

## CORRECTION



# Correction: Nutraceuticals and probiotics in pediatric gastrointestinal disorders

Antonio Corsello , Lorenzo Scatigno, Giulia Fiore, Stefano Baresi , Francesca Eletti, Gianvincenzo Zuccotti , Caterina Strisciuglio, Dario Dilillo and Elvira Verduci

© The Author(s), under exclusive licence to Springer Nature Limited 2023

*European Journal of Clinical Nutrition* (2024) 78:165–169; <https://doi.org/10.1038/s41430-023-01385-6>

Correction to: *European Journal of Clinical Nutrition* <https://doi.org/10.1038/s41430-023-01362-z>, published online 24 October 2023

Five references (143, 144, 145, 147 and 149) have been added to the original reference list. Starting from reference 143, the reference has been updated as follows:

143 Lubbad A, Oriowo MA, Khan I. Curcumin attenuates inflammation through inhibition of TLR-4 receptor in experimental colitis. *Mol Cell Biochem* 2009; 322: 127–135.

144 Liu L, Liu YL, Liu GX, Chen X, Yang K, Yang YX et al. Curcumin ameliorates dextran sulfate sodium-induced experimental colitis by blocking STAT3 signaling pathway. *International Immunopharmacology* 2013; 17: 314–320.

145 Bischoff SC, Escher J, Hébuterne X, Kłęk S, Krznaric Z, Schneider S et al. ESPEN practical guideline: Clinical Nutrition in inflammatory bowel disease. *Clinical Nutrition* 2020; 39: 632–653.

146 Loening-Baucke V, Miele E, Staiano A. Fiber (glucomannan) is beneficial in the treatment of childhood constipation. *Pediatrics* 2004; 113: e259–264.

147 Chmielewska A, Horvath A, Dziechciarz P, Szajewska H. Glucomannan is not effective for the treatment of functional constipation in children: a double-blind, placebo-controlled, randomized trial. *Clin Nutr* 2011; 30: 462–468.

148 Cassettari VMG, Machado NC, Lourenção PLT de A, Carvalho MA, Ortolan EVP. Combinations of laxatives and green banana biomass on the treatment of functional constipation in children and adolescents: a randomized study. *J Pediatr (Rio J)* 2019; 95: 27–33.

149 Krupa-Kozak U, Drabińska N, Jarocka-Cyrta E. The effect of oligofructose-enriched inulin supplementation on gut microbiota, nutritional status and gastrointestinal symptoms in paediatric coeliac disease patients on a gluten-free diet: study protocol for a pilot randomized controlled trial. *Nutr J* 2017; 16: 47.

150 Kline RM, Kline JJ, Di Palma J, Barbero GJ. Enteric-coated, pH-dependent peppermint oil capsules for the treatment of irritable bowel syndrome in children. *J Pediatr* 2001; 138: 125–128.

The reference numbering in tables 2 and 3 has been adjusted accordingly.

The tables from the original article are given below:

166 **Table 2** Prebiotics, probiotics and synbiotics targeting functional constipation in pediatric age.

Biotic	Author, year	Dosage	Duration	Population and age
PREBIOTICS				
INULIN	Closa-Monasterolo et al., 2017 <sup>84</sup>	2 g/day	6 weeks	Constipated children aged 2–5 years
	Lohner et al., 2018 <sup>84</sup>	6 g/day	24 weeks	Children aged 3–7 years
FOS AND GOS	Shahramian et al., 2018 <sup>85</sup>	Formula supplemented with a 90% short-chain GOS and 10% long-chain FOS	From birth to 12 months	Healthy-term infants
PSYLLIUM	No data in pediatric age			
GLUCOMANNAN	Staiano et al., 2000 <sup>87</sup>	100 mg/kg of body weight	12 weeks	Neurologically impaired children with chronic constipation aged $5.7 \pm 4.2$ (mean $\pm$ SD) years old
	Loening-Bucke et al., 2004 <sup>127</sup>	100 mg/kg of body weight daily (maximal 5 g/day) with 50 mL fluid/500 mg	4 weeks	Children with chronic functional constipation aged 4.5–11.7 years
	Chmielewska et al., 2011 <sup>128</sup>	2.52 g/day	4 weeks	Children with chronic functional constipation aged 3–16 years
COCOA HUSK	Castillejo et al., 2006 <sup>89</sup>	Supplement not specified	4 weeks	Children with chronic functional constipation aged 3–10 years
GREEN BANANA	Casettari et al., 2019 <sup>129</sup>	Green banana biomass 30 g/day	8 weeks	Constipated children aged 5–15 years
FIBER MIXTURES	Kokke et al., 2008 <sup>90</sup>	3 g trans GOS, 3 g inulin, 1.6 g soy fiber, and 0.33 g resistant starch 3. Dosage: 10 g daily for <15 kg, 20 g daily for 15 kg–20 kg, 30 g daily for >20 kg	8 weeks	Constipated children aged 1–13 years
	Quitadamo et al., 2012 <sup>91</sup>	Acacia fiber 67.7%, psyllium fiber 17.3% and fructose. Initial dose 16.8 g daily and increased up to 22.4 g if needed (0.5 g/kg body weight daily)	8 weeks	Children with chronic functional constipation aged 4–10 years
	Weber et al., 2014 <sup>92</sup>	FOS 10.5%, inulin 12.5%, gum Arabic 24%, resistant starch 9%, soy polysaccharide 33%, and cellulose 12%. Children <18 kg: 3.8 g (1 spoon of fiber) twice a day, >18 kg: 7.6 g of fiber (2 spoons) twice a day	4 weeks	Children with chronic functional constipation aged 4–12 years
PROBIOTICS				
	Bu et al., 2007 <sup>93</sup>	<i>Lactobacillus casei rhamnosus</i> (Lcr35) $8 \times 10^8$ CFU daily	4 weeks	Children with chronic functional constipation <10 years
	Wojtyniak et al., 2017 <sup>94</sup>	<i>Lactobacillus casei rhamnosus</i> (Lcr35) $8 \times 10^8$ CFU daily	4 weeks	Children with chronic functional constipation <10 years
	Jadrešin et al., 2018 <sup>95</sup>	One tablet daily containing freeze-dried <i>Lactobacillus reuteri</i> DSM 17938, was $1 \times 10^8$ CFU, isomalt, xylitol, sucrose distearate, hydrogenated palm oil, lemon-lime flavoring, and anhydrous citric acid	12 weeks	Children aged 2–18 years
	Wegner et al., 2018 <sup>96</sup>	One tablet daily containing freeze-dried <i>Lactobacillus reuteri</i> DSM 17938, was $1 \times 10^8$ CFU	8 weeks	Constipated children aged 3–7 years
	Coccorullo et al., 2010 <sup>97</sup>	<i>Lactobacillus reuteri</i> DSM 17938, was $1 \times 10^8$ CFU daily, in 5 drops of a commercially available oil suspension 30 min after feeding	8 weeks	Formula-fed infants >6 months of age
SYNBIOTICS				
	Khodadad et al., 2010 <sup>98</sup>	<i>L. casei</i> , <i>L. rhamnosus</i> , <i>S. thermophilus</i> , <i>B. breve</i> , <i>L. acidophilus</i> , <i>B. infantis</i> at the dose $1 \times 10^9$ CFU/1 sachet, and FOS	4 weeks	Children with chronic functional constipation aged 4–12 years
	Baştürk et al., 2017 <sup>99</sup>	<i>L. casei</i> , <i>L. rhamnosus</i> , <i>L. plantarum</i> , <i>B. lactis</i> ( $4 \times 10^9$ CFU) and prebiotics mixture (fiber, polydextrose, FOS, and GOS)	4 weeks	Children with chronic functional constipation aged 4–18 years

Biotic	Author, year	Dosage	Duration	Population and age
	García Contreras et al., 2020 <sup>100</sup>	<i>L. reuteri</i> DSM 17938 ( $1 \times 10^8$ CFU) and 4 g of agave inulin	28 days	Children with cerebral palsy and chronic constipation aged 14–60 months
	Eghbali et al., 2023 <sup>101</sup>	<i>L. rhamnosus</i> , <i>L. casei</i> , <i>L. acidophilu</i> , <i>B. breve</i> , <i>L. bulgaricus</i> , <i>B. longum</i> and <i>S. thermophilus</i> ( $5 \times 10^9$ CFU) with FOS twice a day	7 days	Constipated children aged 5–15 years with acute lymphoblastic leukemia receiving maintenance chemotherapy

FOS fructo-oligosaccharides, GOS galacto-oligosaccharides, SD standard deviation, CFU colony forming units.

**Table 3** Summary of possible pediatric indications and mechanisms of action of nutraceuticals and probiotics in gastrointestinal disorders.

Active ingredient	Possible indications	Mechanism of action	Dosage
<i>Saccharomyces boulardii</i> <sup>22</sup>	Acute gastroenteritis and diarrhea	Improvement of gut barrier function by restoring the tight junctions, pathogen competitive exclusion and production of antimicrobial peptides.	250–750 mg/day, for 5–7 days
<i>Lactobacillus rhamnosus</i> GG (LGG) <sup>108</sup>	Acute gastroenteritis and nosocomial diarrhea	Improvement of gut barrier function by restoring the tight junctions, inhibits chloride secretion.	$\geq 10^{10}$ CFU/day for 5–7 days for acute gastroenteritis at least $10^9$ CFU/day for nosocomial diarrhea for the duration of the hospital stay
<i>Limosilactobacillus reuteri</i> DSM 17938 <sup>24</sup>	Acute gastroenteritis	Induces oxidative stress on pathogens and is resistant to proteolytic and lipolytic enzymes, inhibits inflammatory mediators that suppress the production of TNF	$1 \times 10^8$ to $4 \times 10^8$ CFU for 5 days
Curcumin <sup>54</sup>	IBD	Ability to scavenge oxygen free radicals (ROS) and reactive nitrogen species	Up to 4 g/day for induction and up to 2 g/day during maintenance
Oligofructose-enriched inulin <sup>143</sup>	Celiac disease	Increase in <i>Bifidobacterium</i> and a reduction in <i>Lactobacillus</i> concentration and stimulates Ca absorption	/
Inulin <sup>97,98</sup>	Functional constipation	Increase in <i>Bifidobacterium</i> and <i>Lactobacillus</i>	2 g/day for 6 weeks (children aged 2–5 years) 6 g/day for 24 weeks (children aged 3–7 years)
Fructo-oligosaccharides (FOS) and galacto-oligosaccharides (GOS) <sup>99</sup>	Functional constipation	Positively modify the relationship between symbiotic and pathogenic microorganisms	/
Glucomannan <sup>144</sup>	Functional constipation	Retain water forming a gel increasing stool bulk	100 mg/kg of body weight for $\geq 6$ months
Cocoa Husk <sup>103</sup>	Functional constipation	Attract a large amount of water, thus making stools softer and improving intestinal transit	/
Green Banana <sup>145</sup>	Functional constipation	Regulation of bowel transit	30 g/day for 8 weeks
Peppermint oil <sup>146</sup>	Irritable bowel syndrome (IBS)	Spasmolytic effect	/
Ginger <sup>137</sup>	Nausea and vomiting	Anti-inflammatory properties and modulate gastrointestinal motility	Single dosage of 10 mg

The updated tables are given below:

**Table 2.** Prebiotics, probiotics and synbiotics targeting functional constipation in pediatric age.

BIOTIC	AUTHOR, YEAR	DOSAGE	DURATION	POPULATION AND AGE
PREBIOTICS				
INULIN	Closa-Monasterolo et al., 2017 <sup>97</sup>	2 g/day	6 weeks	Constipated children aged 2–5 years
	Lohner et al., 2018 <sup>98</sup>	6 g/day	24 weeks	Children aged 3–7 years
FOS AND GOS	Shahramian et al., 2018 <sup>99</sup>	Formula supplemented with a 90% short-chain GOS and 10% long-chain FOS	From birth to 12 months	Healthy-term infants
PSYLLIUM	No data in pediatric age			
GLUCOMANNAN	Staiano et al., 2000 <sup>101</sup>	100 mg/kg of body weight	12 weeks	Neurologically impaired children with chronic constipation aged 5.7 ± 4.2 (mean ± SD) years old
	Loening-Bucke et al., 2004 <sup>146</sup>	100 mg/kg of body weight daily (maximal 5 g/day) with 50 mL fluid/500 mg	4 weeks	Children with chronic functional constipation aged 4.5–11.7 years
	Chmielewska et al., 2011 <sup>147</sup>	2.52 g/day	4 weeks	Children with chronic functional constipation aged 3–16 years
COCOA HUSK	Castillejo et al., 2006 <sup>103</sup>	Supplement not specified	4 weeks	Children with chronic functional constipation aged 3–10 years
GREEN BANANA	Casettari et al., 2019 <sup>148</sup>	Green banana biomass 30 g/day	8 weeks	Constipated children aged 5-to-15 years
FIBER MIXTURES	Kokke et al., 2008 <sup>104</sup>	3 g trans GOS, 3 g inulin, 1.6 g soy fiber, and 0.33 g resistant starch 3. Dosage: 10 g daily for <15 kg, 20 g daily for 15 kg – 20 kg, 30 g daily for >20 kg	8 weeks	Constipated children aged 1–13 years
	Quitadamo et al., 2012 <sup>105</sup>	Acacia fiber 67.7 %, psyllium fiber 17.3 % and fructose. Initial dose 16.8 g daily and increased up to 22.4 g if needed (0.5 g/kg body weight daily)	8 weeks	Children with chronic functional constipation aged 4–10 years
	Weber et al., 2014 <sup>106</sup>	FOS 10.5 %, inulin 12.5 %, gum Arabic 24 %, resistant starch 9%, soy polysaccharide 33 %, and cellulose 12 %. Children < 18 kg: 3.8 g (1 spoon of fiber) twice a day, >18 kg: 7.6 g of fiber (2 spoons) twice a day	4 weeks	Children with chronic functional constipation aged 4–12 years
PROBIOTICS				
	Bu et al., 2007 <sup>107</sup>	<i>Lactobacillus casei rhamnosus (Lcr35)</i> 8 × 10 <sup>8</sup> CFU daily	4 weeks	Children with chronic functional constipation <10 years
	Wojtyniak et al., 2017 <sup>108</sup>	<i>Lactobacillus casei rhamnosus (Lcr35)</i> 8 × 10 <sup>8</sup> CFU daily	4 weeks	Children with chronic functional constipation <10 years
	Jadrešin et al., 2018 <sup>109</sup>	One tablet daily containing freeze-dried <i>Lactobacillus reuteri</i> DSM 17938, was 1 × 10 <sup>8</sup> CFU, isomalt, xylitol, sucrose distearate, hydrogenated palm oil, lemon-lime flavoring, and anhydrous citric acid	12 weeks	Children aged 2–18 years
	Wegner et al., 2018 <sup>110</sup>	One tablet daily containing freeze-dried <i>Lactobacillus reuteri</i> DSM 17938, was 1 × 10 <sup>8</sup> CFU	8 weeks	Constipated children aged 3–7 years
	Coccorullo et al., 2010 <sup>111</sup>	<i>Lactobacillus reuteri</i> DSM 17938, was 1 × 10 <sup>8</sup> CFU daily, in 5 drops of a commercially available oil suspension 30 minutes after feeding	8 weeks	Formula-fed infants >6 months of age

BIOTIC	AUTHOR, YEAR	DOSAGE	DURATION	POPULATION AND AGE
SYNBIOTICS				
	Khodadad et al., 2010 <sup>112</sup>	<i>L. casei</i> , <i>L. rhamnosus</i> , <i>S. thermophilus</i> , <i>B. breve</i> , <i>L. acidophilus</i> , <i>B. infantis</i> at the dose $1 \times 10^9$ CFU/1 sachet, and FOS	4 weeks	Children with chronic functional constipation aged 4–12 years
	Baştürk et al., 2017 <sup>113</sup>	<i>L. casei</i> , <i>L. rhamnosus</i> , <i>L. plantarum</i> , <i>B. lactis</i> ( $4 \times 10^9$ CFU) and prebiotics mixture (fiber, polydextrose, FOS, and GOS)	4 weeks	Children with chronic functional constipation aged 4–18 years
	García Contreras et al., 2020 <sup>114</sup>	<i>L. reuteri</i> DSM 17938 ( $1 \times 10^8$ CFU) and 4 g of agave inulin	28 days	Children with cerebral palsy and chronic constipation aged 14–60 months
	Eghbali et al., 2023 <sup>115</sup>	<i>L. rhamnosus</i> , <i>L. casei</i> , <i>L. acidophilus</i> , <i>B. breve</i> , <i>L. bulgaricus</i> , <i>B. longum</i> and <i>S. thermophilus</i> ( $5 \times 10^9$ CFU) with FOS twice a day	7 days	Constipated children aged 5–15 years with acute lymphoblastic leukemia receiving maintenance chemotherapy

\*Abbreviations: fructo-oligosaccharides (FOS); galacto-oligosaccharides (GOS); standard deviation (SD), colony forming units (CFU).

**Table 3.** Summary of possible pediatric indications and mechanisms of action of nutraceuticals and biotics in gastrointestinal disorders.

Active ingredient	Possible indications	Mechanism of action	Dosage
<i>Saccharomyces boulardii</i> <sup>22</sup>	Acute gastroenteritis and diarrhea	Improvement of gut barrier function by restoring the tight junctions, pathogen competitive exclusion and production of antimicrobial peptides.	250–750 mg/day, for 5–7 days
Lactisacibacillus rhamnosus GG (LGG) <sup>108</sup>	Acute gastroenteritis and nosocomial diarrhea	Improvement of gut barrier function by restoring the tight junctions, inhibits chloride secretion.	$\geq 10^{10}$ CFU/day for 5–7 days for acute gastroenteritis at least $10^9$ CFU/day for nosocomial diarrhea for the duration of the hospital stay
<i>Limosilactobacillus reuteri</i> DSM 17938 <sup>24</sup>	Acute gastroenteritis	Induces oxidative stress on pathogens and is resistant to proteolytic and lipolytic enzymes, inhibits inflammatory mediators that suppress the production of TNF	$1 \times 10^8$ to $4 \times 10^8$ CFU for 5 days
Curcumin <sup>54</sup>	IBD	Ability to scavenge oxygen free radicals (ROS) and reactive nitrogen species	Up to 4 g/day for induction and up to 2 g/day during maintenance
Oligofructose-enriched inulin <sup>149</sup>	Celiac disease	Increase in Bifidobacterium and a reduction in Lactobacillus concentration and stimulates Ca absorption	/
Inulin <sup>97,98</sup>	Functional constipation	Increase in Bifidobacterium and Lactobacillus	2 g/day for 6 weeks (children aged 2–5 years) 6 g/day for 24 weeks (children aged 3–7 years)
Fructo-oligosaccharides (FOS) and galacto-oligosaccharides (GOS) <sup>99</sup>	Functional constipation	Positively modify the relationship between symbiotic and pathogenic microorganisms	/
Glucomanan <sup>146</sup>	Functional constipation	Retain water forming a gel increasing stool bulk	100 mg/kg of body weight for $\geq 6$ months
Cocoa Husk <sup>103</sup>	Functional constipation	Attract a large amount of water, thus making stools softer and improving intestinal transit	/
Green Banana <sup>148</sup>	Functional constipation	Regulation of bowel transit	30 g/day for 8 weeks
Peppermint oil <sup>150</sup>	Irritable bowel syndrome (IBS)	Spasmolytic effect	/
Ginger <sup>137</sup>	Nausea and vomiting	Anti-inflammatory properties and modulate gastrointestinal motility	Single dosage of 10mg

The original article has been corrected.