	1	9
	GE	1	2	2
25	GE	16	14	18
26†	GE	4	0	0
27	GE	6	2	8
28	GE	13	13	13
29‡	GE	9	8	0
30‡	GE	5	6	0
31	GE	1	3	1
32	GE	4	4	9
33	GE	1	6	3
34	GE	19	21	15
35‡	GE	9	3	0
36	GE	11	2	3
37	GE	10	12	7
38§	None	0	0	0
39	GE	2	1	2
40§	None	0	0	0
41	Bisacodyl	15	15	9
42§	None	0	0	0
Mean	GE + Bisacodyl	7.7	8.1*	7.5**
SD	GE + Bisacodyl	7.5	7.8	7.5

* Comparison between the pretiral and powdered milk was not significantly analyzed with the paired *t*-test ($p = 0.32$).
** Comparison between the pretiral and kefir was not significant ($P = 0.37$) and the comparison between the powdered milk and kefir was not significant ($P = 0.35$). Those were analyzed with the paired *t*-test.
† Individuals who showed relief of constipation by the oral intake of both the powdered milk and kefir are represented in bold and italic letters.
‡ Individuals who showed relief of constipation by the oral intake of kefir are represented in bold letters.
§ Individuals without administration of either a glycerol enema (GE) or Bisacodyl are represented in gray letters.
¶ Individuals who showed relief of constipation by the oral intake of the powdered milk are represented in italic letters.
SD, standard deviation.

Table 2 Reduction in the number of aperient administrations by the oral intake of lyophilized kefir

Examination	Number of individuals who participated in this study	Number of individuals who did not suffer from constipation during the examination	Number of individuals without administration of either GE or Bisacodyl	Number of individuals to who GE was administered	Number of individuals to who Bisacodyl was administered	Number of individuals to who both GE and Bisacodyl was administered	Ratio of individuals to who neither GE nor Bisacodyl was administrated over the constipated participants	
							Comparison to the pretrial (P-value†)	Comparison to the powdered milk (P-value‡)
Pretrial	42	4	5	31	7	1	1/38 –	–
Powdered milk	42	4	8	28	8	2	4/38 (P = 0.18) OR = 0.23	–
Kefir	42	4	12	26	5	1	8/38 (P = 0.014) OR = 0.10	– (P = 0.17) OR = 0.44

†Ratios of the number of individuals without administration of the indicated medicine(s) per total number of participants were compared between the pretrial and the examined group (either powdered milk or kefir) with Fisher's exact test.
‡Ratios of the number of individuals without administration of the indicated medicine(s) per total number of constipated individuals were compared between the pretrial and the examined group (either powdered milk or kefir) with Fisher's exact test.
GE, glycerol enema; OR, odds ratio.

sufficient to prevent constipation. Next, the volume and shape of each stool were analyzed. The stool volumes (Fig. 1b) and shapes (as determined by the Bristol scale; Fig. 1c) were similar across the three 12 week periods, suggesting that the ingestion of kefir did not affect the stool volume or shape.

Taken together, these findings indicate that the oral intake of lyophilized kefir had therapeutic benefits only in some individuals with constipation.

DISCUSSION

Constipation is a serious problem in the care of persons with a disability in Japanese nursing homes. Efforts have been made to reduce or prevent constipation, such as dietary regimens, including dietary fiber and herbal teas. One of the most effective regimens to date has been the oral intake of kefir-fermented milk. A previous examination of kefir's probiotic effects in 11 individuals with severe constipation showed that three experienced a complete relief of constipation, whereas the other eight experienced no effect (Ino *et al.*, 2014). None of the three individuals who previously had experienced the complete relief of constipation participated in this study. Seven of the eight individuals who did not show a relief in constipation in the previous study joined this study and none of them (participant identification [ID]; 1, 4, 7, 13, 33, 34, and 39) showed any relief of constipation from the kefir intake. In order to better understand the therapeutic effects of kefir on constipation, lyophilized kefir was tested in a larger number of participants. Of the 42 participants who were enrolled, five showed normal bowel movements during the pretrial period. Three additional individuals showed a complete relief in constipation during the powdered milk (placebo control) period and seven additional individuals showed a relief in constipation during the kefir period (Table 1). With four individuals showing a complete relief in constipation during the oral intake of powdered milk, the difference between the placebo control and kefir was not statistically significant (P = 0.17). Some components of milk (e.g. lactose and other oligosaccharides called "lactuloses") might stimulate bowel movements by stimulating the intestinal flora. This effect of powdered milk must be sufficient for some individuals. Although the number of individuals who showed a complete relief in constipation increased, this result gives rise to the question of why GEs and/or bisacodyl administration was not reduced. To address this question, the individuals who received GEs during each

examination period were assessed, with those showing a complete relief of constipation during the kefir intake classified as the "kefir-effective" group (participant ID: 2, 19, 26, 29, 30, and 35) and those who received GEs were labeled as the "kefir-ineffective" group (participant ID: 1, 4, 5, 7, 8, 10, 11, 13, 14, 15, 16, 17, 20, 21, 22, 24, 25, 27, 28, 31, 32, 33, 34, 36, 37, and 39). The average consumption of laxative agents and GEs among the participants in the kefir-effective group during the pretrial period was 6.4 times per 3 months (Fig. 1d). The corresponding rate among the kefir-ineffective group during the pretrial period was 9.8 times per 3 months (Fig. 1d). The difference was statistically significant by the paired *t*-test ($P = 0.033$). This result indicated that those individuals for whom kefir intake is effective might be chronically, but not severely, constipated.

In addition, there were scientific limitations to this study. As the condition of constipation among the participants was quite complicated because the major causes of constipation in these individuals are related to their mental and physical disabilities, the chance to get a significant result could vary by the characteristics of the participants. For instance, the multiplicity/multiple comparison would cause a risk of getting a significant result. In order to obtain a more reliable result, the number of participants should be increased and should be compared, based on the status of constipation. The authors would continue further investigation regarding the probiotic effect of kefir on the prevention of constipation.

A previous study showed that the oral intake of kefir could improve bowel movements in patients with constipation in Turkey. In that study, the participants drank 500 mL of kefir-fermented milk daily for 12 weeks and the status of their bowel movements was recorded. The kefir intake significantly increased the stool frequency ($P < 0.001$), improved the stool consistency ($P = 0.014$), and decreased laxative consumption ($P = 0.031$). The effects of lyophilized, kefir-fermented milk were examined in this study because it was difficult for mentally and physically disabled individuals to drink 500 mL of kefir-fermented milk every day. As 6 g of lyophilized kefir was produced from 60 mL of kefir-fermented milk, the amount of kefir that was administered was much smaller. This might be one of the reasons that decreased laxative consumption was not observed.

The individuals in whom kefir was effective showed almost complete relief of constipation, whereas those in whom kefir was ineffective showed no effect. The same tendency was observed in the authors' previous study, which found that kefir had no effect on the bowel movements in unresponsive individuals (Ino *et al.*, 2014). Thus, a limitation of this strategy is that kefir's probiotic effect of preventing constipation shows individual variation.

Many physically and mentally disabled persons suffer from dysplasia and/or dysfunction of their GI systems and some have eating disabilities; therefore, they might need a soft diet or their food processed to a paste. Individuals with more severe eating disabilities could experience gastric or intestinal fistulae, enabling them to eat only soft diets, which might cause less active GI function, resulting in constipation. Strong chemical and physical stimuli, such as laxative agents and GEs, therefore might be needed to stimulate defecation.

Alternative methods therefore are needed to relieve constipation in individuals who are unresponsive to kefir. The authors would like to address this according to dietary regimens. The best scenario is to find dietary factors that can stimulate bowel movements. One possibility could be to change the probiotic species to other lactic acid bacteria (Aoki *et al.*, 2014; Mazlyn, Nagarajah, Fatimah, Norimah, & Goh, 2013a). As probiotic effects differ markedly among individuals, changing the probiotic species could reduce or prevent constipation in individuals who are unresponsive to kefir. Another possibility is to stimulate the *Bifidobacterium* family in the colon. As the *Bifidobacterium* family is a major constituent of mammalian colon flora, the stimulation of bowel movements by the *Bifidobacterium* family might be stronger than that by other lactic acid bacteria. However, the oral intake of *Bifidobacterium*-containing milk products is not sufficient because *Bifidobacteria* grow only in anaerobic conditions. Even the small amount of oxygen in the stomach and small intestine causes lethal damage to *Bifidobacteria*. Instead of probiotics, the oral intake of oligosaccharides (often called "prebiotics") stimulates *Bifidobacteria* in the mammalian colon because oligosaccharides are the preferential nutrition for *Bifidobacteria*. It is known that prebiotics have various health benefits, including the prevention of constipation (Slavin, 2013), and further health benefits can be expected from the combination of probiotics and prebiotics (Fernandez & Marette, 2017). In the future, the authors would like to investigate the effects of prebiotics, especially in individuals who are unresponsive to kefir.

In the current hospital, nine individuals, including three from the previous study (Ino *et al.*, 2014),

experienced the complete relief of constipation in response to the oral kefir intake. This reduces the physical labor of nurses who are required to administer GEs and increases their work efficiency, allowing them time to perform other tasks. In nurses' daily work, especially in the case of severely disabled persons, it is necessary for several nurses to watch over all excretion assistance for safety management purposes. This affects the efficiency of nursing work. More importantly, treatment, such as enemas, can cause a physical shock to patients and thus avoiding such treatments also can contribute to safety management in nursing. Most importantly, including kefir in the diet can greatly enhance the quality of life and health of disabled individuals who experience constipation. Not only can the mental distress of excretion assistance by others be alleviated, but also, the amount of medicines that are administered can be reduced. Although not all individuals with constipation were cured, adding kefir to the daily diet might at least benefit persons who show a positive effect of constipation prevention from oral kefir intake.

CONCLUSION

Some individuals experienced the complete relief of constipation in response to the oral intake of kefir, whereas some showed no effect. Therefore, it is suggested that screening for the probiotic effects of kefir in order to identify individuals who show a complete relief of constipation in response to oral kefir intake is important as adding kefir to these individuals' daily diet could benefit them by preventing constipation in these patients.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

R. M., M. M., A. M., M. H., K. H., and C. F. designed this study; R. M., M. M., A. M., and C. F. carried out the examination; H. A., Y. Y., and K. H. analyzed the data; and K. H. and C. F. wrote the manuscript.

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