

Chicory Root Fiber, Inulin, Oligofructose and Fructooligosaccharides (FOS)

Source

Chicory (*Cichorium intibus* L.) is a biennial plant in the Asteraceae family that is also known as succory, hendibeh, blue daisy, blue dandelion, blue weed and coffeeweed. The root stores the carbohydrate energy known as inulin.¹

Background

Inulin is present in numerous fruits and vegetables. It has been consumed by man since ancient times, and it is estimated that men living in the North American Chihuahua desert over 10,000 years ago consumed 135 g of inulin per day.² Inulin is a complex carbohydrate that is the chicory plant's source of stored energy. When dried, the chicory root contains about 17 percent inulin.

To isolate inulin, roots are harvested, washed and cut into slices, allowing inulin to dissolve in hot water, which is collected then dried.¹ Chicory inulin is a linear β (2 $\rightarrow$ 1) fructan consisting of chains of fructose units (up to 60 and more units) which may have a glucose unit at the beginning (GF_n; G:Glucose, F: fructose, n: number of fructose units). The shorter chains of inulin are called oligofructose or fructooligosaccharides (FOS). Chicory root fiber is undigested since the bindings between molecules are not hydrolysed by human enzymes.³ Extensive research over 30 years, including more than 200 human intervention studies, substantiates the nutritional and health-related properties of chicory root fiber.

Nutritional Properties

As a dietary fiber, chicory root fiber remains unabsorbed and undigested until it reaches the large intestine. Microbiota in the large intestine, particularly *Bifidobacteria* and *Lactobacilli*, use chicory root fiber as a nutrient. The breakdown products of this saccharolytic prebiotic fermentation are short chain fatty acids and other metabolites.

Physiological Benefits

1. **Gut microbiota support:** Modulation of the gut microbiota by promoting growth of *Bifidobacteria* and *Lactobacilli* (proven prebiotic).
2. **Digestive Health:** Improvement of digestive health by supporting normal regularity (increase of stool frequency per week and improvement of stool consistency).
3. **Weight management support:** Helps us eat less naturally, which supports weight management by helping to affect hunger/satiety, gut hormones, longer-term energy intake, weight loss and body fat composition.

4. **Bone health support:** Increase of calcium absorption and increase in bone mineral density.
5. **Blood sugar management support:** Improvement of blood sugar profiles and insulin profiles.
6. **Blood lipid management support:** Improvement of blood lipid parameters including reduced LDL and total cholesterol and improved HDL cholesterol.

Benefits

Modulation of the microbiota – Established prebiotic: Chicory root fiber is a prebiotic shown to be selectively utilized by beneficial host microorganisms such as *Bifidobacteria* and *Lactobacilli* in the gastrointestinal tract. The prebiotic effect has been observed with a minimum intake of 3g/d and has been observed across the lifespan from infants to elderly in more than 70 human intervention studies.^{4,5}

Research on the effects of chicory root fiber on the gastrointestinal microbiota started in the mid-1990s. It was determined that chicory root fiber (inulin, oligofructose/FOS) was the preferred nutrient for some groups of the gut microbiota. Thus, inulin is considered a prebiotic as the fiber is “selectively utilized by host microorganisms conferring a health benefit”⁴. Various beneficial effects have been described.⁵

Digestive health & regularity: Chicory root fiber supports digestive health with its effects on regularity when 8-12 grams are consumed during various intake occasions throughout the day. Based on a review of the comprehensive scientific evidence by the European Food Safety Authority (EFSA), the European Commission (EC) approved a health claim related to improved regularity because of an increase in stool frequency.⁷ Stool consistency is also influenced positively so that hard stools and painful defecation can be avoided.⁸

Long term weight management: Chicory root fiber helps us eat less, as determined in more than 10 human studies that evaluated satiety and energy intake and supports a healthy body weight and composition as shown in more than 20 human studies that addressed body weight management.^{9,10}

Chicory root inulin can be used both as an added fiber and as a low-calorie replacement for sugar or fat in various foods. The caloric value of chicory root fiber is 1-1.5 kcal/g, which is less than other carbohydrates that provide 4 kcal/g or fats that provide 9 kcal/g.

Bone health: Chicory root fiber improves calcium absorption by increasing the acidity in the large intestine and increasing the surface for calcium absorption in the large intestine. It has also been confirmed that the calcium reaches the bone and supports bone health. Ten human intervention studies with chicory root fiber including a large US Department of Agriculture/National Institutes of Health (USDA/NIH) study with 100 adolescents consuming 8g of oligofructose-enriched inulin per day have been published.¹

Blood sugar management: In 2014, EFSA evaluated data and had a positive opinion that replacing 20 percent of sugars with chicory root fiber helps achieve lower blood sugar levels and insulin levels.^{12,13}

Glucose homeostasis, body weight and insulin sensitivity were also improved in subjects with prediabetes after 6 weeks of 30g/d intake independent of the lifestyle and compared to control (cellulose).^{14,15}

Improved metabolic status on blood lipids: Reduced LDL and total cholesterol as well as reduced triglyceride levels were demonstrated in meta-analyses of randomized control trials in hyperlipidemic individuals or overweight and obese subjects consuming inulin.¹⁶ Prebiotics, including inulin, oligofructose, or fructooligosaccharides, reduce triglyceride and increased HDL-cholesterol in diabetic subjects.¹⁷

What types of food are chicory root fiber, inulin, oligofructose and FOS typically found in?

Chicory root fiber is a soluble fiber that – apart from the mentioned health benefits – has additional texturizing and sensorial properties that allow for fiber enrichment as well as for sugar or fat replacement in a large variety of product applications including e.g. bakery foods, cereals, dairy products and alternatives, confectionery, beverages, spreads, soups and sauces, dressings, ice cream, meat and vegetable products, snack, granola, and nutrition bars as well as infant and special purpose nutrition.¹⁸

Recommended Daily Intake

*“Of the under-consumed nutrients, calcium, potassium, **dietary fiber**, and vitamin D are considered nutrients of public health concern because low intakes are associated with health concerns.” – Dietary Guidelines for American 2015-2020 (8th edition).*

In the United States, the recommended dietary fiber intake is 14g/1,000kcal. For an average adult, this means a daily intake of 25g (female) or 38g (male). Most Americans only consume about half of the recommended intake (13.5 and 18g, respectively). This shortage in our diet is called the fiber gap.

Given Americans' current eating habits, closing the fiber gap without consuming fiber-enriched foods would also mean significantly increasing calorie intake. To reach the recommended fiber intake without fiber-enriched foods, most Americans would need to increase their calorie intake by more than 500 calories per day. But meeting fiber requirements doesn't have to mean adding calories if fiber enriched foods are consumed. Studies have shown, for example, that enriching grain foods with fiber (2.5g–5g) resulted in a fiber intake of 24.7g–39.1g/day with no caloric increase. ([Nicklas et al, 2011](#); [Jones, 2014](#))

Fiber-enriched foods help bridge the fiber gap while delivering excellent taste and additional metabolic benefits. The overall diet should have a mix of various fiber types.

Consuming a Variety of Fibers

Although most fibers will have more than one health-related effect, no one fiber can produce every potential health benefit. Some effects are well recognized for a large number of different fiber types, while others can be very fiber specific. To maximize the health benefits of fiber, it is important to consume a variety of fibers.

Fibers can be found in many different foods. The amount of fiber per serving can easily be found by looking at the Nutrition Facts Panel for the Dietary Fiber line.

Additionally, the fiber content in foods like raw fruits and vegetables that do not have a nutrition label can be found [here](#).

Gastrointestinal Tolerance

Increasing fiber intake suddenly, particularly in individuals consuming a low fiber diet, may result in gastrointestinal effects, such as an increased number of stools per week, having softer stools (but not diarrhea) or having increased flatulence. These effects are due to either bulking effects or due to the fermentation of fiber in the gastrointestinal tract. These potential effects can be minimized by increasing fiber intake more gradually to allow the gastrointestinal tract to adapt. Thus, it may be helpful to decrease fiber intake until these feelings subside and then gradually increase fiber intake until the recommended intake of 14g/1,000kcal is achieved.

Nutrition Facts			
Serving Size (100g)			
Amount Per Serving			
Calories 160			
		% Daily Values*	
Total Fat	14.66g		23%
Saturated Fat	2.13g		11%
Trans Fat	0g		
Polyunsaturated Fat	1.82g		
Monounsaturated Fat	9.8g		
Cholesterol	0mg		0%
Potassium	485mg		14%
Sodium	7mg		0%
Total Carbohydrate	8.53g		3%
Dietary Fiber	6.7g		27%
Sugars	0.66g		
Protein	2g		4%
Vitamin A 0.1%	•	Vitamin C 16.7%	
Calcium 1.2%	•	Iron 3.1%	
Vitamin E 6.9%	•	Vitamin K 26.3%	
Thiamin 4.5%	•	Riboflavin 7.6%	
Niacin 8.7%	•	Vitamin B6 12.9%	
Folate 20.3%	•	Pantothenic Acid 13.9%	
Phosphorus 5.2%	•	Magnesium 7.3%	
Zinc 4.3%	•	Manganese 7.1%	
*Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.			
	Calories	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2400mg	2400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

References

- 1 Moser, M., Agemans, A., Caers, W. (2014) Production and Bioactivity of Oligosaccharides from Chicory Roots. In: Dr.F.Javier Moreno, Dr.Maria Luz Sanz (Eds.), *Food Oligosaccharides: Production, Analysis and Bioactivity*, Wiley-Blackwell, pp. 55–75.
- 2 Leach, J.D. (2007) Prebiotics in ancient diets. *Food Science & Technology Bulletin* 4 (1), 1–8.
- 3 Moser, M., Sentko, A., Alexiou, H. (2015) Inulin and Health Benefits. In: Ramawat, K. G., Merillon, J. M. (Eds.), *Polysaccharides: Bioactivity and biotechnology*, pp. 675–715.
- 4 Gibson GR, Hutkins R, Sanders ME, Prescott SL, Reimer RA, Salminen SJ, Scott K, Stanton C, Swanson KS, Cani PD, Verbeke K, Reid G. (2017) Expert consensus document: The International Scientific Association for Probiotics and Prebiotics (ISAPP) consensus statement on the definition and scope of prebiotics. *Nat Rev Gastroenterol Hepatol.* 14(8):491-502. doi: 10.1038/nrgastro.2017.75. Epub 2017 Jun 14. PMID: 28611480
- 5 Roberfroid, M., Gibson, G.R., Hoyles, L., McCartney, A.L., Rastall, R., Rowland, I., Wolvers, D., Watzl, B., Szajewska, H., Stahl, B., Guarner, F., Respondek, F., Whelan, K., Coxam, V., Davicco, M.-J., Léotoing, L., Wittrant, Y., Delzenne, N.M., Cani, P.D., Neyrinck, A.M., Meheust, A. (2010) Prebiotic effects: metabolic and health benefits. *Br J Nutr* 104, S1-S63.
- 6 Gibson, G.R., Roberfroid, M. (1995) Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. *J Nutr*, 1401–1412.
- 7 EU (2015) Commission Regulation (EU) 2015/2314 of 7 December 2015 authorising a health claim made on foods, other than those referring to the reduction of disease risk an to children’s development and health and amending Regulation (EU) No 432/2012. *Official Journal of the European Union* 12.12.2015.
- 8 Collado Yurrita, L., San Mauro Martin, I., Ciudad-Cabanas, M.J., Calle-Puron, M.E., Hernandez Cabria, M. (2014) Effectiveness of inulin intake on indicators of chronic constipation; a meta-analysis of controlled randomized clinical trials. *Nutr Hosp* 30 (2), 244–252.
- 9 Parnell, J.A., Reimer, R.A. (2009) Weight loss during oligofructose supplementation is associated with decreased ghrelin and increased peptide YY in overweight and obese adults. *Am J Clin Nutr* 89, 1751–1759.
- 10 McCann, M.T., Livingstone, M.B., Wallace, J.M.W., Gallagher, A.M., Welch, R.W. (2011) Oligofructose-enriched inulin supplementation decreases energy intake in overweight and obese men and women. *Obesity reviews* 12, 63–279.
- 11 Abrams, S.A., Griffin, I.J., Hawthorne, K.M. (2007) Young adolescents who respond to an inulin-type fructan substantially increase total absorbed calcium and daily calcium accretion to the skeleton. *J Nutr* 137, 2524S–2526.

- 12 Kellow, N.J., Coughlan, M.T., Reid, C.M. (2014) Metabolic benefits of dietary prebiotics in human subjects: a systematic review of randomised controlled trials. *Br J Nutr* 111, 1147–1161.
- 13 EFSA (2014) Scientific Opinion on the substantiation of health claims related to non-digestible carbohydrates and a reduction of post-prandial glycaemic responses pursuant to Article 13 (5) of Regulation (EC) No. 1924/2006. *EFSA Journal* 8 (10):1801, 1–3.
- 14 Guess, N.D., Dornhorst, A., Oliver, N., Frost, G.S. (2016) A Randomised Crossover Trial: The Effect of Inulin on Glucose Homeostasis in Subtypes of Prediabetes. *Ann Nutr Metab* 68, 26–34.
- 15 Guess, N.D., Dornhorst, A., Oliver, N., Bell, J.D., Thomas, E.L., Frost, G.S. (2015) A randomized controlled trial: the effect of inulin on weight management and ectopic fat in subjects with prediabetes. *Nutrition & metabolism* 12, 36.
- 16 Guo, Z., Liu, X.M., Zhang, Q.X., Tian, F.W., Zhang, H., Zhang, H.P., Chen, W. (2012) Effects of inulin on the plasma lipid profile of normolipidemic and hyperlipidemic subjects: a meta-analysis of randomized controlled trials. *Clinical Lipidology* 7, 215–222.
- 17 Beserra, B.T.S., Fernandes, R., do Rosario, Vinicius A, Mocellin, M.C., Kuntz, M.G.F., Trindade, E. (2015) A systematic review and meta-analysis of the prebiotics and synbiotics effects on glycaemia, insulin concentrations and lipid parameters in adult patients with overweight or obesity. *Clinical nutrition (Edinburgh, Scotland)* 34, 845–858.
- 18 Moser, M., Wouters, R. (2014) Nutritional and Technological Benefits of Inulin-Type Oligosaccharides. In: Dr.F.Javier Moreno, Dr.Maria Luz Sanz (Eds.), *Food Oligosaccharides: Production, Analysis and Bioactivity*, Wiley-Blackwell, pp. 457–469.