

In This Issue:

- Prebiotics and Probiotics:
New Concepts in Nutrition
and Health** 1
- Practical Applications of
Probiotic Agents** 3
- NASPE Issues Physical
Activity Guidelines for
Infants and Toddlers** 4
- Functional Foods:
Possible Implications
for Infant Development
and Later Health** 4

HINI Advisory Council:

L. Clark Lowry, M.S. PHEc.

Nutrition Consultant
Neepawa, MB

R. Hanning, Ph.D., RD

Associate Professor
Department of Health Studies & Gerontology
University of Waterloo, Waterloo, ON

I. Laquatra, Ph.D., RD

Nutrition Consultant
Pittsburgh, PA

D. Secker, M.S., RD

Clinical Dietitian
The Hospital for Sick Children
Toronto, ON

D.L. Yeung, Ph.D.

General Manager of Global Nutrition Services
H.J. Heinz Company, Toronto, ON

D. Yuen, M.D., Ph.D., FRCP(C)

Neonatologist
St. Joseph's Hospital
London, ON

S.H. Zlotkin, M.D., Ph.D., FRCP(C)

Professor, Depts of Pediatrics and
Nutritional Sciences
University of Toronto, Toronto, ON

Editor: D.L. Yeung, Ph.D.

Managing Editor: I. Laquatra, Ph.D., RD

Prebiotics and Probiotics: New Concepts in Nutrition and Health

A. V. Rao, Professor
Department of Nutritional Sciences
Faculty of Medicine, University of Toronto



Introduction

The intestinal microflora of humans represents a rich ecosystem composed of a wide range of metabolically active microorganisms. The large bowel is the most heavily colonized part of the gastrointestinal tract and typically, it yields up to 10^{12} bacteria per gram of feces. Major genera include bacteroides, bifidobacteria, coliform, enterobacteria, eubacteria, fusobacteria, and streptococci. The vital role played by the intestinal microflora in influencing the physiological state of the host is well documented in the literature.

Although under normal conditions the intestinal microbial milieu of humans is highly stable, several internal and external factors including the host's age and diet influence the numbers and types of microbes. At the time of birth the gastrointestinal tract of the infant represents a sterile environment. Soon after the birth, bacteria begin to colonize the large intestine. During the period of breastfeeding, the predominant bacteria in the stools of the infants are bifidobacteria. However, upon weaning, the levels of bifidobacteria decline with a concomitant increase in the numbers of undesirable bacteria such as coliform, clostridia and streptococci. The decline in the number of bifidobacteria continues into old age with a simultaneous increase in susceptibility to infections. The predominance of bifidobacteria in infants at a time when their immune system is not fully developed and the observed antagonistic relationships between bifidobacteria and enteropathogens has stimulated a great deal of interest in the role of bifidobacteria in human health. It is now well recognized that maintaining a predominance of bifidobacteria is consistent with good health.

Bifidobacteria are gram-positive rods that are primarily anaerobic. They ferment carbohydrates to acetic and lactic acid in the molar ratio of 3:2. This ability of bifidobacteria to produce acetic acid as the major metabolite is significant since together with other organic acids it can lower the pH of the large intestine and prevent the growth of many pathogenic microorganisms residing in the colon. Several strategies are now being employed to selectively colonize the large intestine with bifidobacteria and other beneficial bacteria such as *Lactobacillus* and to preferentially stimulate their growth.

*It is now well
recognized that
maintaining a
predominance of
bifidobacteria is
consistent with
good health.*

Probiotics

Probiotics is the term used to indicate the administration of specific bacteria whose predominance in the large intestine is considered beneficial to human and animal health. They include bacteria, although not exclusively, that produce short chain fatty acids such as acetic, butyric and propionic acids. Bacteria such as bifidobacteria, lactobacilli, bacteroides and fusobacteria are some examples of probiotics. Food products such as yogurt and other fermented dairy products containing viable bifidobacterial and *Lactobacillus* cultures have been used to proliferate populations in the infant and adult colon. However, for these bacteria to reach the large intestine in a viable form and to

colonize and grow, they must first survive the hostile environment of the stomach. Studies have shown that bifidobacteria when administered in this way do pass through the terminal ileum and reach feces in a viable form, but their numbers decline rapidly when oral dosing ceases.

This concept of probiotics is in opposition to “antibiotics” which use chemical substances to kill undesirable bacteria. Probiotics utilize beneficial bacteria to suppress the growth of or destroy the undesirable bacteria. The probiotic concept is based on the hypothesis that antibiotics have undesirable side effects and their use should either be kept to a minimum or avoided.

Prebiotics

Prebiotics are compounds that act as selective substrates for the growth of beneficial bacteria such as bifidobacteria in the large intestine. They must first meet several requirements to be considered as ‘prebiotics’ and used in foods. These requirements include that they must neither be hydrolyzed nor absorbed in the upper part of the gastrointestinal tract, must be a selective substrate for one or a limited number of beneficial bacteria that reside in the colon and stimulate their growth or they must be able to alter the colonic flora in favor of a healthier composition, and should be able to induce luminal or systemic effects that may be beneficial towards the health of the host.

The principal substrates for bacterial growth are dietary carbohydrates that have escaped digestion in the upper gastrointestinal tract. However, these carbohydrates can be utilized by several bacterial species for their growth and are not selective for bifidobacteria and other beneficial bacteria in the colon. In recent years several substances have been identified having prebiotic characteristics. They include some of the novel

Since humans and animals lack the enzymes required to hydrolyze these carbohydrates, they reach the colon intact and are fermented by bacteria such as bifidobacteria.

sugars that are being used in foods such as inulin and oligofructose (FOS). Several studies have indicated that these sugars are not degraded in the upper gastrointestinal tract and reach the colon in an intact form and are utilized by the colonic microflora. The oligofructoses are naturally occurring compounds distributed widely in several plants including chicory, onions, asparagus and tomatoes. They consist of a glucose molecule to which several (4-7) molecules of fructose are attached.

In general inulin has a larger degree of polymerization compared to oligofructoses. Since humans and animals lack the enzymes required to hydrolyze these carbohydrates, they reach the colon intact and are fermented by bacteria such as bifidobacteria. In September 2001, the Scientific Committee on Food (SCF) of the European Commission confirmed that oligofructose and inulin could be used in foods targeted to infants older than six months of age at a concentration of 0.8 g/dL. In January 2002, the SCF concluded that use of a mixture of galactooligosaccharides (GOS)

and FOS could be extended to infants aged 0 to 6 months. With this announcement, Europe joined Asia and Latin America in allowing the use of FOS in baby food products.

Synbiotic

Synbiotic is a term that is being used increasingly to denote a synergistic relationship between viable beneficial bacteria and their selective substrate. The synbiotic concept combines both the probiotics and the prebiotics approaches. According to this approach, a food or food supplement will include both the live cells of the beneficial bacteria and a selective substrate. The idea being that the beneficial bacterial cells that survive their transit through the stomach can grow quickly and competitively because of the presence of the selective substrate and establish their predominance.

Significance of Probiotic and Prebiotic Approaches in Infant Nutrition and Health

In the newborn breast-fed infants a stable microflora is developed in the colon and the feces within five days of birth. Predominant bacteria during this developmental phase are bifidobacteria, accounting for more than 90% of the total fecal bacteria. As a result of the production of acetic acid the fecal pH of the infants while on breast milk is low. More importantly, the numbers of pathogenic bacteria such as clostridium and coliform are very low. Upon bottle-feeding with milk, the fecal pH and the levels of fecal bifidobacteria approach the levels of breast feeding. However, as was reported in several studies, when the infants were bottle fed with infant formula levels of fecal bifidobacteria were significantly lower. These observations led to the suggestions that breast milk contained a ‘bifidogenic’ factor that selectively stimulated the growth of bifidobacteria and perhaps a similar compound may also be present in cow’s milk. In-vitro and in vivo studies have shown that in the presence of lactulose the levels of bifidobacteria are increased significantly. Since a certain amount of lactulose is present both in breast milk and cow milk it was considered to be the ‘bifidogenic’ factor responsible for the growth of bifidobacteria.

Several observations suggest an important role for bifidobacteria in infant nutrition and health. Infancy is the period of active developmental growth in the life cycle of humans. During this period, the immune function is not fully developed and the infant remains highly vulnerable to bacterial and viral diseases such as diarrhea and rotavirus. Infantile diarrhea not only results in loss of fluids resulting in dehydration but also contributes towards the loss of essential nutrients that are critically needed for the growth of the infant. A predominance of bifidobacteria creates a colonic environment of low pH that



effectively prevents the growth of infectious and other putrefactive anaerobic bacteria in the colon and also inactivates the activity of the rotavirus. In addition to lowering the pH, acetic acid, the predominant volatile fatty acid produced by bifidobacteria, can be absorbed and utilized in energy metabolism. A low colonic pH also facilitates the absorption of minerals thereby improving the nutritional status of the infant. Since the activity of putrefactive anaerobic bacteria is curtailed when bifidobacteria predominate, production of ammonia, a potential toxic metabolite, is also inhibited. At the low colonic pH, ammonia is present in its ionic form and is not

...bifidobacteria have been shown to synthesize certain vitamins and in particular vitamins of the B-complex and folic acid.

absorbed; instead, it is used as a source of nitrogen for the growth of beneficial bacteria including bifidobacteria. Unlike other bacteria that require the presence of vitamins for their growth, bifidobacteria have been shown to synthesize certain vitamins and in particular vitamins of the B-complex and folic acid. In this respect a predominance of bifidobacteria in the large intestine can contribute to the availability of certain essential vitamins to the infant. Recent studies have also demonstrated that due to the chemical composition of the cell wall of bifidobacteria they are able to stimulate the immune system of the host and provide for an efficient immune surveillance.

Conclusion

There is convincing scientific evidence to suggest that a predominance of bifidobacteria in the colon of humans and animals is essential for the maintenance of good health and the prevention of infectious and metabolic diseases. Several strategies are now being developed to maintain the predominance of bifidobacteria that include probiotic, prebiotic and synbiotic approaches. The gastrointestinal tract represents a hostile environment for the survival of orally ingested bifidobacteria. The probiotic approach provides a better chance of bacterial cells that survive the low pH of the stomach by introducing a large number of bacteria. More recently, identifying acid tolerant bifidobacteria and the use of bioencapsulation technology to increase their survival are being evaluated. However, the surviving cells require a substrate that can be used selectively for their growth. Prebiotics provide such an opportunity. Combining both of these strategies into a synbiotic approach is gaining popularity among the food industry. Infancy and childhood are the stages in the life cycle of a human being that are characterized by maximum growth. They are also vulnerable at this stage to infectious diseases. Scientific studies have shown a positive correlation between the predominance of bifidobacteria in infants and their health. Every effort should be made to provide a healthy colonic environment that can sustain large numbers of beneficial bacteria such as bifidobacteria. Probiotics, prebiotics and synbiotics can all play an important role in providing this advantage to the host.

References

- Gibson, G. R. and Roberfroid, M. B. (1995) Dietary modulation of the human colonic microbiota – introducing the concept of prebiotics. *J Nutr* 125: 1401-1412.
- Hidaka, H., Tashiro, Y. and Toshiaki, E. (1991) Proliferation of bifidobacteria by oligosaccharides and their useful effect on human health. *Bifidobacteria Microflora* 10:65-79.
- Langhendries, J.P. et al (1995) Effect of fermented infant formula containing viable bifidobacteria on the fecal flora composition and pH of healthy full-term infants. *J Ped Gastroent Nutr* 21: 177-181.
- Majamaa, H., Isolauri, E., Saxelin, M. and Vesikari, T. (1995) Lactic acid bacteria in the treatment of acute rotavirus gastroenteritis. *J Ped Gastroent Nutr* 20: 333-338.
- Mitsuoka, T. (1987) Recent trends in research on intestinal flora. *Bifid. Microflora* 1: 3-24.
- Mitsuoka, T. (1990) Bifidobacteria and their role in human health. *J Indus Microbiol* 6:263-268.
- Modler, H. W., McKellar, M. C. and Yaguchi, M. (1990) Bifidobacteria and bifidogenic factors – review. *Can Inst Food Sci Techno J* 23:29-41.
- Rao, A. V. and Koo, M. (1992) Effect of oral administration of bifidobacteria and neosugar on plasma ammonia concentration in CF1 mice. *Intr J Fd Sc Nutr* 43: 9-17.
- Roberfroid, M. B., Van Loo, J. A. E. and Gibson, G. Ra. (1998) The bifidobenic nature of chicory inulin and its hydrolysis products. *J Nutr* 128: 1-9.
- Roberfroid, M. B. (1997) Functional foods and intestinal micro-environment: the concept of prebiotics, probiotics and synbiotics. *Symposium on Nutrition and Gastrointestinal Microenvironment, Leuven, Belgium*.

Practical Applications of Probiotic Agents

- The best-established benefit of using probiotic agents has been to manage pediatric diarrheal disease¹. A significant decrease in duration of diarrhea of 1-3 days occurred in children who received *Lactobacillus* GG (as a supplement or in fermented milk) early in the course of the condition²⁻⁴.
- Doses between 10⁶ and 10⁹ colony-forming units daily are required (most clinical trials use these dose ranges)¹.
- For preventive purposes, regular consumption of *Bifidobacterium bifidum* and *S. thermophilus* in chronically hospitalized children⁵ and *Lactobacillus* GG in undernourished children⁶ for weeks to months decreased the incidence of acute diarrhea.



References:

- Saavedra JM. Clinical applications of probiotic agents. *Am J Clin Nutr* 2001; 73(suppl):1147S-51S.
- Isolauri E, Juntunen M, Rautanen T, Sillanaukee P, Koivula T. A human *Lactobacillus* strain (*Lactobacillus casei* sp strain GG) promotes recovery from acute diarrhea in children. *Pediatrics* 1991;88:90-7.
- Raza S, Graham SM, Allen SJ, Sultana S, Cuevas L, Hart CA. *Lactobacillus* GG promotes recovery from acute nonbloody diarrhea in Pakistan. *Pediatr Infect Dis J* 1995;14:107-11.
- Guarino A, Canani RB, Spagnuolo MI, Albano F, Benedetto L. Oral bacterial therapy reduces the duration of symptoms and of viral excretion in children with mild diarrhea. *J Pediatr Gastroenterol Nutr* 1997;25:516-9.
- Saavedra JM, Bauman NA, Oung I, Perman JA, Yolken RH. Feeding of *Bifidobacterium bifidum* and *Streptococcus thermophilus* to infants in hospital for prevention of diarrhoea and shedding of rotavirus. *Lancet* 1994;344:1046-9.
- Oberhelmean RA, Gilman RH, Sheen P, et al. A placebo-controlled trial of *Lactobacillus* GG to prevent diarrhea in undernourished Peruvian children *J Pediatr* 1999;134:15-20.

NASPE Issues Physical Activity Guidelines for Infants and Toddlers

The National Association for Sport and Physical Education (NASPE) recently released the first physical activity guidelines specifically designed to meet the developmental needs of infants, toddlers and preschoolers. The purpose of the guidelines is to provide teachers, parents, caregivers and health care professionals with recommendations that cover the kind of physical activity, the environment and the individuals responsible for facilitating the physical activity.

Guidelines for Infants

1. Infants should interact with parents and/or caregivers in daily physical activities that are dedicated to promoting the exploration of their environment.
2. Infants should be placed in safe settings that facilitate physical activity and do not restrict movement for prolonged periods of time.
3. Infants' physical activity should promote the development of movement skills.
4. Infants should have an environment that meets or exceeds recommended safety standards for performing large muscle activities.
5. Individuals responsible for the well being of infants should be aware of the importance of physical activity and facilitate the child's movement skills.

Guidelines for Toddlers and Preschoolers

1. Toddlers should accumulate at least 30 minutes daily of structured physical activity, preschoolers at least 60 minutes.
2. Toddlers and preschoolers should engage in at least 60 minutes and up to several hours per day of daily, unstructured physical activity and should not be sedentary for more than 60 minutes at a time except when sleeping.
3. Toddlers should develop movement skills that are building blocks for more complex movement tasks; preschoolers should develop competence in movement skills that are building blocks for more complex movement tasks.
4. Toddlers and preschoolers should have indoor and outdoor areas that meet or exceed recommended safety standards for performing large muscle activities.
5. Individuals who are responsible for the well-being of toddlers and preschoolers should be aware of the importance of physical activity and facilitate the child's movement skills.

Visit the web site www.aahperd.org for more information about NASPE and for details about ordering copies of the full document.

Opinions expressed In-Touch are those of the authors and do not necessarily reflect the views of the HINI or the H.J. Heinz Company.

Material from In-Touch may be reproduced without written permission provided the source is acknowledged. Correspondence is welcome. Please write to Dr. I. Laquatra, Nutrition Consultant, H.J. Heinz Company, PO Box 57, Pittsburgh PA, 15230-0057.

Functional Foods: Possible Implications for Infant Development and Later Health

David L Yeung and Crystal T Peters



Abstract

The aim of optimizing nutrition is not only to prevent deficiency, but also to promote health. "Functional" components of food, that is, "biologically active components that impart health benefits or desirable physiological effects beyond basic nutrition," may play a central role in promoting optimal health by preventing many adult chronic diseases. The effects of functional components are conferred very early in life through transfer of these components from the mother to the fetus during the gestational period and to the newborn infant from breastfeeding. Breast milk, in addition to its complete content of essential nutrients, contains numerous functional components, such as lactoferrin, nucleotides, oligosaccharides, antioxidants, and immunoglobulins. It has been clearly demonstrated that breastfeeding promotes general health and well-being, growth, visual acuity and cognitive development of infants. Infant formula and cow's milk are low in functional components and at the present time it is not possible to add all of these components to match breast milk.

Intake of functional components drops in the older infant upon weaning from breastfeeding. During this stage, the recommendations for the types of foods introduced in an infant's diet should include consideration of the functional components. Carrots, tomatoes, bananas, and wheat are a sampling of foods containing beneficial functional components that can be considered at this time. In view of the potential long-term impact of functional components in infant nutrition on long-term health and development, additional research is needed.

If you would like to read the full text of this article, please visit our Web Site at www.heinzbaby.com/HINI/index.html.



If you are not on our mailing list...

Complimentary copies of In-Touch are available to health care professionals by writing us at the address indicated.

Have you moved?

If your address has changed, please forward your new address, and if possible a copy of the old label to: In-Touch, c/o Dr. I. Laquatra at the address indicated.



Printed on recycled paper

Please post or photocopy the reverse side for your patients.

ACTIVITY GUIDELINES

FOR INFANTS & TODDLERS



INFANTS

- ◆ Help your child explore his/her surroundings.
- ◆ Get your child moving and using his/her leg and arm muscles through activities like rolling over, standing, and walking.
- ◆ Don't restrict movement for long periods.
- ◆ Make sure play areas are safe for crawling and exploring.
- ◆ Inform caregivers of the importance of physical activity for your child.

TODDLERS

- ◆ Encourage your toddler to be physically active.
- ◆ Help your toddler to accumulate at least 30 minutes of structured or planned physical activity daily.
- ◆ Encourage your toddler to be active throughout the day, accumulating at least 60 minutes (and ideally more) of unstructured movement through play and routine activities.
- ◆ Help your child minimize sedentary activities like television watching. Toddlers shouldn't be sedentary for more than 1 hour at a time unless they are sleeping.
- ◆ Make sure play areas are safe.
- ◆ Inform caregivers of the importance of physical activity for your child. Skills learned at this age are building blocks for more complex movement.

