Matching today's expectations.
Digestive health and prebiotic fibers.

With the pace of life continuously accelerating, the global trend towards easy-to-prepare and on-the-go food continues. At the same time, market research has shown that today's consumers are increasingly realizing the positive effect nutrition can have on their well-being. People today are looking for food and snacks that support a healthy lifestyle from an early age.

When it comes to the importance of dietary fiber intake for a healthy nutrition, public awareness has been steadily growing over the last decades. Although vast parts of the world's population are still lacking a sufficient fiber intake, many consumers are already actively asking for convenient food and drinks that include dietary fibers.

A healthy digestive system concerns us all; some aim to improve a problematic situation, others are keen to keep a pleasant balance. Looking around the world, more than a third of the Chinese are concerned about digestive discomfort, such as constipation[1]. Close to two thirds of Americans want to maintain a healthy digestion and over 70% of those confirm that it plays a very important role in their shopping decisions[2-3]. Also in Europe consumers see digestive health as desirable: three out of four people in the UK and Spain eat digestive health products to improve their overall health[3].

Digestive health is a silent, yet important driver of consumer decisions; specifically related to their overall well-being and appearance (feel good, look good). Where in England and Spain, every one in two people eats digestive health products to lose weight, Americans spontaneously associate fibers with satiety and even bowel regularity[4]. In Indonesia, nearly the entire population links a healthy digestive system to beauty (90% consumers agree it makes them look better)[2].

A good digestion is a matter of wellness and a healthy digestive system makes the majority of consumers feel better.

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connecting nutrition and health

The importance of microorganisms.

The world of microorganisms is somewhat mysterious for most consumers. They are too small to be visible but powerful enough to make you ill. Hygiene is part of everyone's daily life in order to prevent the organisms that can make you sick from taking over. While most consumers are aware of pathogens and antibiotic drugs, the fact that there are beneficial or even essential microorganisms in the intestine, e.g. for the production of some vitamins, is hardly known.

Microorganisms in the gut create their own universe and live together with us, even in dialog with parts of the human body. Some may harm us, some do good... and we may depend on them.

Microorganisms accompany food as it passes through the gastrointestinal tract:
Microorganisms in the gastrointestinal tract eat the nutrients available to them within the specific environment they live.

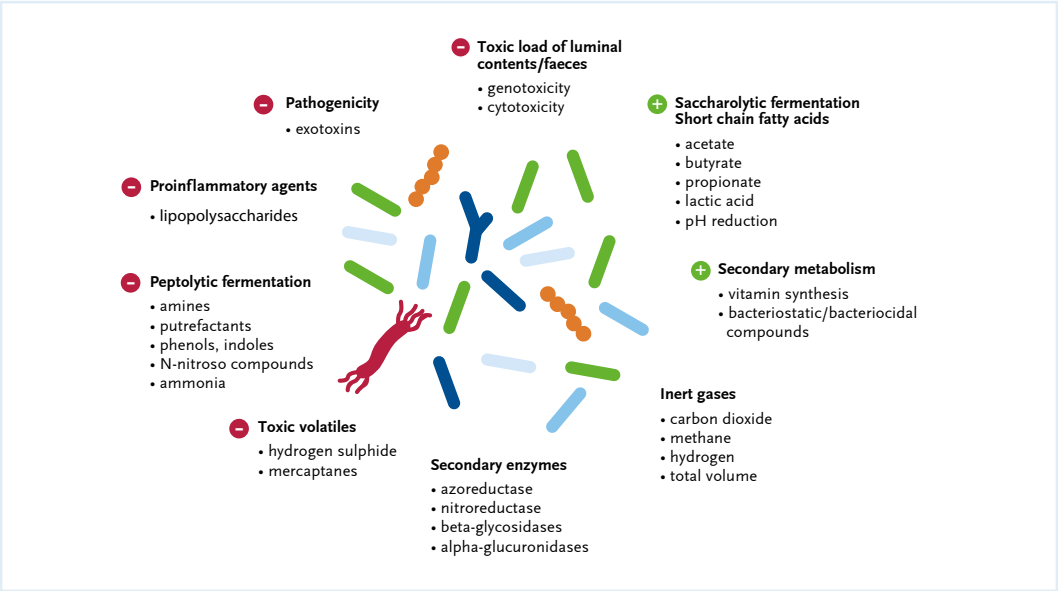
The stomach hosts only a small number of microorganisms due to its low pH value. In the small intestine, a higher bacterial density is possible due to the higher pH value. However, the density is still limited because of the rapid transit time and secretions with microbiostatic effects such as bile acids and pancreatic juices. The large intestine is a favorable organ for bacterial growth because of its slow transit time, readily available nutrients (those escaping digestion and absorption) and a favorable pH. The microbial density is high. The physiology of the colon is controlled to a large degree by the gut microbiota and its fermentation of indigestible nutrients, its secondary metabolites, its interaction with the host, as well as by internal competition of microorganisms against each other.

Composition of the colonic microbiota – the healthy flora concept.

Our knowledge about the composition of bacterial flora in healthy people comes largely from fecal analysis, as the colonic lumen is rarely accessible. Knowledge of microbiota continuously improves with advances in microbial methods.

Meanwhile, around 1,000 different bacterial species have been reported in the human gut. In terms of characterization of metabolism, direct microbe-host interactions and other relevant properties for host health need to be considered (See fig. 1).

Figure 1: Characteristics of the microbiota with implications to the host.



Characteristics of a beneficial microorganism:

- Should contribute to the stabilization of a balanced flora
- Produces short chain fatty acids and prefers non-digestible carbohydrates as its food
- Should not have negative effects like being a pathogen, producing toxins, nor stimulating disease-related inflammatory responses

Bifidobacteria and lactobacilli clearly fulfill these criteria. Other microbes fulfilling these criteria may be identified in future. **Bifidobacteria represent valid markers today for a healthy gut microbiota and a balanced colonic ecosystem.**

Maintaining and optimizing a balanced microbiota supports gut health and is therefore part of maintaining a healthy lifestyle. In other words supporting bacterial metabolism results in beneficial effects and a reduced toxic load for the host.

It is not only the composition of the flora but also its activity in total that contributes to a healthy gut function and to the integrity of the gut barrier.

How prebiotics support the healthy flora concept.

Around 20 years ago researchers started looking for nutrients that could support the growth of the beneficial microorganisms that occur naturally in the large intestine. This new research direction was based on the knowledge that certain microorganisms can potentially harm the host while other microorganisms were known to, for example, produce vitamins and short chain fatty acids that positively influence the environment in the gut.

It was assumed that with this smart choice of an ingredient in the normal diet a consumer would apply a "help yourself by eating smart" approach, therefore supporting healthy flora in a natural way. Such a nutrient would need to reach the colon intact, escaping the digestion process. On reaching the large intestine, this nutrient would be the preferred substrate for those specific beneficial microorganisms, i.e. the bifidoflora would just love that food and eat it quickly. With the advantage of a privileged nutrient supply, the Bifidobacteria would benefit more than any other microorganism and would grow faster than others. The number of the good bacteria in the large intestine would increase. This increase would logically go hand in hand with an increase in the beneficial functions and thus would support a healthy microflora (microbiota) ecosystem.

The prebiotic term was then born in order to have a definition to describe the physiological characteristic: "Prebiotics are non-digestible food ingredients that selectively stimulate the growth and/or activity of one or a limited number of bacteria in the colon, which improves host health[5]."

The definition was further developed in the course of the following years and today is defined as: "A dietary prebiotic is a selectively fermented ingredient that results in specific changes, in the composition and/or activity of the gastrointestinal microbiota, thus conferring benefit(s) upon host health." [6]

Proven prebiotics today are inulin-type fructans from chicory (**plant-made dietary fiber**), such as Orafti® Inulin and Oligofructose (FOS, fructo-oligosaccharides) which are found in many fruits and vegetables and which are added to food for fiber enrichment. For classification as "proven prebiotic", the microbiota modulation and health benefits were demonstrated in vitro, with animal studies and with a large number of human intervention studies. GOS (galacto-oligosaccharides, man-made dietary fibers) and lactulose (a disaccharide and not a dietary fiber) are regarded as "proven" as well [6]. Some other non-digestible carbohydrates have been identified as potential candidates, i.e. in vitro fermentation indicates a prebiotic effect, while the effect still needs to be confirmed in animal and human studies.

Health benefits and main physiological targets for prebiotic effects by BENEO chicory root fibers.

The metabolic and health benefits of prebiotics, such as Orafti® Inulin and Oligofructose are linked to today's key diet-related challenges and could be a tool for consumers to achieve better health over time. Where most of the physiological health effects listed below are already well established, others will be reinforced by ongoing research:

Digestive health

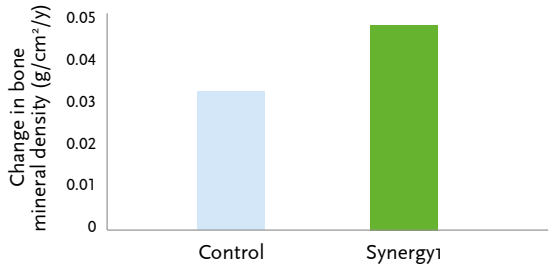
- Improvement and/or stabilization of gut microbiota composition
- Improvement of intestinal functions (stool regularity, bulking, consistency)
- Reduction of the risk of intestinal infections
- Initiation and modulation of immune response
- Improvement of intestinal barrier functions and reduction of metabolic endotoxemia

Chicory root fiber has an abundance of sound science related to digestive health, with an official, exclusive health claim (art 13.5) authorized by the European Commission: Chicory inulin contributes to normal bowel function by increasing stool frequency [7-11]**.** Consumers understand and deem this official health claim as credible. They will be additionally intrigued by packaging statements such as "promotes digestive health" and "supports a healthy and balanced digestive system".

Bone health [12-14]

- Increase in mineral absorption and improvement of bone health (bone calcium content, bone mineral density)
- The Oligofructose-enriched Inulin, Orafti® Synergy1 has been found to be particularly efficient in enhancing the bioavailability of calcium in the diet

Figure 2: Orafti® Synergy1 positively affects bone mineral density.

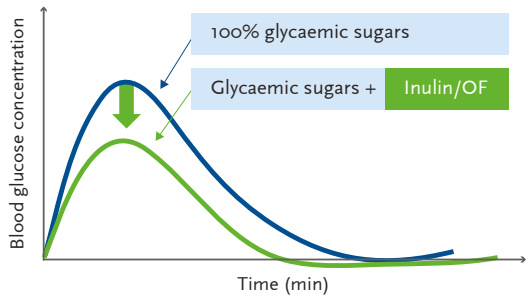


Change in body bone mineral density of individuals whose diets were supplemented with Orafti® Synergy1 for one year.

Blood glucose management [15-17]

- Reduction of blood glucose response of food when replacing sugar with chicory root fiber
- Reduction of the risk of type 2 diabetes mellitus, metabolic syndrome if applying a diet lower in blood glucose profile than what currently is applied in the fast majority of the population.

Figure 3: Blood glucose response, when adding Inulin/Oligofructose to a food/drink.



Weight management [18-21]

- Reduction of energy intake with consumption of Orafti® Synergy1 and Orafti® Oligofructose (helping to eat less, naturally)
- Modulation of GI peptide production, energy metabolism and satiety
- Influencing the gut-brain axis and thus influencing the hunger/satiety mechanism
- Supporting weight loss by in particular trunk fat loss
- Reduction of the risk of obesity

Chicory root fiber – one of the best-researched fibers globally.

Over two decades of nutrition research on chicory root fiber makes it one of the best-researched fibers in the world. For many studies, BENEO worked in close collaboration with renowned universities pioneering prebiotic research and research on metabolic aspects.

In total, more than 150 high quality human intervention studies are published on chicory root fiber, delivering strong evidence for seven distinct physiological benefits, mentioned in the table below. Health benefits related to chicory root fiber intake are established in the following areas:

Figure 4: Numbers of published human intervention studies with chicory root fibers (inulin & oligofructose).

Prebiotic effect	45
Bowel function	36
Satiety / Energy intake	19
Body weight management	16
Blood glucose postprandial	14
Blood glucose management	17
Mineral absorption	10

Feel good – improve regularity.

A sufficient dietary fiber intake is needed to ensure a proper emptying of the gut. That is the reason for the recommendation of experts in the field to eat at least 25g of fiber per day. The actual intake is significantly less, only about half of it in many countries. The current intake level of dietary fiber leads to "lazy and silent guts," the intake is too low to feel digestion processes. Hard stools, pain and constipation are the consequences, not addressing potential long-term consequences.

Feeling digestion is a synonym for regular bowel movements and digestive health: a sufficient frequency per week, a stool consistency that is not too hard, some gas production reflecting microbial activity, some bowel noise and contractions reflecting the movement of bowel content through the intestine sections.

Fiber-enriched products today increase the choice of food containing fiber beyond such fiber-rich foods as fruits, vegetables and whole grains. Also non-traditional fiber sources like yogurt or dairy drinks help to bridge the gap. Eating double the amount of fiber that is eaten today by the majority of consumers, would significantly support digestive health. It would also increase the awareness and processes in the gut - you may feel it and get adapted over some time.

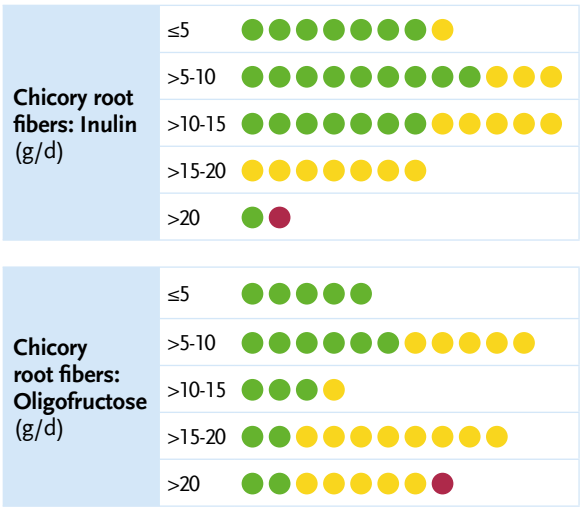
Chicory root fiber is the best choice ingredient to bridge the fiber gap for several reasons:

- The gap is only bridged if the taste and texture of the fiber enriched products is good. Chicory root fiber guarantees this.
- The scientific evidence that the dietary fiber of choice really works to improve stool frequency and consistency needs to be strong. This is the case for chicory root fiber (see figure 4).

The latest example that BENEO's data are very robust is the exclusive approval of a digestive health related health claim in the European Union following a thorough review process of the scientific evidence by the European Food Safety Authority (EFSA) [7].

BENEO also looked extensively into the data how consumers feel about the improved activity of the gut with emphasis on chicory root fiber. This is reflected in Figure 5, demonstrating that the feeling of being disturbed by this increased activity is very rare. Comparing with other fibers in the market - that in fact do not really compete due to limitations in taste, applications and severe limitations in the scientific proof – chicory root fiber scores very well.

Figure 5: Chicory root fibers: positive tolerance scores in a multitude of human intervention studies.



Categorization of each trial: Color codes

- "very well" or "well tolerated" without or with non-significant increase of GI* symptoms
- "well tolerated" with mild to moderate, yet significant GI symptoms
- "not well tolerated"
  - ≥25% of subjects with severe (increase in) flatulence
  - (key symptoms) and/or diarrhea and/or
  - remarkable number of dropouts due to
    - severe GI symptoms /discomfort and/or
    - too much occasions with severe GI symptoms

*GI: Gastro Intestinal

BENEO at your trade fair.

BENEO is present at a number of local and international events, where its full range of ingredients for a variety of physiological benefits is on display. To name a few: blood sugar management, weight management, digestive health, energy management, healthy aging – all connected with technical benefits such as improved shelf life, enhanced mouth feeling, brighter colors, sugar reduction, natural sweetness, non-GMO, fiber enrichment and last but certainly not least: improved taste and texture.

Check our website events calendar and come visit BENEO at a local fair. Find out more about how using our carbohydrates, fibers, proteins and specialty rice ingredients can help you to innovate and produce appealing products for today's consumers.

Always at your side: Profit from our interdisciplinary expertise.

Our experts offer valuable insights. No matter if your question concerns physiology or process technology, if it is marketing-related or if it is about legislation and regulations. With nutritionists, marketers, regulatory professionals, technical food engineers and a competent sales force team throughout the world, there is always a BENEO expert that can help you. It's the combination of advanced ingredients and specialist knowledge together with access to a global network of experts, which makes BENEO a unique business partner.

Learn more about the BENEO nutrients online: www.beneo.com

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