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Review Article

Effect of a Fermented Soy-Based Probiotic Beverage on Bowel Habit and Faecal Microbiota Composition in Adults with Functional Constipation: A Randomized, Double-Blind, Placebo-Controlled Trial

Kazlauskas D[1]*, Rinaldi V[2] and Perkovic A[3]

[1]Department of Clinical Nutrition, Vilnius University, Vilnius, Lithuania
[2]Department of Gastroenterology, University of Turin, Turin, Italy
[3]Department of Food Microbiology, University of Zagreb, Zagreb, Croatia

*Address for Correspondence: Darius Kazlauskas, Department of Clinical Nutrition, Vilnius University, Vilnius, Lithuania; E-mail: darius.kazlauskas@vilniusuniversity.edu

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Abstract

Background: Functional constipation affects roughly one in ten adults; fermented soy beverages have been proposed to improve bowel habit.

Objective: To synthesise trial evidence on soy/dairy probiotic beverages and microbiota outcomes in constipation.

Methods: Narrative review of randomised trials, meta-analyses, and mechanistic studies.

Findings: Probiotic beverages increase stool frequency and shorten transit time (SMD 0.40); galacto-oligosaccharides expand faecal Bifidobacterium (10.9% to 23.9%). Synbiotics outperform single agents.

Conclusions: Fermented soy-based probiotic beverages are a plausible, safe adjunct for constipation.

Keywords: Functional constipation; Probiotic; Fermented soy beverage; Faecal microbiota; Short-chain fatty acids

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Introduction

Functional constipation is one of the most common disorders of gut-brain interaction, with a pooled global prevalence of 10.1% under Rome IV criteria and a burden roughly twice as high in women as in men [1]. Community-based data confirm that low fibre and fluid intake, sedentary behaviour, and older age are consistent risk factors, and that the condition substantially impairs quality of life [2]. Because first-line fibre and osmotic laxative strategies do not satisfy all patients, food-based interventions delivering live micro-organisms — probiotics — alongside fermentable substrates have attracted sustained clinical interest [3].

Soy-based beverages are an attractive probiotic vehicle: fermentation by lactic acid bacteria converts glycosylated soy isoflavones to more bioavailable aglycone and equol-type metabolites [4], degrades the raffinose and stachyose oligosaccharides responsible for soy's flatulence-inducing reputation while generating fermentable substrate for colonic bacteria [5], and reduces other antinutritional and off-flavour compounds that otherwise limit palatability [6]. These transformations, reviewed comprehensively for lactic-acid-bacteria-fermented soymilk, are associated with antihypertensive, antioxidant and gut-modulating bioactivities beyond those of the unfermented substrate [7,8]. A randomised, double-blind, placebo-controlled trial of fermented soymilk containing *Lacticaseibacillus paracasei* strain YIT 9029 in adults reporting a tendency to constipation demonstrated improved defecation habits alongside measurable shifts in gut microbiota composition, directly motivating the present synthesis [9].

This review synthesises the published randomised-trial, systematic-review, and mechanistic literature on fermented soy-based and dairy-based probiotic beverages, prebiotic oligosaccharide comparators, and their combined effects on bowel habit, faecal microbiota composition, and short-chain fatty acid (SCFA) production in adults with functional constipation. Relevant publications were identified through targeted searches of PubMed, Europe PMC and Crossref for randomised controlled trials, systematic reviews, meta-analyses, and mechanistic microbiology studies addressing fermented soy or dairy probiotic beverages, prebiotic oligosaccharides, and functional constipation or its Rome-defined equivalents, supplemented by hand-searching reference lists of retrieved reviews. It is a narrative synthesis of the existing evidence base rather than a report of a single new dataset, and it deliberately situates the soy-specific evidence within the larger and more mature dairy-based probiotic literature to indicate where extrapolation, rather than direct evidence, currently underpins clinical practice.

Fermented Soy Substrates and Probiotic Strain Selection

Soymilk is a favourable but technically demanding fermentation substrate. Lactic acid bacteria growth is

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initially limited by soy's low free-sugar content, but *Lactobacillus* and *Lacticaseibacillus* strains adapted to plant matrices deglycosylate isoflavones, hydrolyse raffinose-family oligosaccharides via β-D-fructofuranosidase activity, and improve gel and sensory properties of the coagulated product [5,7]. Comparative metabolic profiling of lactic-acid-bacteria fermentation across plant-based dairy alternatives shows consistent reductions in off-flavour aldehydes and antinutrients alongside increases in bioavailable phenolics [6], and an integrative review of the "gut microbiome axis" of Lactobacillus-fermented soymilk links these substrate changes mechanistically to downstream shifts in host microbiota and short-chain fatty acid output [8]. Strain selection therefore matters: *L. paracasei* YIT 9029 was selected for a fermented-soymilk constipation trial specifically for its survival through soy fermentation and demonstrated colonisation of the lower gut [9], while *Lacticaseibacillus paracasei* strain Shirota and two-strain heat-inactivated (postbiotic) *paracasei* formulations have been validated in dairy vehicles for the same indication [10,11]. Because soy fermentation additionally removes much of the raffinose and stachyose load that otherwise reaches the colon undigested, a fermented soy beverage delivers a smaller but more readily fermentable oligosaccharide residue than unfermented soymilk, which may explain why fermented rather than raw soy products are preferentially studied as constipation interventions [5].

Bowel Habit, Stool Consistency and Transit Time (Table 1)

Across probiotic fermented-beverage trials, the most consistently reported outcomes are weekly stool frequency, Bristol stool consistency, and instrumented transit time (Table 1). A randomised, double-blind, placebo-controlled trial of a probiotic fermented milk in adults with functional constipation reported clinically meaningful improvements in stool frequency and consistency relative to placebo over the intervention period [12]. The double-blind trial of *L. paracasei* YIT 9029 fermented soymilk similarly improved defecation frequency and self-reported evacuation difficulty relative to an unfermented control beverage [9]. In a depression cohort with comorbid constipation, fermented milk containing *L. paracasei* strain Shirota produced greater relief of stool-related symptoms than placebo alongside reduced interleukin-6 [10], and a heat-inactivated two-strain *paracasei* postbiotic fermented milk improved constipation scores without requiring viable organisms [11]. Foundational work with *Bifidobacterium animalis* DN-173 010 fermented milk showed significantly shortened total and sigmoid colonic transit time in healthy women [13], later corroborated by improved self-reported digestive comfort in a general adult population [14]. Pooling across the wider probiotic literature, a meta-analysis of 11 trials (464 participants) found a pooled standardised mean difference of 0.40 (95% CI 0.20–0.59) for reduced intestinal transit time with probiotic supplementation [15], and independent meta-analyses of randomised trials confirm probiotics significantly increase stool frequency and soften consistency versus placebo in adults with functional constipation [16,17].

Table 1: Selected randomised controlled trials of fermented soy- and dairy-based probiotic beverages in adults with functional constipation or constipation-predominant symptoms reviewed here [9,12,10,11,13,14].

Study	Vehicle/strain	Design	Duration	Key bowel-habit outcome
Kaga 2024	Fermented soymilk, L. paracasei YIT 9029	RCT, double-blind	Not stated (trial period)	Improved defecation frequency and microbiota shifts

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Study	Vehicle/strain	Design	Duration	Key bowel-habit outcome
Mazlyn 2013	Probiotic fermented milk	RCT, double-blind	2 weeks	Improved stool frequency and consistency
Zhang 2021	Fermented milk, L. paracasei Shirota	RCT, double-blind	9 weeks	Greater relief of stool-related symptoms; lower IL-6
Li 2026	Heat-inactivated two-strain L. paracasei (postbiotic) milk	RCT, double-blind	Not stated (trial period)	Improved constipation scores
Marteau 2002	Fermented milk, B. animalis DN-173 010	RCT, double-blind	2 weeks	Shortened total and sigmoid colonic transit time
Guyonnet 2009	Fermented milk, B. lactis DN-173 010	Randomised, open-label, controlled pilot	2 weeks	Improved self-reported digestive comfort

Faecal Microbiota Composition and Diversity (Figure 1)

Functional constipation is associated with altered, rather than uniformly depleted, faecal microbiota: constipated women of reproductive age show a distinct compositional signature relative to eupeptic controls [18], and characterisation across constipation subtypes links specific taxa to colonic physiology and lifestyle factors [19]. Integrated metabolomic and metagenomic profiling shows that gut microbiota and their metabolites are jointly altered and interrelated in functional constipation, implicating deficits in saccharolytic, SCFA-producing taxa [20]. A synthesis of this literature situates probiotic and fermented-food interventions as a rational strategy for restoring a saccharolytic, Bifidobacterium-rich profile [21]. The *L. paracasei* YIT 9029 fermented-soymilk trial documented favourable shifts in faecal microbiota alongside improved defecation habits [9], and a randomised trial of soy-relevant galacto-oligosaccharides in self-reported constipated adults found that an 11 g daily dose increased faecal Bifidobacterium relative abundance from 10.9% to 23.9% ($p<0.001$), with the largest bowel-frequency gains in participants with the lowest baseline frequency (Figure 1) [22].

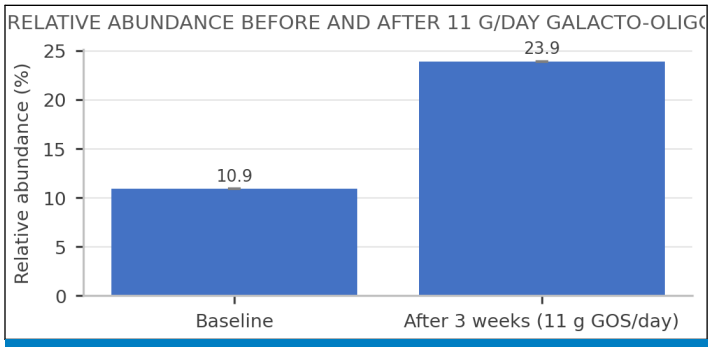

Figure 1: Faecal Bifidobacterium relative abundance before and after three weeks of 11 g/day galacto-oligosaccharide supplementation in self-reported constipated adults (10.9% to 23.9%, $p<0.001$) [22].

Short-Chain Fatty Acid Mechanisms

The plausible mechanistic link between fermented soy probiotic beverages and improved bowel habit runs through colonic SCFA production. Saccharolytic fermentation of surviving soy oligosaccharides and probiotic biomass by resident Bifidobacterium and Lactobacillus populations yields acetate, propionate and butyrate, which stimulate colonic mucosal serotonin release, modulate smooth-muscle contractility, and accelerate transit; a recent mechanistic synthesis frames the gut microbiota–SCFA signalling axis as a multi-target node in slow-transit constipation, spanning enteric neurotransmission, water and electrolyte handling, and hormonal secretion [23]. Butyrate and propionate in particular have been shown to increase colonic smooth-muscle contractile activity and to stimulate enterochromaffin-cell serotonin release, both of which shorten transit time, while a saccharolytic shift away from proteolytic fermentation reduces the generation of potentially pro-inflammatory metabolites in the distal colon. This mechanistic framework is consistent with the

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transit-time and frequency benefits observed for both soy-derived oligosaccharide substrates and their fermenting probiotic organisms described above, and it offers a testable rationale for why isoflavone- and oligosaccharide-rich fermented soy beverages might outperform isolated probiotic strains delivered in a non-fermentable vehicle.

Comparative Evidence Across Strains and Prebiotic Approaches (Figure 2, Table 2)

Fermented soy beverages sit within a broader landscape of probiotic, prebiotic, and synbiotic options, and comparative data help contextualise expected effect size (Table 2). A network meta-analysis of 37 randomised controlled trials (3,903 patients) evaluating 21 distinct interventions found lactulose alone increased weekly stool frequency by a mean difference of 3.39 movements versus placebo, while multi-agent synbiotic combinations performed still better — a lactulose-Bacillus coagulans combination by 3.63 and a lactulose-Bifidobacterium-Enterococcus combination by 4.58, the latter carrying the highest probability of superiority among all combinations tested (Figure 2) [24]. A scoping review of strain-specific *Lactiplantibacillus plantarum* evidence likewise emphasises that clinical benefit for gastrointestinal endpoints is strain- and formulation-dependent rather than a generic species-level effect [25], reinforcing the International Scientific Association for Probiotics and Prebiotics consensus that probiotic, prebiotic and synbiotic terminology should not be used interchangeably when comparing evidence [3]. Relative to these comparators, fermented soy beverages combine a probiotic organism with an endogenous prebiotic-like oligosaccharide/isoflavone matrix, but head-to-head trials against dairy-based or synbiotic formulations in functional constipation remain few.

Safety and Tolerability

Table 2: Selected systematic reviews and meta-analyses of probiotic, prebiotic and synbiotic interventions for functional/chronic constipation in adults [16,15,17,24,1].

Synthesis	Scope	Studies pooled	Key quantitative finding
Dimidi 2014	Probiotics vs placebo, functional constipation	Systematic review/meta-analysis	Significant increase in stool frequency and softening of consistency
Miller 2013	Probiotics vs placebo/control, transit time	11 trials, 464 participants	Pooled SMD 0.40 (95% CI 0.20-0.59) for reduced transit time
Zhang 2020	Probiotics vs placebo, functional constipation	Meta-analysis of RCTs	Significant improvement in stool frequency and consistency
Deng 2024	Probiotics, prebiotics, synbiotics, chronic constipation	37 RCTs, 3,903 patients	Synbiotic combinations up to MD 4.58 bowel movements/week vs placebo
Barberio 2021	Global epidemiology of functional constipation	45 studies, 275,260 subjects	Pooled Rome IV prevalence 10.1%

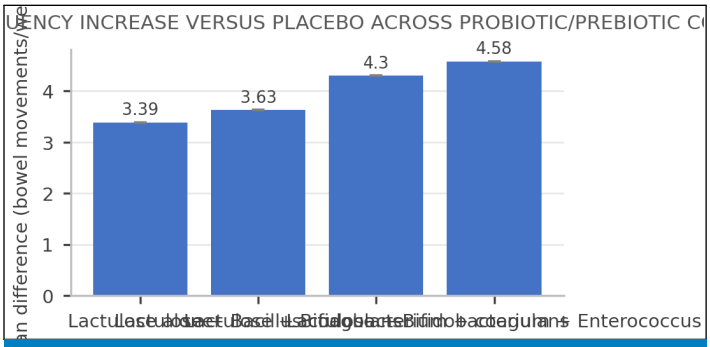

Figure 2: Mean difference in weekly stool frequency versus placebo for lactulose alone and three multi-agent probiotic/prebiotic combinations, from a network meta-analysis of 37 randomised controlled trials (3,903 patients) [24].

Across the fermented-beverage and meta-analytic literature reviewed here, adverse event rates with probiotic and postbiotic interventions did not differ significantly from placebo, including in the largest network meta-analysis to date [24] and in individual dairy- and soy-based trials [10,11,9]. A contemporary review of probiotic safety and efficacy across commonly used strains found no signal of excess serious adverse events in immunocompetent adults, while noting that rigorous

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strain-level and dose-level safety reporting remains inconsistent across the literature [26]. Soy-based fermented beverages carry the additional practical advantage of a lactose-free matrix, potentially widening tolerability in lactose-intolerant populations relative to dairy-based probiotic vehicles, though this comparative claim has not been directly tested in head-to-head constipation trials.

Conclusion

Fermented soy-based probiotic beverages combine a probiotic organism, bioavailable isoflavone metabolites, and residual fermentable oligosaccharide substrate in a single food matrix, and the limited direct trial evidence — anchored by a randomised, double-blind, placebo-controlled study of *L. paracasei* YIT 9029 fermented soymilk — shows improved defecation habits and favourable faecal microbiota shifts consistent with the wider probiotic and prebiotic literature in functional constipation [9]. Pooled data across dairy-based probiotic trials confirm meaningful reductions in transit time and increases in stool frequency [15,16,17], and network meta-analysis suggests multi-agent synbiotic combinations may exceed single-strain effects [24]. The principal evidence gap is the paucity of adequately powered, soy-specific randomised trials directly comparing fermented soy beverages against dairy-based probiotics and non-fermented soy or oligosaccharide comparators; such trials, with standardised stool-diary and sequencing-based microbiota endpoints, are needed to establish fermented soy beverages as an evidence-based constipation therapy rather than a plausible extrapolation from related probiotic literature.

References

1. Barberio, B., Judge, C., Savarino, E.V., Ford, A.C. (2021) Global prevalence of functional constipation according to the Rome criteria: a systematic review and meta-analysis. Lancet Gastroenterology & Hepatology, 6(8): 638-648.

2. Suares, N.C., Ford, A.C. (2011) Prevalence of, and risk factors for, chronic idiopathic constipation in the community: systematic review and meta-analysis. American Journal of Gastroenterology, 106(9): 1582-1591.

3. Hill, C., Guarner, F., Reid, G., Gibson, G.R., Merenstein, D.J., Pot, B., Morelli, L., Canani, R.B., Flint, H.J., Salminen, S., Calder, P.C., Sanders, M.E. (2014) The International Scientific Association for Probiotics and Prebiotics consensus statement on the scope and appropriate use of the term probiotic. Nature Reviews Gastroenterology & Hepatology, 11(8): 506-514.

4. Langa, S., Peirotén, Á., Curiel, J.A., Ruiz de la Bastida, A., Landete, J.M. (2023) Isoflavone metabolism by lactic acid bacteria and its application in the development of fermented soy food with beneficial effects on human health. Foods, 12(6): 1293.

5. Chen, Z., Shen, Y., Xu, J. (2023) Efficient degradation for raffinose and stachyose of a β-D-fructofuranosidase and its new function to improve gel properties of coagulated fermented-soymilk. Gels, 9(4): 345.

6. Molina, G.E.S., Ras, G., da Silva, D.F., Duedahl-Olesen, L., Hansen, E.B., Bang-Berthelsen, C.H. (2025) Metabolic insights of lactic acid bacteria in reducing off-flavors and antinutrients in plant-based fermented dairy alternatives. Comprehensive Reviews in Food Science and Food Safety, 24(2): e70134.

7. Kumari, M., Kokkiligadda, A., Dasriya, V., Naithani, H. (2022) Functional relevance and health benefits of soymilk fermented by lactic acid bacteria. Journal of Applied Microbiology, 133(1): 104-119.

8. Saini, V., Verma, A., Kumari, S., Chaudhary, S., Mishra, A., Kumar, A., Jha, H.C. (2026) The gut microbiome axis: how Lactobacillus-fermented soymilk orchestrates health. Archives of Microbiology, 208(7): 321.

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9. Kaga, C., Nagino, T., Gomi, A., Takagi, A., Miyazaki, K., Yoshida, Y., Shida, K. (2024) Effects of fermented soymilk with Lacticaseibacillus paracasei YIT 9029 on gut microbiota and defecation habits: a randomised, double-blind, placebo-controlled study. Beneficial Microbes, 15(2): 127-143.

10. Zhang, X., Chen, S., Zhang, M., Ren, F., Ren, Y., Li, Y., Liu, N., Zhang, Y., Zhang, Q., Wang, R. (2021) Effects of fermented milk containing Lacticaseibacillus paracasei strain Shirota on constipation in patients with depression: a randomized, double-blind, placebo-controlled trial. Nutrients, 13(7): 2238.

11. Li, X., Lan, H., Guan, Y., Wang, L., Zhao, W., He, J., Zhao, Z., Li, M., Han, Q., Gong, Y., Yan, X., Li, Z., Guo, J., Wang, R., He, J. (2026) A heat-inactivated two-strain Lacticaseibacillus paracasei fermented milk as a postbiotic for functional constipation: a randomized, double-blind, placebo-controlled trial. Nutrients, 18(13): 2114.

12. Mazlyn, M.M., Nagarajah, L.H., Fatimah, A., Norimah, A.K., Goh, K.L. (2013) Effects of a probiotic fermented milk on functional constipation: a randomized, double-blind, placebo-controlled study. Journal of Gastroenterology and Hepatology, 28(7): 1141-1147.

13. Marteau, P., Cuillerier, E., Meance, S., Gerhardt, M.F., Myara, A., Bouvier, M., Bouley, C., Tondu, F., Bommelaer, G., Grimaud, J.C. (2002) Bifidobacterium animalis strain DN-173 010 shortens the colonic transit time in healthy women: a double-blind, randomized, controlled study. Alimentary Pharmacology & Therapeutics, 16(3): 587-593.

14. Guyonnet, D., Woodcock, A., Stefani, B., Trevisan, C., Hall, C. (2009) Fermented milk containing Bifidobacterium lactis DN-173 010 improved self-reported digestive comfort amongst a general population of adults: a randomized, open-label, controlled, pilot study. Journal of Digestive Diseases, 10(1): 61-70.

15. Miller, L.E., Ouwehand, A.C. (2013) Probiotic supplementation decreases intestinal transit time: meta-analysis of randomized controlled trials. World Journal of Gastroenterology, 19(29): 4718-4725.

16. Dimidi, E., Christodoulides, S., Fragkos, K.C., Scott, S.M., Whelan, K. (2014) The effect of probiotics on functional constipation in adults: a systematic review and meta-analysis of randomized controlled trials. American Journal of Clinical Nutrition, 100(4): 1075-1084.

17. Zhang, C., Jiang, J., Tian, F., Zhao, J., Zhang, H., Zhai, Q., Chen, W. (2020) Meta-analysis of randomized controlled trials of the effects of probiotics on functional constipation in adults. Clinical Nutrition, 39(10): 2960-2969.

18. Li, H., Chen, J., Ren, X., Yang, C., Liu, S., Bai, X., Shan, S., Dong, X. (2021) Gut microbiota composition changes in constipated women of reproductive age. Frontiers in Cellular and Infection Microbiology, 10: 557515.

19. Yu, T., Ding, Y., Qian, D., Lin, L., Tang, Y. (2023) Characteristics of fecal microbiota in different constipation subtypes and association with colon physiology, lifestyle factors, and psychological status. Therapeutic Advances in Gastroenterology, 16: 1-14.

20. Li, Y-q., Yan, X-y., Xiao, X-j., Ma, P-t., Wang, S-q., Liu, H-l., Zhang, W., Chen, M., Yao, J-p., Li, Y. (2023) The gut microbiome and metabolites are altered and interrelated in patients with functional constipation. Frontiers in Microbiology, 14: 1320567.

21. Ohkusa, T., Koido, S., Nishikawa, Y., Sato, N. (2019) Gut microbiota and chronic constipation: a review and update. Frontiers in Medicine, 6: 19.

22. Schoemaker, M.H., Hageman, J.H.J., ten Haaf, D., Hartog, A., Scholtens, P.A.M.J., Boekhorst, J., Nauta, A., Bos, R. (2022) Prebiotic galacto-oligosaccharides impact stool frequency and fecal microbiota in self-reported constipated adults: a randomized clinical trial. Nutrients, 14(2): 309.

23. Liu, S.H., Yang, X.F., Liang, L., Song, B.B., Song, X.M., Yang, Y.J.,

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Alhoot, M.A. (2025) Regulatory mechanisms of the gut microbiota-short chain fatty acids signaling axis in slow transit constipation and progress in multi-target interventions. Frontiers in Microbiology, 16: 1689597.

24. Deng, X., Liang, C., Zhou, L., Shang, X., Hui, X., Hou, L., Wang, Y., Liu, W., Liang, S., Yao, L., Yang, K., Li, X. (2024) Network meta-analysis of probiotics, prebiotics, and synbiotics for the treatment of chronic constipation in adults. European Journal of Nutrition, 63(6): 1999-2010.

25. Chatsirisakul, O., Leenabanchong, N., Siripaopradit, Y., et al. (2025) Strain-specific therapeutic potential of Lactiplantibacillus plantarum: a systematic scoping review. Nutrients, 17(7): 1165.

26. Churin, A.A., Sokolyanskaya, L.O., Lukina, A.P., Karnachuk, O.V. (2026) Current concepts in probiotic safety and efficacy. Nutrients, 18(4): 696.

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