

## **Banana Flakes Control Diarrhea in Enterally Fed Patients**

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**ABSTRACT:** Diarrhea occurs frequently in the critically ill tube-fed population and may result from a multitude of causes. Despite the availability of antidiarrheal medication, diarrhea associated with enteral feedings remain a problem for clinicians and for the patients affected by it. We tested the hypothesis that administration of banana flakes would control diarrhea in critically ill patients receiving enteral feedings. Thirty-one patients with diarrhea and receiving enteral feedings were randomized to receive either banana flakes or medical treatment for diarrhea. Medical treatments included the use of pharmacological agents according to the discretion of the patient's physician or reducing feeding rates. Both banana flakes and the medical treatment reduced the severity of diarrhea in critically ill tube-fed patients. Over the course of treatment, mean diarrhea scores were  $21.64 \pm 7.81$  for the banana flake group and  $25.41 \pm 9.76$  for the medical group. These differences were not statistically significant. Both groups achieved similar nutrition support. The banana flake group had less diarrhea clinically, with 57% of the subjects diarrhea free on their last study day as opposed to 24% of the medically treated subjects. This occurred despite a threefold increase in the number of patients testing positive for *Clostridium difficile* toxin in the banana flake group. We conclude that banana flakes can be used as a safe, cost effective treatment for diarrhea in critically ill tube-fed patients. Banana flakes can be given concurrently with a workup for *C. difficile* colitis, thereby expediting treatment of diarrhea.

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Enteral nutrition support is the method of choice in feeding patients who cannot eat but have a functioning gastrointestinal tract. Its use has been shown to promote nitrogen retention, restore cell-mediated immunity, and help in wound healing. Deitch has further shown enteral feedings to be beneficial in the prevention of bacterial translocation. Enteral feeding is thought to be more physiological, safer, and less expensive than parenteral nutrition.

Despite these advantages, diarrhea is a common complaint and often discourages the use of enteral feedings. The reported incidence of diarrhea in critically ill patients receiving tube feedings ranges from 32% to 68%. An early report by Burkitt et al suggested that fiber may assist in controlling diarrhea. This led researchers to include fiber in enteral formulas. Many different types of fiber were investigated, including soy polysaccharide, ispagula husk (psyllium), and pectin. Of all these fibers, pectin seemed the most promising in decreasing the amount of liquid stool and increasing fecal mass. Pectin is fermented by colonic bacteria and yields short-chain fatty acids (SCFAs). These SCFAs have been shown to be preferentially absorbed by the colonocyte and exert a trophic effect on colonic epithelial mucosa; SCFAs also augment water resorption by increasing sodium transport and lower bowel pH to inhibit *C. difficile*.

Various fruits, especially bananas, contain pectin, in fact, two fruits, banana and apple, have been part of the banana, rice, applesauce, and tea(Brat) diet used to treat diarrhea in children. Banana flakes (Kanana Banana; Corpak Co. , Wheeling, IL) have been marketed for use in patients receiving enteral feedings. However, a controlled study documenting the positive effect of banana flakes on diarrhea in enteral feedings has not been performed. The purpose of this study was to evaluate the effectiveness of banana flakes in reducing the severity of diarrhea in critically ill patients receiving enteral feedings.

## MATERIALS AND METHODS

**Subjects.** Thirty-one subjects, critically ill tube-fed patients from the Pennsylvania Hospital intensive care and step down units, were entered into the study following informed consent. Exclusion criteria were the following: (1) age <18 or >90 years; (2) administration of lactulose or sodium polystyrene sulfonate within 72 hours prior to or during the study period; (3) need for tightly restricted potassium intake; (4) inflammatory bowel disease; (5) short bowel syndrome; (6) documented protein or carbohydrate malabsorption; and (7) enteral feeding duration of <3 days.

Patients who developed diarrhea during enteral feeding received appropriate medical workup and analysis of stool for *C. difficile* toxin. When appropriate, patients in both groups were given metronidazole or enteral vancomycin to treat known or suspected *C. difficile* diarrhea.

All patients received full strength, lactose-free, fiber-free feeding formulas that ranged in osmolality from 300 to 690 mOsm/kg. Formulas were administered via pump as continuous drip, starting at 20 to 40 mL/h and advancing as tolerated with a goal of 30 to 35 kcal/kg body weight. The biochemical profile with magnesium was checked weekly, and electrolytes were monitored at least three times weekly according to Pennsylvania Hospital protocol. Treatment continued until diarrhea was resolved or until patients were transferred from the study units. Any patient with <3 full days of data was dropped from the study.

Diarrhea was defined using the scale developed by Hart and Dobb. Any score >12 over a 24-hour period represented clinically significant diarrhea.

**Treatment.** Patients with diarrhea were randomized by birthdate to receive either routine medical treatment or banana flakes for diarrhea. By the end of the study period, 17 patients had completed medical management (groupA), and 14 patients had received banana flake treatment (groupB). Patients in group A ranged in age from 51 to 87 years. One patient in this group was fed via jejunostomy tube, and the remainder by nasoenteric tubes.

Patients in group A were treated for diarrhea with routine methods that included antidiarrheal medications and adjustment of tube feeding rate according to the discretion of the primary physician. Medications included tincture of opium, diphenoxylate hydrochloride(Lomotil; GD Searle & Co, Chicago, IL), loperamide(Immodium; Janssen Pharmaceutica Inc., Titusville, NJ), and kaolin(Kaopectate; Upjohn Co, Kalamazoo, MI). Patients in group B were treated with banana flakes. Treatment consisted of giving 1 to 2 tablespoons(Tbl) of banana flakes every 8 hours and increasing to 3 Tbl every 8 hours according to the clinical judgement of the dietitian or physician. Dried banana flakes contain 6.25 g carbohydrate/Tbl, 0.5 g fiber, and negligible protein or fat.

The potassium content is 2.36 mEq/Tbl. Each tablespoon of banana flakes was mixed with 60 mL of water and administered via the feeding tube in a bolus fashion.

*Data.* All data were analyzed with SPSS-X Release 4.0. Parametric statistics were used to analyze group differences for all 7 days. Data for both groups tended to be highly positively skewed, a function of isolated high Hart scores. Thus, raw Hart scores were transformed into natural logarithms to normalize the data. To discount the possibility that the nonnormal nature of the data might create spurious results, a Mann-Whitney U test was used for analysis of the data. Tests were used to compare percentages of patients without diarrhea (Hart scores  $\leq 12$ ). Fisher's exact test was used to compare numbers of patients testing positive for *C. difficile* toxin.

## RESULTS

*Diarrhea.* Results showed that both routine medical treatments and banana flakes reduced the severity of diarrhea in critically ill tube-fed patients. Average duration of treatment for diarrhea was  $5.24 \pm 1.52$  days for group A (medical treatments) and  $4.93 \pm 1.00$  days for group B (banana flakes). Patients in group B received slightly more calories from enteral formula daily with an average of  $1387 \pm 650$  kcal/d (69% of nutritional goal) versus  $1160 \pm 642$  kcal/d (64% of goal) for those in group A. This difference was not significant. Over the course of treatment, mean diarrhea scores were  $25.41 \pm 9.76$  for group A and  $21.64 \pm 7.16$  for group B (see Fig 1 and Table 2). These differences were not statistically significant.

Although diarrhea scores were similar in both groups, group B had less diarrhea clinically, ie, 57% of the subjects were free of diarrhea on their last day of study compared with 24% of the patients in group A.

*C. difficile Colitis.* Toxin assays for *C. Difficile* were sent for all patients. Of patients in group B, 36% were found to have stool positive for *C. difficile* toxin compared with 12% of the patients in the group A.

*Cost of Treatment.* Table 4 compares Pennsylvania Hospital costs in 1995 for selected antidiarrheals in their recommended daily dose. The dose of banana flakes most commonly found to be effective in our practice was 2 Tbl. three times a day. When used in this dose as a treatment for diarrhea rather than a routine addition to tube feedings, banana flakes were found to be less expensive than most other commonly used antidiarrheals.

## DISCUSSION

This study showed the positive effects of banana flakes on diarrhea in enterally fed patients. Pectin and other soluble fibers are presumed to be the active antidiarrheal component of banana flakes. One previous report supported the conclusion that pectin reduces diarrhea in tube-fed subjects. In 1988, Zimmaro et al showed that isotonic tube feedings supplemented with pectin significantly reduced the incidence of liquid stool and promoted normalization of colonic fluid composition in healthy subjects.

Many factors contribute to diarrhea during enteral feeding. These commonly include the intraluminal presence of nonabsorbed substances exerting an osmotic effect, such as liquid medications containing sorbitol or magnesium, *C. difficile* colitis, intestinal motility disorders, malabsorptive states, hypoalbuminemic states, and bile salt malabsorption. The mechanism by which fiber, pectin in particular, reduces diarrhea is not completely understood.

It has been shown that patients receiving fiber-free enteral formulas have colonic mucosal atrophy and altered bacterial flora. Bacteria can degrade the mucin glycoprotein protective layer of gut mucosa when dietary fiber is lacking. This alteration of the mucous barrier may adversely affect colonic function and cause diarrhea.

Dietary fibers are fermented by colonic bacteria to SCFAs. The absorption of SCFAs decreases luminal osmolality and facilitates the absorption of water. Kripke et al have shown that intracolonic infusion of SCFAs led to a greater mucosal weight, protein, and DNA content of cecetomized rats fed a fiber-free diet. SCFAs may also exert a trophic effect on colonic mass by increasing colonic blood flow and motility, and by stimulating the release of trophic hormones such as enteroglucagon. Rombeau and Kripke have shown that SCFAs promote sodium and water resorption and stimulate pancreatic enzyme secretion.

It is not known whether pectin or other components of banana flakes were responsible for the antidiarrheal effect seen in this study. The dose of pectin from banana flakes used in our study was significantly lower than that used in prior studies. Banana flakes have 0.2 g pectin/Tbl of product. Patients therefore, received from 0.6 to 2 g pectin/24h. In past studies, a positive effect was noted with pectin when used at a significantly higher dosage (14.5 to 31.5 g). No studies have tested the effects of pectin at lower doses, aside from a single case report that showed that a blended formula containing <1% pectin reduced diarrhea in a patient with AIDS. One explanation for the beneficial effects of low-dose pectin in the form of banana flakes may be the high percentage of fermentable fibers other than pectin in banana that our study did not account for. According to the manufacturer, 78% of the fiber in banana flakes is in the form of soluble fiber.

This study appeared to show a beneficial effect on the treatment of diarrhea caused by *C. difficile* toxin. Of the patients in group B, 36% tested positive for *C. difficile* toxin, whereas only 12% of group A tested positive. Because of the small sample size, this difference was not shown to be statistically significant. Despite the fact that there was a threefold increase in patients testing positive for *C. difficile* toxin in group B, both groups had similar reductions in their diarrhea. Possible explanations for fiber's positive effect on infection with *C. difficile* include improvement of water absorption, alteration of colonic microflora and pH, and an increase in the expulsion of pathogens and toxins by a decrease in intestinal transit time.

This study was limited by the fact that it was based on clinical practice. Although we compared the effects did not distinguish between those treatments. In fact, most patients treated medically had combination antidiarrheal medications. Both groups received antibiotic treatment if *C. difficile* was suspected.

We found no statistically significant difference in the resolution of diarrhea or duration of treatment between treatment modalities. Both groups achieved similar levels of nutritional intake. This suggests that banana flakes are at least as effective as conventional treatments for diarrhea in enterally fed patients.

Because banana flakes are not known to decrease gastrointestinal motility, they are not specifically contraindicated during *C. difficile* diarrhea. Unlike antidiarrheal medications that do affect gastrointestinal motility, banana flakes may be started concurrently with a workup for *C. difficile*, thereby expediting treatment of diarrhea.

No side effects of banana flakes, including hyperkalemia, were noted during this study. The banana flakes provided only 14mEq potassium/d at a dose of presumed diarrheal potassium losses. When feeding increased incidence of occluded tubes. One potential limitation of using banana flakes is the volume of water necessary for administration, which is generally at least 360mL/d.

This study was also limited by a small sample survey. A larger study needs to be done to confirm these results and establish an optimal fiber source and dose for treatment of diarrhea in enterally fed patients.

In conclusion, banana flakes were found to be a cost effective treatment for diarrhea in enterally fed patients when compared with routine medical care.