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EUOLIGO® FOS

Health Benefits of EUOLIGO®

Fructo-oligosaccharide (FOS)

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The gastrointestinal tract is increasingly recognised for its importance in determining health and wellness[1]. While we still have a lot to learn about the gut microbiota, it is nevertheless clear that a healthy gut with a high diversity of microorganisms, including a significant proportion of beneficial species, may help to protect us from infection and chronic diseases[2]. In contrast, gut dysbiosis – where diversity is low or there is an imbalance of species – can increase the risk of infection and chronic diseases[3].

Studies over the past decade have discovered that certain dietary interventions can shift the gut microbiota towards a healthier balance.

These include high-fibre diets and prebiotics[4,5]. A prebiotic is "a substrate that is selectively utilised by host microorganisms conferring a health benefit"[6,7].

Several studies have demonstrated the prebiotic characteristics of FOS[8,9,10].

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Introducing FOS

FOS can be found naturally in plants, including onion, artichoke and wheat.

EUOLIGO® FOS is an ingredient produced enzymatically[11].

FOS are mostly not digested in the upper intestine; hence, they act as dietary fibres and are considered low in energy[12].

Potential benefits:

FOS are not broken down by digestive enzymes so they reach the colon intact where they are fermented by favourable bacterial species such as *Bifidobacteria* into short-chain fatty acids (SCFA) and other metabolites[12].

Studies suggest SCFA have positive health effects, such as strengthening the gut barrier[13], which may lead to a potentially beneficial impact on immunity, a favourable glycaemic response[14,15], reducing gut pH[13], and increasing mineral absorption[16].

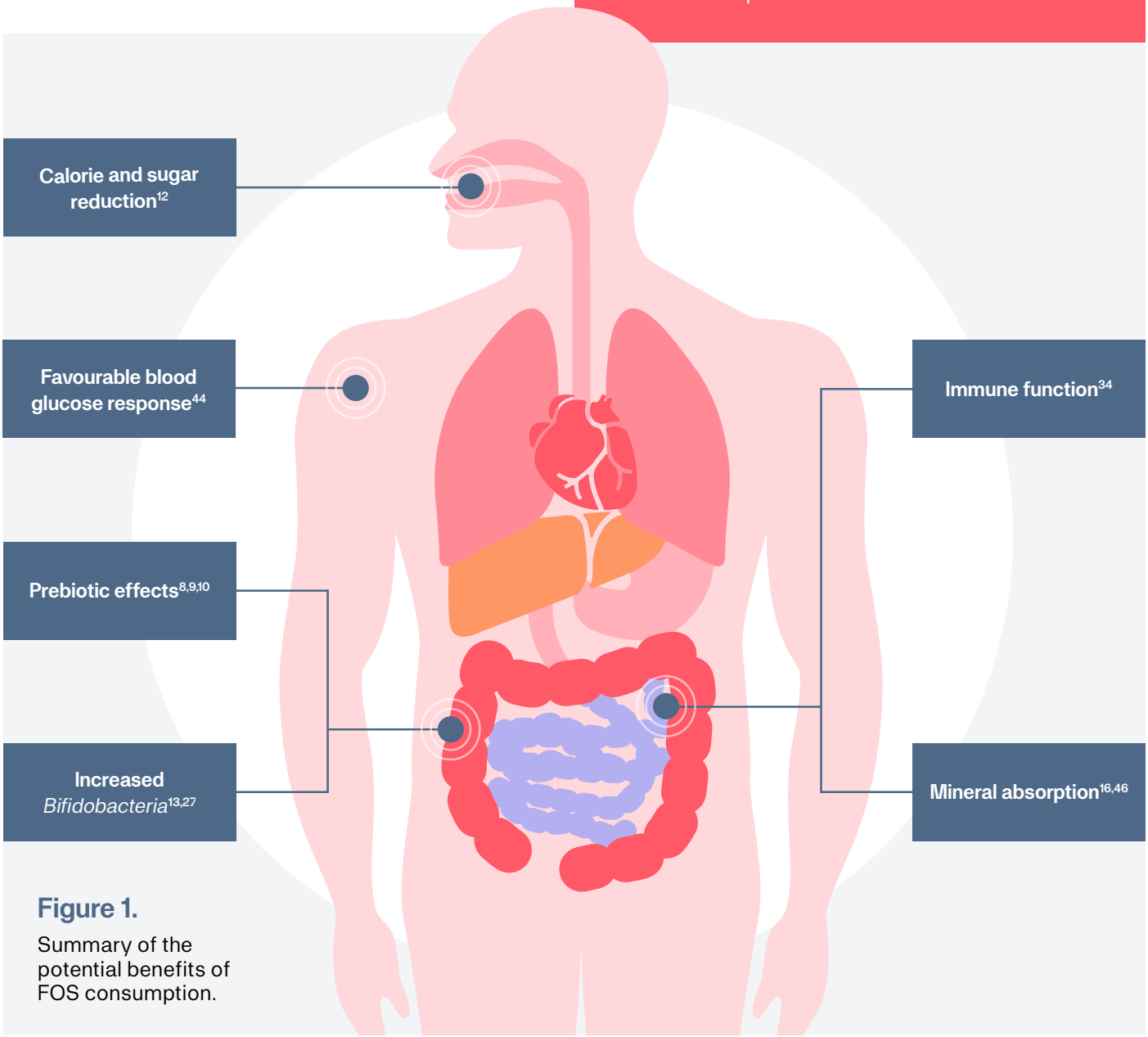

Figure 1.
Summary of the potential benefits of FOS consumption.

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Digestive health

Constipation is a common complaint, affecting 14.4% of children[17], 15.3% of adults[18], and 18.9% of older adults[19] globally."

FOS has a bulking effect on stools helping them to be passed more easily by the body[20]. Studies in healthy adults and adults with constipation show that adding FOS to the diet helps to increase stool frequency[21,22] or bulk[20] and improve stool consistency[23] as well as boosting numbers of more favourable bacterial species, such as *Bifidobacteria*[24,25].

Research findings:

Healthy, young adults who were given yoghurts and snack bars containing FOS **doubled** their dietary fibre intake and reported a more regular stool frequency[26].

In a study in nursing homes, constipated elderly residents given FOS passed stools more easily and **boosted** their gut levels of *Bifidobacteria*[27].

Another study, in which healthy adults consumed FOS daily in muffins, reported improvements in stool consistency without an increase in frequency[28]. Daily doses of 10–20g FOS appear to be well tolerated[29,30,31,32].

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Immune function

The gut has a major role in immune function, not only by providing a physical barrier to pathogens but also via interactions between the gut microbiota and immune cells[33].

In one study, older people were given 8g of FOS daily and followed up for three weeks. The results showed an increase in *Bifidobacteria* and a positive impact on immune function, expressed as increased numbers of key immune cells and a decrease in one type of inflammatory marker[34].

FOS may induce positive immune effects as a consequence of its selective stimulation of favourable types of microorganisms[35]. *Bifidobacteria* – a key species which ferments FOS – are known to release SCFA, which may strengthen the gut barrier[36] and lower the pH inside the gut[13]. As pathogens typically prefer environments with a neutral pH, they are less likely to thrive[37].

SCFA also support immune function by positively influencing toll-like receptor signalling and control of inflammation[38]. Toll-like receptors are immune cells responsible for identifying pathogens and launching an inflammatory response which attracts other types of cells that can 'attack' the pathogen.

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Favourable Glycaemic Response

Impaired glucose tolerance is an important risk factor for type 2 diabetes[42]. Hence, diet and lifestyle strategies to improve glucose tolerance can lower the risk of type 2 diabetes[43].

Studies show that adding FOS to the diet can support a favourable glycaemic response. In two studies in healthy adults, replacing the sugar (sucrose) in dairy desserts with FOS resulted in a significant decrease in post-meal blood glucose and insulin compared with a regular dessert[15, 44].

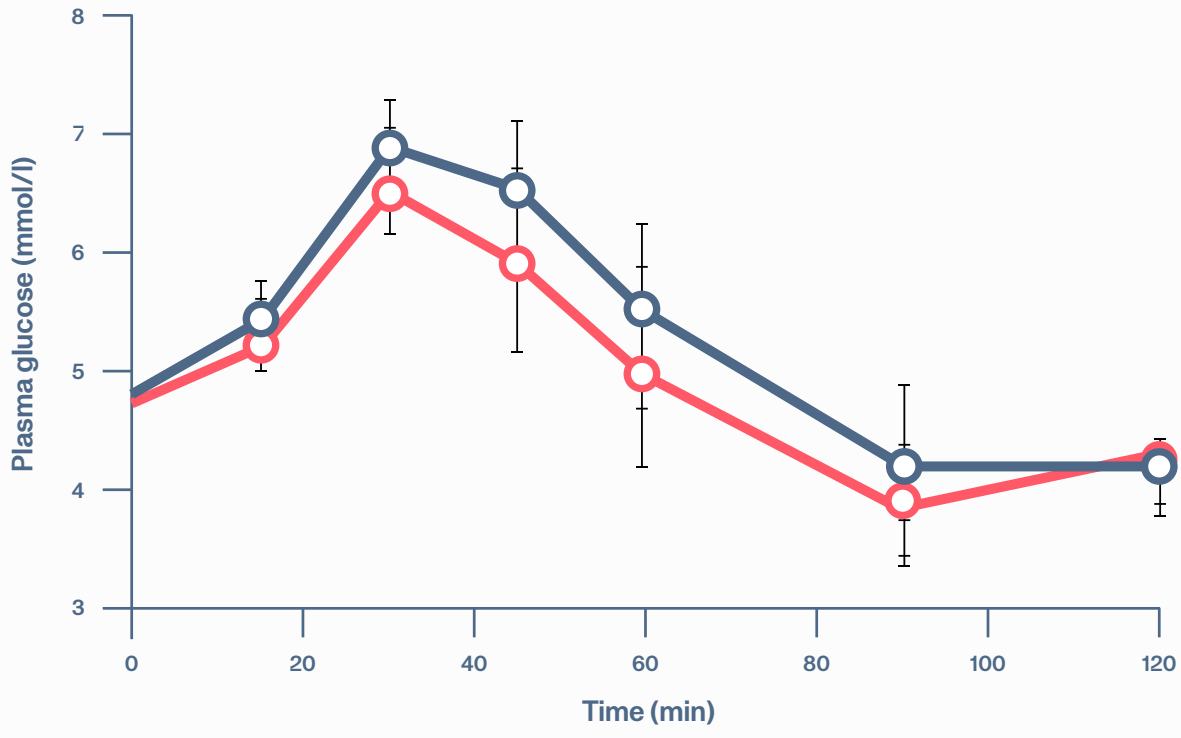
Type 2 diabetes is a growing issue globally[39].

In 2021, there were **529 million people** living with diabetes worldwide[39]. By 2050, more than **1.31 billion people** are projected to have diabetes worldwide[39].

Type 2 diabetes, which makes up **96%** of diabetes cases, is preventable and sometimes reversible if identified and managed **early** in the disease course[39-41].

Figure 2.

Post-meal plasma glucose curve following consumption of a dairy dessert with sucrose (slate circles) versus the same dairy dessert with FOS (coral circles); Adapted from Reference[15].



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Mineral absorption

Prebiotics, such as FOS, have been found to increase the uptake of some minerals[16].

Benefits were particularly seen for post-menopausal women, a group with a higher risk of bone mineral depletion due to oestrogen deficiency.

Individual intervention studies using intakes of 10g FOS per day have reported increased copper[45] and magnesium[46] absorption in post-menopausal women.

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References

1. Ruxton CHS, Kajita C, Rocca P, Pot B. Microbiota and probiotics: chances and challenges – a symposium report. Gut Microbiome, 2023, 4 :e6.

2. Rinninella E, Raoul P, Cintoni M et al. What is the healthy gut microbiota composition? A Changing Ecosystem across Age, Environment, Diet, and Diseases. Microorganisms, 2019, 7(1): 14.

3. Gagliardi A, Totino V, Cacciotti F et al. Rebuilding the gut microbiota ecosystem. Int J Environ Res Public Health, 2018, 15(8): 1679.

4. Vinelli V, Biscotti P, Martini D et al. Effects of dietary fibres on short-chain fatty acids and gut microbiota composition in healthy adults: A systematic review. Nutrients, 2022, 14(13): 2559.

5. Myhrstad MCW, Tunsjø H, Charnock C, Telle-Hansen VH. Dietary fibre, gut microbiota, and metabolic regulation – Current status in human randomized trials. Nutrients, 2020, 12(3): 859.

6. Gibson G, Hutkins R, Sanders M et al. 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 2017, 14: 491–502.

7. Hutkins R, Walter J, Gibson GR, Bedu-Ferrari C, Scott K, Tancredi DJ, Wijeyesekera A, Sanders ME. Classifying compounds as prebiotics - scientific perspectives and recommendations. Nat Rev Gastroenterol Hepatol. 2024 Oct 2. doi: 10.1038/s41575-024-00981-6.

8. Gibson GR, Beatty ER, Wan X, Cummings JH. Selective stimulation of bifidobacteria in the human colon by oligofructose and inulin. Gastroenterol, 1995, 108: 975-982.

9. Ten Bruggencate SJ, Bovee-Oudenhoven IM, Lettink-Wissink ML, Katan MB, van der Meer R. Dietary fructooligosaccharides affect intestinal barrier function in healthy men. J Nutr. 2006 Jan;136(1):70-4. doi: 10.1093/jn/136.1.70.

10. Bouhnik Y, Achour L, Paineau D et al. Four-week short-chain fructo-oligosaccharides ingestion leads to increasing fecal bifidobacteria and cholesterol excretion in healthy elderly volunteers. Nutr J, 2007, 6: 42.

11. EUOLIGO FOS website. https://www.qhtbio.com/cover-37.html

12. Molis C, Flourié B, Ouarne F et al. Digestion, excretion, and energy value of fructooligosaccharides in healthy humans. Am J Clin Nutr, 1996, 64(3): 324-8.

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References cont.

13. Bornet FR, Brouns F, Tashiro Y, Duvillier V. Nutritional aspects of short-chain fructooligosaccharides: natural occurrence, chemistry, physiology and health implications. Dig Liver Dis, 2002, 34 Suppl 2: S111-20.

14. Facchin S, Bertin L, Bonazzi E et al. Short-chain fatty acids and human health: From metabolic pathways to current therapeutic implications. Life, 2024, 14: 559.

15. Lecerf JM, Clerc E, Jaruga A et al. Postprandial glycaemic and insulinaemic responses in adults after consumption of dairy desserts and pound cakes containing short-chain fructo-oligosaccharides used to replace sugars. J Nutr Sci, 2015, 4: e34.

16. Costa GT, Vasconcelos QDJS, Abreu GC et al. Systematic review of the ingestion of fructooligosaccharides on the absorption of minerals and trace elements versus control groups. Clin Nutr ESPEN, 2021, 41: 68-76.

17. Tran DL, Sintusek P. Functional constipation in children: What physicians should know. World J Gastroenterol. 2023 Feb 28;29(8):1261-1288. doi: 10.3748/wjg.v29.i8.1261

18. Barberio B, Judge C, Savarino EV, Ford AC. Global prevalence of functional constipation according to the Rome criteria: a systematic review and meta-analysis. Lancet Gastroenterol Hepatol. 2021 Aug;6(8):638-648. doi: 10.1016/S2468-1253(21)00111-4.

19. Salari N, Ghasemianrad M, Ammari-Allahyari M, Rasoulpoor S, Shohaimi S, Mohammadi M. Global prevalence of constipation in older adults: a systematic review and meta-analysis. Wien Klin Wochenschr. 2023 Aug;135(15-16): 389-398. doi: 10.1007/s00508-023-02156-w

20. Buddington RK, Kapadia C, Neumer F, Theis S. Oligofructose Provides Laxation for Irregularity Associated with Low Fibre Intake. Nutrients, 2017, 9 (12): 1372.

21. Cummings JH, Christie S, Cole TJ. A study of fructo oligosaccharides in the prevention of travellers' diarrhoea. Aliment Pharmacol Ther, 2001, 5(8): 1139-45.

22. Dahl WJ, Wright AR, Specht GJ et al. Consuming foods with added oligofructose improves stool frequency: a randomised trial in healthy young adults. J Nutr Sci, 2014 3: e7.

23. Meksawan K, Chaotrakul C, Leeaphorn N et al. Effects of Fructo-Oligosaccharide Supplementation on Constipation in Elderly Continuous Ambulatory Peritoneal Dialysis Patients. Perit Dial Int, 2016, 36(1): 60-6.

24. Bouhnik Y, Flourie B, Riottot M et al. Effects of fructo-oligosaccharides ingestion on fecal bifidobacteria and selected metabolic indexes of colon carcinogenesis in healthy humans. Nutr Cancer, 1996, 26(1): 21-9.

25. Dou Y, Yu X, Luo Y et al. Effect of fructooligosaccharides supplementation on the gut microbiota in humans: A systematic review and meta-analysis. Nutrients, 2022, 14(16): 3298.

26. Dahl WJ, Wright AR, Specht GJ et al. Consuming foods with added oligofructose improves stool frequency: a randomised trial in healthy young adults. J Nutr Sci, 2014, 3: e7.

27. Yen CH, Kuo YW, Tseng YH et al. Beneficial effects of fructo-oligosaccharides supplementation on fecal bifidobacteria and index of peroxidation status in constipated nursing-home residents--a placebo-controlled, diet-controlled trial. Nutrition, 2011, 27(3): 323-8.

28 Mendlik K, Albrecht J & Schnepf M. Effects of Fructooligofructoses Chain Length on the Bifidobacteria of the Human Colon: A Pilot Study. Food and Nutrition Sciences, 3(12): 1615-1618.

29. Bouhnik Y, Vahedi K, Achour L et al. Short-chain fructo-oligosaccharide administration dose-dependently increases fecal bifidobacteria in healthy humans. J Nutr, 1999, 129(1): 113-6.

30. Briet F, Achour L, Flourie B et al., Symptomatic response to varying levels of fructo-oligosaccharides consumed occasionally or regularly. Eur J Clin Nutr, 1995, 49(7): 501-7.

31. Garleb KA, Snook JT, Marcon MJ et al. Effect of Fructooligosaccharide Containing Enteral Formulas on Subjective Tolerance Factors, Serum Chemistry Profiles, and Faecal Bifidobacteria in Healthy Adult Male Subjects. Microbiol Ecol Health Dis, 1996, 9(6): 279–285.

32. Respondek F, Hilpipre C, Chauveau P et al. Digestive tolerance and postprandial glycaemic and insulinaemic responses after consumption of dairy desserts containing maltitol and fructo-oligosaccharides in adults. Eur J Clin Nutr, 2014, 68(5): 575-80.lis C., et al., Digestion, excretion, and energy value of fructooligosaccharides in healthy humans. Am J Clin Nutr, 1996. 64(3): p. 324-8.

33. Kamada N, Chen GY, Inohara N, Núñez G. Control of pathogens and pathobionts by the gut microbiota. Nat Immunol, 2013, 14(7): 685-90.

34. Guigoz Y et al. 2002; Effect of oligosaccharide on the faecal flora and non-specific immune system in elderly people. Nutrition Research 22: 13-25.

35. Costa GT, Vasconcelos QDJS, Aragão GF. Fructooligosaccharides on inflammation, immunomodulation, oxidative stress, and gut immune response: a systematic review. Nutr Rev, 2022, 80(4): 709-722.

36. Akram W, Garud N, Joshi R. Role of inulin as prebiotics on inflammatory bowel disease. Drug Discov Ther, 2019, 3(1): 1-8.

37. Yamamura R, Inoue KY, Nishino K, Yamasaki S. Intestinal and fecal pH in human health. Front Microbiomes, 2023, 2: 1192316.

38. van der Beek CM, Dejong CHC, Troost FJ et al. Role of short-chain fatty acids in colonic inflammation, carcinogenesis, and mucosal protection and healing. Nutr Rev, 2017, 75(4): 286-305.

39. Ong KL, Stafford LK, McLaughlin SA, Boyko EJ, Vollset SE, Smith AE, Dalton BE, Duprey J, Cruz JA, Hagins H et al. 2023. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the Global Burden of Disease Study 2021. The Lancet. 402(10397):203-234.

40. Kolb H, Martin S. Environmental/lifestyle factors in the pathogenesis and prevention of type 2 diabetes. BMC Med. 2017 Jul 19;15(1):131. doi: 10.1186/s12916-017-0901-x.

41. Pot GK, Battjes-Fries MC, Patijn ON, Pijl H, Witkamp RF, de Visser M, van der Zijl N, de Vries M, Voshol PJ. Nutrition and lifestyle intervention in type 2 diabetes: pilot study in the Netherlands showing improved glucose control and reduction in glucose lowering medication. BMJ Nutr Prev Health. 2019 May 14;2(1):43-50. doi: 10.1136/bmjnph-2018-000012.

42. Huang Y, Cai X, Mai W et al. Association between prediabetes and risk of cardiovascular disease and all cause mortality: systematic review and meta-analysis. BMJ, 2016, 355: i5953.

43.Pan XR, Li GW, Hu YH et al. Effects of diet and exercise in preventing NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. Diabetes Care, 1997, 20(4): 537-44.

44. Respondek F, Hilpipre C, Chauveau P et al. Digestive tolerance and postprandial glycaemic and insulinaemic responses after consumption of dairy desserts containing maltitol and fructo-oligosaccharides in adults. Eur J Clin Nutr, 2014, 68(5): 575-80.

45. Ducros V, Arnaud J, Tahiri M et al. Influence of short-chain fructo-oligosaccharides (sc-FOS) on absorption of Cu, Zn, and Se in healthy postmenopausal women. J Am Coll Nutr, 2005, 24(1): 30-7.

46. Tahiri M, Tressol JC, Arnaud J et al. Five-week intake of short-chain fructo-oligosaccharides increases intestinal absorption and status of magnesium in postmenopausal women. J Bone Miner Res, 2001, 16(11): 2152-60.

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