

Potential of Synbiotic Yogurt with Prebiotics FOS and GOS from Banana and Probiotic Bacteria *Bifidobacterium Lactis* and *Lactobacillus Rhamnosus GG* as Prevention and Treatment of Acute Diarrhea in Children: A Literature Review

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Abstract

Diarrhea, or as Indonesians usually refer it as *mencret*, is defined as defecation more than three times per day along with a change in the consistency of the stool to liquid with or without mucus and blood. There exist various causes of diarrhea in Indonesia, both viral and bacterial. The main pathogen causing diarrhea in our country is Rotavirus (40-60%), followed by *Escherichia coli* bacteria (20-30%), and the rest is dominated by other microorganisms (10-20%). Based upon previous research, probiotics and prebiotics have been shown to have potential in preventing and treating diarrhea caused by various pathogenic microorganisms. Probiotics are supplemented live bacteria that have a beneficial response on the health of human digestive organs by improving the balance of normal gut flora, whereas prebiotics are substrates that are not to be digested by the intestines, but instead bring benefits to the health of human digestive system that selectively stimulate the growth and activity of good bacteria in the gut. Bananas apparently contain a source of prebiotics that we are rarely aware of. The probiotic content of inulin and fructooligosaccharides (FOS) in bananas plays an important role in nourishing and stimulating the growth of probiotic bacteria. Accordingly, they are also considered “colonic foods” for the natural flora of the intestine. Fermented milk products, such as yogurt, have the benefit of inhibiting gastrointestinal infections. Aside from the aforementioned benefits, yogurt also contains anticancer effects, lowers blood cholesterol levels, and stimulates the immune system. The beverage innovation called “YOPI EN NUNO”, which of this is a synbiotic banana yogurt with the addition of *B. Lactis* and *L. rhamnosus GG* bacterial starters has various advantageous potentials to prevent and treat acute diarrhea in children.

Keywords: Diarrhea, Children, Banana, Yogurt

1. INTRODUCTION

The turn of the new year 2020 in Indonesia was preceded by floods in several areas, including but not limited to Jakarta. Referring to the report from m.cnnindonesia.com page, on February 8th 2020, BNPB or the National Disaster Management Agency said that the floods had submerged in 23 sub-districts within the city. Floods not only take wealth and property away, but also bring diseases to the affected communities. One of the diseases that oftentimes arise due to poor environment condition and sanitation is diarrhea. Diarrhea has claimed many lives, namely 11% of children under the age of 5 in all parts of the world[1]. In Indonesia itself, diarrhea is the third leading cause of death for the aforementioned population of children after neonatal deaths and pneumonia with the highest prevalence in underdeveloped, frontier, and outermost areas[2]. The number of gastrointestinal diseases continues to fluctuate, hence the need of being handled seriously by all parties of

society, considering that children are the most valuable asset compared to gold for the future of the nation. Starting from their dreams, nation's prosperity will be guided graciously by them.

Diarrhea, or as Indonesians usually refer it as *mencret*, is defined as defecation more than three times per day along with a change in the consistency of the stool to liquid with or without mucus and blood[3]. There exist various causes of diarrhea in Indonesia, both viral and bacterial. The main pathogen causing diarrhea in our country is Rotavirus (40-60%), followed by *Escherichia coli* bacteria (20-30%), and the rest is dominated by other microorganisms (10-20%)[4]. The type of diarrhea to be aware of, namely acute diarrhea, is the most common type of diarrhea suffered by children under 5 years of age.

Regrettably, our society still underestimates diarrhea as a self-limiting condition. They will seek treatment to a health facility only if the diarrhea worsens. Deaths from diarrhea are as a matter of fact often caused by improper health management[5]. When left untreated, diarrhea will lead to more dangerous complication of dehydration[3,6]. Dehydration is then the precursor to death in 50-60% of the child population due to complications of diarrhea[6]. By then would it be too late for an intensive medication. Therefore, new breakthroughs are needed currently to prevent and treat acute diarrhea in children.

Based upon previous research, probiotics and prebiotics have been shown to have potential in preventing and treating diarrhea caused by various pathogenic microorganisms[7-10]. Probiotics are supplemented live bacteria that have a beneficial response on the health of human digestive organs by improving the balance of normal gut flora[11]. *Bifidobacterium* and *Lactobacillus* are types of probiotics that are usually used to treat acute diarrhea[11-13]. Prebiotics are substrates that are not to be digested by the intestines, but instead bring benefits to the health of human digestive system that selectively stimulate the growth and activity of good bacteria in the gut. Broadly speaking, prebiotics help probiotics in the gut by providing substrates that humans cannot digest in order for the bacteria to digest, hence the increase of their amount and indirectly fights infection with intestinal pathogenic microorganisms[7]. The combination of both is also known as synbiotics and yogurt is one of the beverages that rely on the 'magic' of synbiotics.

Bananas apparently contain a source of prebiotics that we are rarely aware of. The probiotic content of inulin and fructooligosaccharides (FOS) in bananas plays an important role in nourishing and stimulating the growth of probiotic bacteria. Accordingly, they are also considered "colonic foods" for the natural flora of the intestine[7]. Banana is one of the fruits that is always found anywhere and is harvested continuously. Even in the year 2018, this heavenly fruit became the second largest export commodity after mangosteen, which is around 30.38 thousand tons or equal to USD 14,610,426[14]. Whether we realize it or not, bananas are Indonesia's produce that, if properly utilized and developed, might become the latest innovation in the field of health. However, both the government and the community unfortunately are not aware of its potential to prevent and treat acute diarrhea in children. This potential was taken over by Japan, who imports bananas from Indonesia in the form of flour.

Fermented dairy products, namely yogurt, are no longer news regarding their benefits in inhibiting gastrointestinal infections. In addition, yogurt also has anticancer effect, lowers blood cholesterol levels, and stimulates the immune system[15]. In the manufacturing process itself, *Lactobacillus bulgaricus* and *Streptococcus thermophilus* bacteria are used as the initial starter of lactic acid bacteria (LAB) in yogurt on the market. However, the probiotic properties of these two bacteria are less effective in terms of protecting the intestines from the invasion of pathogens that cause diarrhea. Therefore, it is necessary to add other bacterial isolates that have better probiotic properties in order to improve the functionality of the yogurt product produced[15].

Looking at this gap, the authors initiated adding two other beneficial bacterial isolates as additional yoghurt starters, namely *Bifidobacterium Lactis* and *Lactobacillus rhamnosus GG*. It is in the light of the fact that the combination of the two has the strongest beneficial effect in preventing and treating diarrhea, as well as the addition of banana, containing prebiotics inulin and FOS, in which will increase the effectiveness of probiotics in inhibiting the pathogenesis of acute diarrhea[16]. Banana was chosen due to its sweet taste and fragrant aroma, which will greatly increase the added value of yogurt products. In addition, bananas are accessible, empower and maximize this local potential in the field of health. For this reason, the authors have an innovation that is poured in the form of a scientific essay with the title of "YOPI EN NUNO: Synbiotic Banana Yogurt with the Addition of *Bifidobacterium Lactis* and *Lactobacillus rhamnosus GG* Starter Bacteria as a New

Innovation in Preventing and Treating Acute Diarrhea in Children”. This essay is for the sole purpose of determining the potential of synbiotic yogurt “YOPI EN NUNO” in preventing and treating acute diarrhea in children. Another aim of this product is to maximize the abundant natural resources in Indonesia as a new breakthrough for the prevention and management of acute diarrhea. Other than the aforementioned advantages, the standard of living of the community and the utilization of local bananas will be improved indirectly if the commercialization of this synbiotic yogurt is to be realized.

2. CONTENTS

2.1 Potentials of *Bifidobacterium Lactis* in Preventing and Treating Acute Diarrhea

Research conducted by Neveen Helmy and colleagues proved the ‘magic’ of *B. Lactis* in 50 infants aged 1 to 23 months who suffered from acute diarrhea by comparing formula feeding without additional supplementation with formula feeding with supplementation of *B. Lactis* 14.5 x 10⁶ CFU/100 mL. Within one week, positive results were obtained in the *B.Lactis*-supplemented group, which experienced a significant reduction in the frequency and duration diarrhea, along with a reduction in hospital stays compared to the group that was not supplemented with the said probiotics. Ultimately, the researchers concluded that administering these probiotics at levels ranging from 108 to 10¹⁰ CFU/day had the potential to increase colonization of good bacteria in the infant’s digestive system[16].

This research is also supported by the publication of Marsyamdat Mirfasi and his colleagues who showed that the administration of probiotic *B. Lactis* with a concentration of 500 µg/mL to the invasion of *Shigella dysenteriae* bacteria is able to reduce the expression of *IpaC* gene up to 37%[17]. The said fact has dismissed the endless fears of dysentery in the community. It is due to the fact that 15% of under-five deaths from diarrhea in Indonesia are associated with bloody diarrhea or dysentery[18]. The mechanisms, by which *B. Lactis* inhibits *S. dysenteriae* pathogens, include influencing plasmid plasmid antigen invasion, antimicrobial competition at intestinal attachment sites, increased cell membrane permeability by the production of metabolites, such as quenchers from the quorum-sensing system, and pathogen-inhibiting substances, such as *bacteriocin*[17].

Not only effective in inhibiting the invasion of pathogenic bacteria, the research of Ozlem Erdogan and his colleagues proved the ‘specialty’ of *B. Lactis* in treating acute diarrhea caused by *Rotavirus* infection. The study was conducted on 75 children aged between 5 months and 5 years, who were diagnosed with *Rotavirus gastroenteritis*. The researchers thereupon divided the subjects into 3 groups that were given oral rehydration and rapid refeeding therapy with the addition of different probiotics: the first group used *S. boulardii*, the second used *B. Lactis* bacteria, and the last was not given any special treatment (control). The results proved that the second group, who was given probiotic *B. Lactis*, had the most potent reduction in the duration of diarrhea due to *Rotavirus* compared to the other groups (Table 1)[19].

Table 1. Duration of Diarrhea (in days) in All Groups [19].

Groups	n	The mean duration time of diarrhea (day)	P
1*	25	6.6 + 1.7	
2**	25	4.1 + 1.3	F = 25.94
3***	25	7.0 + 1.6	P < 0.001
Total	75	5.9 + 2	

N: total of subjects, F: post hoc Tukey’s HSD 2 versus 3 (P<0.05).

*Group 1: treated with oral rehydration and rapid feeding with normal *S. boulardii* diet.

**Group 2: treated with oral rehydration and rapid feeding with normal *B. Lactis* diet.

***Group 3: treated with oral rehydration and rapid feeding with normal diet (control).

2.2 Potential of *Lactobacillus rhamnosus* GG in Preventing and Treating Acute Diarrhea

Aside from the bacteria from the Bifidobacterium group, *Lactobacillus* bacteria also have 'their own way' of suppressing the growth of intestinal pathogenic microorganisms. One of the experimental studies conducted by Zhen Zhang and his colleagues to observe changes in secretory immunoglobulin A (sIgA), interferon gamma (IFN- γ), tumor necrosis factor (TNF- α), and immunoglobulin A serum (IgA) levels using enzyme-linked immunosorbent assay (ELISA) in *Rotavirus*-induced mouse models that cause diarrhea in humans using *Lactobacillus rhamnosus* GG (LGG). The aforesaid researchers divided the subjects into 8 different treatment groups, including 1 control group, 1 *Rotavirus*-induced group, 3 groups who were given LGG pretherapy with 3 different doses, and the 3 other groups were treated using LGG against *Rotavirus* activity with different doses. As a result, the group given LGG probiotic pretherapy at a dose of 2×10^9 CFU had the greatest effect in suppressing *Rotavirus* pathogens. The levels of sIgA, IgA, and IFN- γ showed the highest values in this group, which function to protect the intestinal mucosa and enhance the immune response to *Rotavirus*. Au contraire, TNF- α was found to be the lowest, indicating a low-grade inflammatory state in the circulation (Table 2)[20].

Researchers from the University of Tasmania, Australia, also support the application of yogurt containing LGG as a therapy for diarrhea caused by *Rotavirus*. Researchers then compared immunoglobulin serum levels in subjects treated with LGG with those treated with placebo control alone. After 10 days, IgA and IgG serum samples were taken and analyzed using ELISA. To all appearances, IgG serum concentration increased from 456 EU to 2215 EU and similarly, IgA serum increased from 156 EU to 211 EU in *Rotavirus*-induced diarrhea[21]. The results of this study strongly support previous facts regarding the potential of *Lactobacillus rhamnosus* GG in suppressing the growth of *Rotavirus* in the gastrointestinal by providing a positive immunomodulatory effect and reducing the incidence of reinfection. To such a degree, LGG is suitable for prevention of acute diarrhea caused by *Rotavirus*.

Although many studies have proven the potential of *L. rhamnosus* GG in suppressing pathogenic viruses that cause gastrointestinal diseases, other facts mention that LGG is also prove to prevent and treat acute diarrhea cause by bacteria, namely *Escherichia coli*. Research conducted by Lu Zhang and colleagues proved that there was a significant increase in TNF- α and sIgA concentrations in the group given LGG culture. Short-term administration of LGG before *E. coli* infection in fact helped attenuate the *E. coli* K88-induced increase in IL-6 serum[22]. The mentioned fact proved that LGG is not only effective in treating diarrhea caused by *E. coli*, but also in preventing it as early as possible by modulating gut microflora, increasing antibodies, and regulating systemic inflammatory cytokine production. Based on the aforementioned description, LGG is potentially an appropriate candidate for combination with *B. lactis* when considering the potential both.

2.3 Potential of Inulin and Fructooligosaccharides (FOS) in Preventing and Treating Acute Diarrhea

Beyond its aroma and its deliciousness, the prebiotic content of inulin and FOS in bananas adds to the benefits and yogurt products by maintaining the natural flora of the gut and inhibiting harmful pathogens[7-9, 23]. In line with the research conducted by Dewi Desnilasari and Ni Putu Ayu Lestari, the formulation of synbiotic drinks with the addition of banana from Ambon, or as one calls it *Pisang Ambon* (*Musa paradisiacavar-sapientum*), and 2% unlin supports the potential of good bacteria *L. casei* in suppressing *Coliform* and *Salmonella* pathogens[23]. Other reviews also support the fact that both prebiotic substances can inhibit the growth of pathogens *E. coli*, *Campylobacter jejuni*, *Salmonella enteritidis*, and *Clostridium pefringens* by

increasing the growth rates of the *Bifidobacterium* bacteria[24]. *Bifidobacterium* and FOS are the perfect blend for the growth of gut microflora[10].

Not only limited to the stated studies, Fiqhi and colleagues' publication shows the hidden potential of synbiotic banana yogurt in mice suffering from metabolic syndrome. Glucose and insulin levels were analyzed before and after the synbiotic banana yogurt. The results were highly unanticipated, because rats that received synbiotic banana yogurt intake at a dose of 0.018 mL/g rat BW/day for 2 weeks experienced a decrease in blood glucose of up to 37.31%[8]. This evidence dismisses the assumption in the community that people with diabetes mellitus (DM) are not encouraged to consume excessive sweet foods or beverages, such as yogurt. As a matter of fact, synbiotic banana yogurt actually has the property of lowering the body's blood glucose levels. Not to mention that yogurt's lactic acid bacteria (LAB) has the capacity to lower blood cholesterol levels, reduce the frequency of diarrhea, stimulate the immune system, can act as a substitute for antibiotics, and is safe for children who suffer from milk lactose intolerance[25].

Bananas are well known for their potassium (K) and zinc (Zn) content. Potassium plays an important role in rehydrating the body by maintaining electrolyte balance in the digestive system, thus the body will avoid the danger of severe dehydration due to acute diarrhea[26]. In addition, zinc is one of the therapies introduced by the Gastro-Hepatology Coordination Unit of the Indonesian Pediatric Association regarding diarrhea management. Zinc therapy plays an active role in the process of revitalizing damage to the intestinal mucosa caused by diarrhea, and has been proven safe and effective, including for the long run[26-27]. Researchers from Faculty of Medicine of Universitas Diponegoro, Indonesia, have proven the effect of zinc supplementation and probiotics on the incidence of recurrent diarrhea. The results of the study found that the diarrhea group given standard therapy, zinc, and probiotics, had a slightly shorter frequency and duration of diarrhea than the group who is given only standard therapy[27].

2.4 Implementation of Synbiotic Banana Yogurt Products in Overcoming the Problem of Acute Diarrhea in Children in Indonesia

The implementation of the "YOPI EN NUNO" product if examined using a futuristic point of view will be a new breakthrough in terms of prevention and treatment of acute diarrhea in children, especially in underdeveloped, frontier, and outermost areas. Bananas are the second largest crop after mangoes, 50% of which should be allocated for the benefit of Indonesian people, namely in the field of health. On the assumption that the synbiotic banana yogurt is to be commercialized, the product can be distributed to all regions in Indonesia, especially those with high mortality rates due to acute diarrhea. Primary health care centers in Indonesia such as *posyandu*, which is a community based vehicle to improve child survival and development, and *puskesmas*, a government-mandated community health clinics, should have a program to distribute synbiotic yogurt products regularly to the community. The government should also strive to make the product affordable for all elements of society with better benefits than typical yogurt in markets. If one looks further, the local resource of bananas processed into products that have more selling value can be used as an export commodity for the country with greater profits than bananas alone. Possible targets are poor and developing countries with high diarrhea mortality rates. Indirectly, the stand of living of our society in terms of economy and health will increase if the commercialization is to be realized.

3. CONCLUSION

The "YOPI EN NUNO" innovation, a synbiotic banana yogurt with the addition of *B. Lactis* and *L. rhamnosus* GG bacterial starters, can be concluded to have various good potentials regarding preventing and treating acute diarrhea in children. The mechanisms of synbiotic banana yogurt in maintaining a healthy digestive system include, (1) stimulating colonization of good gut bacteria, (2) inhibiting pathogen attachment sites, (3) inhibiting the growth of pathogenic microorganisms, (4) protecting and revitalizing the intestinal mucosa, and (5) increasing antibodies. Into the bargain, these products will indirectly improve people's lives in terms of economy and health.

Considering the immense benefits of synbiotic banana yogurt products with the addition of *B. Lactis* and *L.*

rhamnosus GG bacterial starters, a holistic review of the dosage, duration of product effectiveness, and proper packaging are needed. It is due to the fact that innovations in the prevention and treatment of acute diarrhea in children using local resources will reduce child mortality from diarrhea, considering children are the most valuable asset compared to gold.

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