Key references related to the physiological benefits of BENEO Chicory Root Fibers (inulin, oligofructose/FOS).

Inulin is a non-digestible carbohydrate naturally occurring as storage carbohydrate in many plants that have always been part of the human diet, including many vegetables, fruits and cereals such as leeks, onions, garlic, wheat, chicory, artichokes and bananas. Chicory is at present the preferred crop for large-scale inulin production.
Chicory root fibers are linear polydisperse carbohydrates mainly composed of fructose units joined by a series of β(2-1) fructosyl-fructose linkages. The chemical formula of inulin is $C_6H_{11}O_6(C_6H_{10}O_5)_nOH$ and the systematic name for all fructans is ß-D-glucopyranoside-(1-2)-ß-D-fructofuranosyl]$_n$ (notably, the α-D-glucopyranoside part is not always present). The number of fructose units ranges mainly from 2 to 60 or even more for chicory inulin.

Chicory inulin is an umbrella term that comprises the whole range of shorter chain (oligosaccharide type, degree of polymerization [DP] from 2 to 9) and longer chain (> DP 9) inulin. Due to enzyme activity in the root the shorter chain inulin increases in late harvest time. Oligofructose (a shorter chain inulin) is produced by the partial enzymatic hydrolysis of chicory inulin, and is characterized by a DP from 2 to 9.

Chicory root fibers act in the colon. Chicory root fibers are non-digestible in the small intestine and are fermented in the large intestine, resulting in healthful modifications in the colonic microbiota composition, and in the production of several metabolites. Thereby, they are among the very few scientifically proven prebiotics. Several health effects are related to this activity in the colon. An overview of the most relevant physiological aspects and benefits of chicory root fibers is provided in this document, along with the most pertinent publications (human studies) supporting these effects.

Table of Content:

1. Chicory root fibers: Prebiotic properties

Prebiotics are non-digestible or partially digestible food ingredients that beneficially affect the host (consumer) by selectively stimulating the growth and/or activity of one or more of a limited number of bacteria in the colon, and thus improve host health. Chicory root fibers are among the very few ingredients scientifically proven to be prebiotics. Numerous studies in infants, young children, and adults have been carried out to investigate and confirm the prebiotic effect of chicory root fibers. Selective changes in the microbiota's composition, especially a significant increase in bifidobacteria have been convincingly demonstrated after chicory root fiber consumption. The activities of the gut microbiota, and notably the saccharolytic fermentation further contributes to colonic function, through the generation of short-chain fatty acids (SCFA), the decreased production of potential harmful nitrogen-containing compounds and the modulation of toxic enzymatic activities in the colon.

Chicory root fibers contribute accordingly to a healthy state of microbiota structure called normobiosis, as opposed to dysbiosis in which one or more potentially harmful bacterial species are dominant.

Key references (human studies) of effect on the microbiota composition:

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2. Chicory root fibers: Effects on bowel regularity

The fermentation of chicory root fibers by the colonic microbiota result in an increased bacterial cell mass and SCFA. Due to the high water content of intestinal bacteria, the moisture content of feces is increased after chicory root fibers supplementation. As a consequence, stools become softer and excretion is facilitated. Inulin and oligofructose intake facilitate fecal excretion, which results in an increase in frequency of bowel movements and/or in stool weight which is shown in several human interventions.

Those are included in the key references below:

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3. The role of chicory root fibers in weight management

Controlled human intervention studies indicate that individual dietary fibers - apart from their "energy diluting" properties - may influence energy intake and appetite control. This is the case of chicory root fibers, and more specifically Orafti® Synergy1 and oligofructose.

A growing number of well-designed human studies, in healthy, overweight and obese volunteers, suggest a particular role for Orafti® Synergy1 and oligofructose in promoting a moderate negative energy balance in humans consuming an ad *libitum diet*.

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4. Chicory root fibers and blood sugar management

Since inulin and oligofructose are non-digestible carbohydrates they do not contribute to post-prandial glycemia. Replacing digestible and glycemic carbohydrates partially or completely with inulin or oligofructose on a weight-by-weight basis in a food product reduces the amount of available carbohydrates and consequently the postprandial blood glucose response of the food. Human studies (including unpublished data) show significant reductions in the postprandial glycemic response for different foods in which sugars have been replaced by oligofructose at levels of 20% or more. A linear relationship between the extent of sugar replacement and a reduction in the resulting blood glucose response shows that higher fructan levels will result in greater effects, respectively.

A positive European Food Safety Authority (EFSA) opinion and approved health claim have been granted as a result of these data.

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5. Orafti® Synergy1 (oligofructose-enriched inulin) and calcium absorption

Several human studies have shown that Orafti® Synergy1 intake results in a significant increase in true calcium absorption. One 1-year human intervention study shows that this increase in calcium absorption persists over the long-term and results in increased bone mineralization.

Colonic fermentation of Orafti® Synergy1 is thought to be the main mechanism contributing to its effect on the stimulation of intestinal calcium absorption.

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6. Inulin and oligofructose as bioactive substances in infants and small children: Digestive health

The development of the gut microbiota is a critical and essential process early in life as it impacts later health outcomes. Inulin and oligofructose can safely be used in milks for infants 0-6 years of age, showing effects on the modification of the composition of the microbiota (prebiotic properties) towards a breastfed type composition and improvements in stool consistency.

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