

**Nutrition
Centre**

By TATE & LYLE

GOSYAN[®] GOS

**Health Benefits
of GOSYAN[®]
Galacto-oligosaccharide (GOS)**

Health benefits of GOSYAN® Galacto-oligosaccharide (GOS) from infants to older adults

Our unique gut microbiota is developed at birth and evolves throughout our lives, particularly at weaning and older age¹. The lactic acid bacteria (LAB), *Bifidobacteria* and *Lactobacilli* sp, are important for normal gut health across the lifecycle, helping to repel pathogens and producing short-chain fatty acids (SCFA) as a by-product of their metabolism².



Research suggests that SCFA have supportive effects across many aspects of human health including gut health, immune function, mineral absorption, and brain and mental health^{3,4,5}

We can support our gut microbiota by consuming prebiotics, such as GOS¹



Introducing GOSYAN® (GOS)

GOS are prebiotics, defined as “a substrate that is selectively utilised by host microorganisms conferring a health benefit”^{6,7}

GOSYAN® GOS is made enzymatically. GOS can be synthesised from lactose by microbial β -galactosidases that catalyse the transfer of galactose residues to lactose, its hydrolysis products galactose or glucose, or newly produced oligosaccharides.

Potential benefits:



GOS are resistant to digestion, which enables them to reach the colon intact, where they can have beneficial effects⁸. GOS are non-digestible oligosaccharides characterised by a mix of structures that vary in their degree of polymerisation (DP) and glycosidic linkage between the galactose moieties or between galactose and glucose¹⁰.

Several studies have demonstrated the prebiotic characteristics of GOS^{8,9}. GOS has been widely used in milk powders, infant foods, functional foods, and dairy products.



Benefits for infants, children, and adolescents

One reason for the superiority of breast milk over formula milk is the presence of naturally occurring GOS, which support the infant's gut microbiota and healthy digestion¹¹. GOS can also be manufactured, and several studies have demonstrated the positive health effects of these types in infants and children^{9,12,13}.

Promoting lactic acid bacteria (LAB) in the gut

A gut microbiota rich in LAB is more favourable to human health. Studies in infants have associated the presence of *Bifidobacteria* with the inhibition of pathogens, prevention of diarrhoea, increased SCFA, anti-inflammatory activity, immune development, and brain development¹⁰.



Research findings:

In a study of newborn term infants, those not receiving breast milk were randomised to receive a standard formula or one with 0.24g GOS per 100mL¹⁴.

Breast-fed infants acted as a reference group.

After 3 months, gut levels of *Bifidobacteria* and *Lactobacilli* had increased in the breast-fed infants as well as those receiving the GOS-fortified formula, compared with the standard formula.

Another trial in infants aged 4-6 months compared a standard formula with one containing 0.5g GOS per 100 mL. The results after 6 and 12 weeks showed increased *Bifidobacteria* levels in the GOS formula group compared with standard formula¹⁵.

Similar effects on *Bifidobacteria* and *Lactobacilli* in infants were confirmed in a systematic review of the evidence, which also reported a lower stool pH and lower levels of *Clostridium* (a potential pathogen)¹².



Digestive health and comfort

Stools are typically harder and less frequent in formula-fed infants compared with breast-fed infants, which can lead to discomfort¹⁶.

Adding GOS to infant formula can help soften and regularise stools in formula-fed infants according to the findings of clinical trials^{13,17,18,19}. This may be because SCFA produced by the increased levels of LAB stimulate gut peristalsis and draw water into the faeces⁸.

Calcium absorption

Almost all the calcium in our bodies is stored in the bones, making it a critical mineral for normal bone development²⁰. GOS resists digestion, allowing it to be fermented in the large intestine, in particular by *Bifidobacteria*, to produce SCFA². These lower gut pH which may improve calcium absorption in the gut^{9,21}.

A clinical trial examined the effect of consuming two GOS-fortified smoothies (5g and 10g per day) in 31 healthy girls aged 10–13 years⁹. The results showed a significant improvement in calcium absorption over three weeks, equivalent to an extra 130 mg/day or 49 g/year of calcium being available for deposition into bone. According to the International Osteoporosis Foundation, approximately half of bone mass is accumulated during childhood and adolescence, making these critical periods for bone development²². Maximising bone mass before adulthood helps lower the risk of osteoporosis later in life.

Tolerance and impact on growth

According to systematic reviews, GOS-supplemented formula supported normal growth in infants from 0–12 months of age, while gastric tolerance was good at intakes of 0.15 to 0.8 g/100mL^{13,19}. This indicates that GOS can be added safely to infant formula. In adolescents, 10g of GOS per day was well tolerated with no adverse gastrointestinal effects⁹.



Benefits for adults and older adults

GOS offers benefits across the lifecycle, which is relevant as many countries now have aging populations.

Promoting lactic acid bacteria (LAB) in the gut

Studies in adults have confirmed that adding GOS to the diet stimulates LAB in adults^{6,23}. In one trial, 5-10g GOS per day added to confectionery significantly increased gut levels of *Bifidobacteria*²⁴.



Digestive health and comfort, research findings:



Several studies report that GOS can help alleviate constipation in adults²⁵ and elderly populations²⁶.

GOS may work by bulking faeces and drawing more water into the gut, as well as by promoting intestinal peristalsis via the actions of SCFA⁸.

In one trial, constipation severity and quality of life were improved in healthy, sedentary adults following 30 days of gummies containing 10g of GOS per day²⁷.

Research also suggests benefits for the prevention of travellers' diarrhoea when GOS is taken prior to overseas travel^{28,29}, and for the alleviation of bloating and flatulence³⁰.

Research^{31,32,33} also suggests that adding GOS to the diet can help improve tolerance of lactose, a dairy sugar. The worldwide prevalence of lactose malabsorption is 68%, with symptoms including diarrhoea, flatulence, nausea, gut distension, and abdominal pain³⁴.



Immune health

Both LAB and SCFA benefit the gut barrier, which is our first line of immune defence³⁵. Studies show that GOS indirectly acts on immune function via its prebiotic effects⁶.



Research findings:



Two studies in older adults found positive changes to immune markers after a daily GOS intake of 5.5g per day for 10 weeks^{36,37}.

The results showed increased activity of specific immune cells, such as natural killer cells, and a shift towards anti-inflammatory markers. The authors concluded that GOS: "could be of importance in the elderly as an attractive option for enhancement of both the microbial and immune systems."



Calcium absorption

Calcium remains important for bone health across the lifecycle, especially in the post-menopausal stage, when it helps to reduce the risk of osteoporosis³⁸

Calcium absorption was improved by 16% in post-menopausal women who consumed 20g of GOS daily in fortified yoghurt³⁹. As the authors concluded, this would be expected to lead to better uptake of calcium by bones since there was no increase in calcium excretion in urine.



Tolerance

Studies providing 5–20g of GOS per day report good tolerance in healthy adults^{23,26,39}.

The prebiotic benefits of GOS in adults include metabolic health, urogenital health, digestive function^{25,26}, immune function, and travellers' diarrhoea⁶.



Health benefits of Galacto-oligosaccharide (GOS)



Adults and older adults

- Digestive health
- Lactic acid bacteria
- Immune health
- Calcium absorption



Adolescents and children

- Calcium absorption
- Lactic acid bacteria



Infants

- Lactic acid bacteria
- Softer stools



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 Mei Z, Yuan J, Li D. Biological activity of galacto-oligosaccharides: A review. *Front Microbiol*, 2022, 13: 993052.
- 3 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.
- 4 Zhang D, Jian YP, Zhang YN et al. Short-chain fatty acids in diseases. *Cell Commun Signal*, 2023, 21: 212.
- 5 Macfarlane S, Macfarlane GT, Cummings JH. Review article: prebiotics in the gastrointestinal tract. *Aliment Pharmacol Ther*, 2006, 24(5): 701-14.
- 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 Meyer TSM, Miguel ASM, Fernández DER, Ortiz GMD. Biotechnological Production of Oligosaccharides – Applications in the Food Industry [Internet]. *Food Production and Industry*. InTech, 2015. Available from: <http://dx.doi.org/10.5772/60934>.
- 9 Whisner CM, Martin BR, Schoterman MHC et al. Galacto-oligosaccharides increase calcium absorption and gut bifidobacteria in young girls: a double-blind cross-over trial. *Br J Nutr*, 2013, 110: 1292-1303.
- 10 Ambrogi V, Bottacini F, Cao L, et al. Galacto-oligosaccharides as infant prebiotics: Production, application, bioactive activities and future perspectives. *Critical Reviews in Food Science and Nutrition*, 2023, 63(6): 753-766.
- 11 Intanon M, Arreola SL, Pham NH et al. Nature and biosynthesis of galacto-oligosaccharides related to oligosaccharides in human breast milk. *FEMS Microbiol Lett*, 2014, 353(2): 89–97.
- 12 Ferro LE, Crowley LN, Bittinger K et al. Effects of prebiotics, probiotics, and synbiotics on the infant gut microbiota and other health outcomes: A systematic review. *Crit Rev Food Sci Nutr*, 2023, 63(22): 5620-5642.
- 13 Rao S, Srinivasjois R, Patole S. Prebiotic supplementation in full-term neonates: a systematic review of randomized controlled trials. *Arch Pediatr Adolesc Med*, 2009, 163(8): 755–64.
- 14 Ben XM, Li J, Feng ZT, Shi SY et al. Low level of galacto-oligosaccharide in infant formula stimulates growth of intestinal Bifidobacteria and Lactobacilli. *World J Gastroenterol*, 2008, 14(42): 6564–8.
- 15 Fanaro S, Marten B, Bagna R et al. Galacto-oligosaccharides are bifidogenic and safe at weaning: a double-blind randomized multicenter study. *J Pediatr Gastroenterol Nutr*, 2009, 48(1): 82–8.
- 16 Mao M, Zhang L, Ge J et al. Infant Feeding Regimens and Gastrointestinal Tolerance: A Multicenter, Prospective, Observational Cohort Study in China. *Glob Pediatr Health*, 2018, 5: 2333794X17750271.
- 17 Sierra C, Bernal MJ, Blasco J et al. Prebiotic effect during the first year of life in healthy infants fed formula containing GOS as the only prebiotic: a multicentre, randomised, double-blind and placebo-controlled trial. *Eur J Nutr*, 2015, 54(1): 89–99.
- 18 Ashley C, Johnston WH, Harris CL et al. Growth and tolerance of infants fed formula supplemented with polydextrose (PDX) and/or galactooligosaccharides (GOS): double-blind, randomized, controlled trial. *Nutr J*, 2012, 11: 38.
- 19 Skórka A, Pieścik-Lech M, Kotodziej M, Szajewska H. Infant formulae supplemented with prebiotics: Are they better than unsupplemented formulae? An updated systematic review. *Br J Nutr*, 2018, 119(7): 810–825.
- 20 National Institutes of Health. Calcium, 2024. <https://ods.od.nih.gov/factsheets/Calcium-HealthProfessional/#1>
- 21 Nogacka AM, Salazar N, Arboleya S et al. In vitro evaluation of different prebiotics on the modulation of gut microbiota composition and function in morbid obese and normal-weight subjects. *Int J Mol Sci*, 2020, 21(3): 906.
- 22 International Osteoporosis Foundation factsheet – available online: https://www.osteoporosis.foundation/sites/IOFbonehealth/files/2019-03/2015_ServeUpBoneStrengthNutrition_FactSheet_English_0.pdf
- 23 Wilms E, An R, Smolinska A et al. Galacto-oligosaccharides supplementation in prefrail older and healthy adults increased faecal bifidobacteria, but did not impact immune function and oxidative stress. *Clin Nutr*, 2021, 40(5): 3019–3031.
- 24 Davis LM, Martínez I, Walter J, Hutkins R. A dose dependent impact of prebiotic galactooligosaccharides on the intestinal microbiota of healthy adults. *Int J Food Microbiol*, 2010, 144(2): 285–92.
- 25 Schoemaker MH, Hageman JHJ, Ten Haaf D et al. Prebiotic Galacto-Oligosaccharides Impact Stool Frequency and Fecal Microbiota in Self-Reported Constipated Adults: A Randomized Clinical Trial. *Nutrients*, 2022, 14(2): 309.
- 26 Niittynen L, Kajander K, Korpela R. Galacto-oligosaccharides and bowel function. *Scand J Food Nutr*, 2007, 51(2): 62–6.
- 27 Dey K, Sheth M, Anand S et al. Daily consumption of galactooligosaccharide gummies ameliorates constipation symptoms, gut dysbiosis, degree of depression and quality of life among sedentary university teaching staff: A double-blind randomized placebo control clinical trial. *Indian J Gastroenterol*, 2023, 42(6): 839–848.
- 28 Hasle G, Raastad R, Bjune G et al. Can a galacto-oligosaccharide reduce the risk of traveller's diarrhoea? A placebo-controlled, randomized, double-blind study. *J Travel Med*, 2017, 24(5): <https://doi.org/10.1093/jtm/tax057>
- 29 Drakoularakou A, Tzortzis G, Rastall RA, Gibson GR. A double-blind, placebo-controlled, randomized human study assessing the capacity of a novel galacto-oligosaccharide mixture in reducing travellers' diarrhoea. *Eur J Clin Nutr*, 2010, 64(2): 146–52.
- 30 Vulevic J, Tzortzis G, Juric A, Gibson GR. Effect of a prebiotic galactooligosaccharide mixture (B-GOS®) on gastrointestinal symptoms in adults selected from a general population who suffer with bloating, abdominal pain, or flatulence. *Neurogastroenterol Motil*, 2018, 30(11): e13440.
- 31 Chey W, Sandborn W, Ritter AJ et al. Galacto-Oligosaccharide RP-G28 Improves Multiple Clinical Outcomes in Lactose-Intolerant Patients. *Nutrients*, 2020, 12(4): 1058.
- 32 Mysore Saiprasad S, Moreno OG, Savaiano DA. A narrative review of human clinical trials to improve lactose digestion and tolerance by feeding Bifidobacteria or galacto-oligosaccharides. *Nutrients*, 2023, 15(16): 3559.
- 33 Savaiano DA, Ritter AJ, Klaenhammer TR. Improving lactose digestion and symptoms of lactose intolerance with a novel galacto-oligosaccharide (RP-G28): a randomized, double-blind clinical trial. *Nutr J*, 2013, 12: 160.
- 34 Storhaug CL, Fosse SK, Fadnes LT. Country, regional, and global estimates for lactose malabsorption in adults: a systematic review and meta-analysis. *Lancet Gastroenterol Hepatol* 2017, 2(10): 738–746.
- 35 Kamada N, Chen GY, Inohara N, Núñez G. Control of pathogens and pathobionts by the gut microbiota. *Nat Immunol*, 2013, 14(7): 685–90.
- 36 Vulevic J, Drakoularakou A, Yaqoob P et al. Modulation of the fecal microflora profile and immune function by a novel trans-galactooligosaccharide mixture (B-GOS) in healthy elderly volunteers. *Am J Clin Nutr*, 2008, 88(5): 1438–46.
- 37 Vulevic J, Juric A, Walton GE, Claus SP et al. Influence of galacto-oligosaccharide mixture (B-GOS) on gut microbiota, immune parameters and metabonomics in elderly persons. *Br J Nutr*, 2015, 114(4): 586–95.
- 38 Food and Drugs Administration. Review of the scientific evidence on the physiological effects of certain non-digestible carbohydrates, 2018. <https://www.fda.gov/media/113659/download>
- 39 Van den Heuvel EGHM, Schoterman MHC & Muijs T. Trans galacto-oligosaccharides stimulate calcium absorption in postmenopausal women. *Journal of Nutrition* 2000, 130:2938–2942.

Nutrition Centre

By TATE & LYLE

To learn more about Tate & Lyle ingredients and innovations as well as health benefits and relevant research, please visit www.tateandlyle.com/nutrition-centre

The purpose of this brochure is to provide information about the current state of the science around GOS and associated health benefits. The health benefit statements included in this brochure are not suggested as claims to be used in labelling or advertising. Customers are encouraged to conduct their own risk assessments and due diligence regarding the use and claims related to GOS. It is the customers' responsibility to ensure compliance with all relevant local regulations and to verify the accuracy and appropriateness of any claims made.
