

Supplementary Table S3: Characteristics of eligible studies

Probiotics

Study	Type of study	Sample	Age	Male	Primary Disease/Condition	Type of surgery	Intervention group	Control group	Treated days (pre + post-surgery)	Outcome
Liu, 2010	DB, RCT	I: 50 C: 50	69	66	Colorectal cancer	Radical colectomy	Encapsulated bacteria containing Lactobacillus plantarum (CGMCC No. 1258, cell count 10^{11} CFU/g), Lactobacillus acidophilus (LA-11, cell count 7.0×10^{10} CFU/g) and Bifidobacterium longum (BL-88, cell count 5.0×10^{10} CFU/g), 2 g/day	Placebo	6 days preoperative + postoperative day 1–10	TD, AD, LOP
Diepenhorst, 2010	RCT	I: 10 C: 10	64	10	Periampullary or ampullary pancreatic cancer	PD	Ecologic641 consisting of six probiotic strains (3g twice a day)	No intervention	7 days preoperative + postoperative 1-7	PI
Zhang, 2012	DB, RCT	I: 30 C: 30	65	24	Colorectal cancer	Radical colectomy	Bifid triple viable capsules, each of which contained 0.21 g (10^8 CFU/g) of B longum, L acidophilus and Enterococcus faecalis (one capsule 3 times a day).	Placebo	3-5 days preoperative	PI
Mangell, 2012	DB, RCT	I: 32 C: 32	72	36	Colorectal cancer	Colon resection	Daily consumption of 10^{11} CFU of Lp 299v	Placebo	8 days preoperative + postoperative 1-5	TD, TF
Chen, 2014	DB, RCT	I: 35 C: 35	N	N	Colorectal cancer	Radical colectomy	Probiotics preparation consisting of two combined live bacteria	Placebo	5 days preoperative + postoperative day 1–7	TD, TF, AD
Liu, 2015	DB, RCT	I: 66 C: 68	63	70	Colorectal liver metastases	Colorectal liver metastases surgery	Encapsulated admixture of three probiotics bacteria, composed of LP (CGMCC No.1258, cell count $\geq 10^{11}$ CFU/g), LA-11 (cell count $\geq 7.0 \times 10^{10}$ CFU/g) and BL-88 (cell count $\geq 5.0 \times 10^{10}$ CFU/g) (2 g a day)	Placebo	6 days preoperative + postoperative day 1–10	AD, LOP, TD
Mizuta, 2015	RCT	I: 31 C: 29	70	35	Colorectal cancer	Colorectal cancer resection	A sachet containing 2 g of B. longum BB536 powder (approximately 5×10^{10} colony-forming units/2 g) daily	SC	7-14 days preoperative + postoperative day 1–14	LOP
Kotzampassi 2015	DB, RCT	I: 84 C: 80	66	115	Colorectal cancer	Colon resection	Lactobacillus acidophilus LA-5 1.75×10^9 CFU, Lactobacillus plantarum 0.5×10^9 CFU, Bifidobacterium lactis BB-12 1.75×10^9 CFU and Saccharomyces boulardii 1.5×10^9 CFU per capsule	Placebo	postoperative day 1–14	LOP, TD

Consoli, 2015	RCT	I: 15 C: 18	55	15	Colorectal cancer, other diseases	Elective colon resection	Once-daily oral lyophilized yeast capsule with 100 mg (0.5×10^9 CGU/g) of <i>S. boulardii</i> (Merck S.A., Biocodex, France).	No intervention	1-7 days preoperative	LOP
Yang, 2016	DB, RCT	I: 30 C: 30	63	27	Colorectal Cancer	Colorectal cancer surgery	Combined probiotics containing <i>Bifidobacterium longum</i> ($\geq 1.0 \times 10^7$ CFU/g), <i>Lactobacillus acidophilus</i> ($\geq 1.0 \times 10^7$ CFU/g), and <i>Enterococcus faecalis</i> ($\geq 1.0 \times 10^7$ CFU/g) (2g, 3 times a day)	Placebo	5 days preoperative + postoperative day 1–7	TF, TD, LOP, AB
Tan, 2016	DB, RCT	I: 20 C: 20	66	24	Colorectal Cancer	Colorectal cancer surgery	An orange-flavored granular powder, containing 30 billion colony-forming units of highly compatible, acid- and bile-resistant strains of <i>Lactobacillus acidophilus</i> , <i>Lactobacillus casei</i> , <i>Lactobacillus lactis</i> , <i>Bifidobacterium bifidum</i> , <i>Bifidobacterium longum</i> , and <i>Bifidobacterium infantis</i> (twice daily)	Placebo	7 days preoperative	LOP
Xie, 2018	RCT	I: 70 C: 70	68	67	Gastric cancer	Distal gastrectomy	Probiotics three times a day	SC	Postoperative day 1–8	TF, LOP
Xu, 2018	RCT	I: 30 C: 30	62	38	Colorectal cancer	Colorectal cancer surgery	<i>Bifidus</i> -triple viable preparation daily	SC	Postoperative day 1–7	TF
Bajramagic, 2019	RCT	I: 39 C: 39	N	N	Colorectal cancer	Colorectal cancer surgery	Probiotic capsules contain eight bacterial cultures (<i>Lactobacillus acidophilus</i> , <i>Lactobacillus casei</i> , <i>Lactobacillus plantarum</i> , <i>Lactobacillus rhamnosus</i> , <i>Bifidobacterium lactis</i> , <i>Bifidobacterium bifidum</i> , <i>Bifidobacterium breve</i> , <i>Streptococcus thermophilus</i>) (one capsule twice daily)	SC	Postoperative day 3–30	PI
Park, 2020	DB, RCT	I: 29 C: 30	61	32	Colorectal cancer	Colorectal cancer surgery	Two g probiotic powder contained three probiotic strains (twice daily)	Placebo	7 days preoperative + postoperative day 1–21	PI
Zeng, 2020	RCT	I: 54 C: 53	56	71	Gastric cancer	Gastrectomy	<i>Bifid</i> triple viable (0.42-0.84g twice daily)	SC	Postoperative day 1–7	TF, TD
Yoon, 2020	DB, RCT	I: 19 C: 17	60	23	Rectal cancer	Ileostomy reversal	Three-week course of probiotics at a dose of 1×10^{10} lactic acid bacteria (<i>Lactobacillus plantarum</i>) one sachet per day orally. Only one day before the operation, the patients received two sachets.	Placebo	21 days preoperative+ 21 days postoperative	TF, TD
Fowarski, 2021	RCT	I: 20 C: 20	N	25	Pancreatic cancer/ Chronic Pancreatitis	Pylorus-preserving Longmire-Traverso PD with pancreateojejunostomy	<i>L. rhamnosus</i> GG- one capsule containing 6 million CFU of this PB strain every 12 hours from the day of the surgery for 30 days	SC	Day of surgery + postoperative day 1–30	TF, TD, LOP
Wang, 2021	DB, RCT	I: 26 C: 25	70	N	Colorectal Cancer	Colorectal cancer surgery	Probiotic capsules (0.84 g) twice daily from admission until discharge. The probiotic capsule (BIFICO, Sine Pharmaceuticals, Shanghai, China) contained <i>Bi fi</i> <i>dobacterium longum</i> ($\geq 1.0 \times 10^7$ CFU/capsule), <i>Lactobacillus acidophilus</i> ($\geq 1.0 \times 10^7$ CFU/capsule), and <i>Enterococcus faecalis</i> ($\geq 1.0 \times 10^7$ CFU/capsule).	Placebo	3-5 days preoperative + Postoperative day 1–7	TF, TD, LOP

Synbiotics

Study	Type of study	Sample	Age	Male	Primary Disease	Type of surgery	Intervention group	Control group	Treated days (pre + post-surgery)	Outcome
Rayes, 2002	RCT	I: 30 C: 30	61	30	Abdominal disease	Major abdominal surgery	Lactobacillus plantarum 299 in a dose of 10^9 and oat fiber twice daily through the feeding tube during the first 4 days.	Placebo	Postoperative day 1–5	LOP
Rayes, 2002	RCT	I: 31 C: 32	50	30	Liver disease	Liver transplantation	Lactobacillus plantarum 299 (AB Probi, Lund, Sweden) in a dose of 10^9 and oat fiber were added twice daily via the feeding tube.	Placebo	Postoperative day 1–12	LOP
Rayes, 2005	DB, RCT	I: 33 C: 33	51	38	Cirrhosis	Liver transplantation	Synbiotic composition of pre- and probiotics was administered twice daily via the feeding tube or orally. Each dose of the combination contains four different LAB: 10 10 Pediacoccus pentosaceus 5-33:3 (dep. no. LMG P-20608), Leuconostoc mesenteroides 77:1 (dep. no. LMG P-20607), Lactobacillus paracasei ssp. paracasei F19 (dep. no. LMG P-17806) and L. plantarum 2362 (dep. no. LMG P-20606) plus four bioactive fibers: 2.5 g of each betaglucan, inulin, pectin and resistant starch, totally 10 g/dose, or 20 g/day.	PRE (Four bioactive fibers))	Postoperative day 1–14	LOP
Kanazawa, 2005	RCT	I: 21 C: 23	64	29	Biliary cancer	Combined liver and extrahepatic bile duct resection with hepaticojejunostomy	Yakult BL Seichōyaku (3 g/day) and GOS (12 g/day). Yakult BL Seichōyaku contains: 1×10^8 living Bifidobacterium breve strain Yakult and 1×10^8 living Lactobacillus casei strain Shirota/g	SC	Postoperative day 1–14	LOP
Rayes, 2007	DB, RCT	I: 40 C: 40	58	45	Pancreatic cancer/ Chronic Pancreatitis	Pylorus-preserving PD	Synbiotic composition of pre- and probiotics was administered twice daily via the feeding tube or orally. Each dose of the combination contains 4 different lactic acid bacteria: 10^{10} Pediacoccus pentosaceus 5–33:3 (dep.nr LMG P-20608), Leuconostoc mesenteroides 77:1 (dep.nr LMG P-20607), Lactobacillus paracasei subspecies paracasei F19 (dep.nr LMG P-17806), and Lactobacillus plantarum 2362 (dep.nr LMG P-20606) plus 4 bioactive fibers: 2.5 g of each betaglucan, inulin, pectin, and resistant starch, totally 10 g per dose, or 20 g per day	PRE (Four bioactive fibers)	1 day preoperative + postoperative day1-8	LOP,AD

Usami, 2010	RCT	I: 32 C: 29	66	55	Primary or metastatic liver cancer	Liver resection	Yakult BL Seichōyaku (3 g/day) and GOS (10g/day). Yakult BL Seichōyaku contains: 1×10^8 living Bifidobacterium breve strain Yakult and 1×10^8 living Lactobacillus casei strain Shirota/g.	SC	14 days preoperative + postoperative day 3–14	LOP
Horvat, 2010	DB, RCT	I: 20 PRE: 28 C: 20	63	30	Colorectal cancer	Elective colorectal	Combination of pro- and prebiotics was the multi-strain/ multi-fiber Synbiotic 2000™, four lactobacilli, one from each of four main genera: 10^{10} of Pediacoccus pentosaceus 5-33:3, 10^{10} of Leuconostoc mesenteroides 32–77:1, 10^{10} of Lactobacillus paracasei subsp. paracasei 19 and 10^{10} of Lactobacillus plantarum 2362. Each dose thus contains a total of 40 billion lactobacilli plus 10 g of well-studied bioactive plant fibers (2.5 g betaglucan, 2.5 g inulin, 2.5 g pectin, 2.5 g resistant starch) packed in sachets that are mixed with water.	Placebo & PRE	1-3 day preoperative	TF, LOP
Tanaka, 2012	RCT	I: 30 C: 34	62	51	Esophageal cancer	Esophagectomy	Yakult BL Seichōyaku (3 g/day) and GOS (15g/day). Yakult BL Seichōyaku contains: 1×10^8 living Bifidobacterium breve strain Yakult and 1×10^8 living Lactobacillus casei strain Shirota/g.	SC	Postoperative day 1–21	TD, TF
Russolillo, 2014	RCT	I: 20 C: 20	63	24	Hepato-biliary pancreatic cancer	Hepato-biliary pancreatic surgery	Prebiotic (Mediabase srl., Prato, Italy) in a dose of one sachet twice a day for at least 1 week preoperatively. Postoperatively, the medication was reintroduced as tolerated and continued until discharge from hospital. One 4.5 gr sachet of Prebiotic contains at least 10^{10} living Bifidobacterium bifidum, 10^{10} living Streptococcus thermophilus, 10^{10} living Streptococcus salivarius, 3×10^9 Lactobacillus acidophilus, 10^{10} living Lactobacillus casei, 10^{10} living Lactobacillus bulgaricus and galacto-oligosaccharides (4.5g).	SC	7 day preoperative + until discharge	LOP
Krebs, 2015	DB, RCT	I: 20 C: 16	66	22	Colorectal cancer	Colorectal surgery	One sachet consists 10^{11} of each of four LAB: Pediacoccus pentosaceus 5–33:3, Leuconostoc mesenteroides 32–77:1, Lactobacillus paracasei subsp paracasei 19, and Lactobacillus plantarum 2362. This makes 400 billion LAB per dose. Also included in the sachet is 2.5 g of each of the four fermentable fibres (one sachet twice a day)	Placebo	1-3 days preoperative	TD, TF, DS
Yokoyama, 2014	RCT	I: 21 C: 21	66	37	Oesophageal cancer	Oesophagectomy	One 80-ml bottle of Yakult 400, which contained at least 4×10^{10} living Lactobacillus casei strain Shirota; one 100-ml bottle of MILMIL-S, which contained at least 1×10^{10} living Bifidobacterium breve strain Yakult; and 15 g GOS (Daily)	SC	7 days preoperative + postoperative day 1–14	LOP

Komatsu, 2015	RCT	I: 168 C: 194	67	210	Colorectal cancer	Colorectal surgery	One 80-ml bottle of Yakult Ace, which contained at least 4×10^{10} living <i>Lactobacillus casei</i> strain Shirota with 2.5 g GOS; and one 100-ml bottle of MILMIL-S, which contained at least 1×10^{10} living <i>Bifidobacterium breve</i> strain Yakult (Daily)	SC	7-11 days preoperative + postoperative day 2-7	PI
Sommecal, 2015	DB, RCT	I: 23 C: 23	60	N	Periampullary cancer	PD	<i>Lactobacillus acidophilus</i> 10, 1×10^9 CFU, <i>Lactobacillus rhamnosus</i> HS 111, 1×10^9 CFU, <i>Lactobacillus casei</i> 10, 1×10^9 CFU, <i>Bifidobacterium bifidum</i> , 1×10^9 CFU + fructooligosaccharides 100 mg (twice daily)	Placebo	4 days preoperative + postoperative day 1-10	LOP
Rammohan, 2015	RCT	I: 39 C: 36	43	48	Chronic pancreatitis	Frey procedure	Specific composition of prebiotics and probiotics (synbiotics) [<i>Streptococcus faecalis</i> T-110-60 million, <i>Clostridium butyricum</i> TOA-4 million, <i>Bacillus mesentericus</i> TO-A-2 million, <i>Lactobacillus sporogenes</i> -100 million, Fructooligosaccharides (<i>Bifiliac</i> HP, Tablets, India)] was administered thrice daily orally.	Placebo	5 days preoperative + postoperative day 1-10	LOP
Yokoyama, 2016	RCT	I: 22 C: 22	65	12	Biliary pancreatic cancer, Chronic pancreatitis	PD	80-ml bottle of Yakult 400 (Yakult Honsha, Tokyo, Japan), which contained 4×10^{10} living <i>Lactobacillus casei</i> strain Shirota; one 100-ml bottle of MILMIL S (Yakult Honsha), which contained 1×10^{10} living <i>Bifidobacterium breve</i> strain Yakult; and 15 g of galacto-oligosaccharides (Oligomate S-HP; Yakult Honsha)	SC	7 days preoperative + postoperative day 1-14	LOP
Flesch, 2017	DB, RCT	I: 49 C: 42	62	37	Colorectal cancer	Colorectal cancer surgery	Two sachets twice a day <i>L. bacillus acidophilus</i> NCFM (10^9), <i>Lactobacillus rhamnosus</i> HN001 (10^9), <i>Lactobacillus paracasei</i> LPC-37 (10^9), <i>Bifidobacterium lactis</i> HN019 (10^9) and fructo -oligosaccharides (FOS) 6g.	Placebo	5 days preoperative + postoperative day 1-14	LOP
Zhao, 2017	RCT	I: 40 C: 40	65	38	Gastric cancer	Gastrectomy	Six g of live <i>bifidobacterium</i> and <i>lactobacillus</i> in tablets, 30 g of Shen Jia (daily).	SC	postoperative day 1-7	TF, AD, LOP
Polakowski, 2018	DB, RCT	I: 36 C: 37	60	39	Colorectal cancer	Colorectal cancer surgery	Simbioflora, a dietary supplement comprising 6g of fructooligosaccharide, and the probiotics <i>Lactobacillus acidophilus</i> NCFM, <i>Lactobacillus rhamnosus</i> HN001, <i>Lactobacillus casei</i> LPC-37 and <i>Bifidobacterium lactis</i> HN019 in the concentration of 10^9 (6g twice daily)	Placebo	1-7 days preoperative	LOP

CFU, colony forming units; C, Control group; DB, Double blind; I, Intervention group; GOS, galacto-oligosaccharides; PD, pancreatoduodenectomy N; not available; RCT, randomized controlled trial; SC, standard care; TF, time to first flatus; TD: time to first defecation; LOP: Length of postoperative hospital stay; PI: Postoperative ileus; AD; abdominal distension; Prebiotics; PRE.