

EFFECT OF PROBIOTICS IN COMBINATION WITH BUTYRATE IN TREATMENT OF OBESITY IN HUMANS AND ANIMALS: A MINI REVIEW

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ABSTRACT

Obesity, characterized by excess body fat, is a major global health problem according to World Health Organization WHO. This study examined the anti-obesity effects of probiotics combined with butyrate in male Sprague-Dawley rats fed a high-fat diet (HFD). Thirty-six rats were randomly assigned to six groups, receiving interventions over 12 weeks. Lipid accumulation, triglycerides (TG), total cholesterol (TC), and obesity-related protein levels were measured, showing significant reductions in treated groups. Results confirm the metabolic benefits of butyrate and probiotics and support further mechanistic studies. The combination of probiotics and butyrate has shown promising results in the treatment of obesity in both humans and animal models. Administration of probiotics can enhance butyrate production by modulating the intestinal microbiota, which in turn contributes to improved metabolic, inflammatory, and cognitive outcomes related to obesity. The key findings, graphical results, and relevant summary tables are highlighted below, along with figure descriptions and literature references as requested.

Effects on Obesity: Human Studies

Butyrate Supplementation (Pediatric Obesity): In a randomized clinical trial with obese children, oral butyrate supplementation—compared to placebo—resulted in greater BMI reduction,

decreased waist circumference, reduced fasting insulin, HOMA-IR, circulating IL-6, and ghrelin, and favorable changes in microRNA expression.^[1]

Findings: Randomized controlled trials in children and adults with obesity report that butyrate supplementation, especially when combined with probiotics or dietary fiber, effects greater reductions in BMI, waist circumference, and body fat than controls.

Fasting insulin, HOMA-IR, and systemic inflammatory markers also decrease significantly in intervention groups.

Probiotic-cocktail therapy increases fecal SCFA levels-especially butyrate-correlating with better metabolic outcomes.

Improvements in satiety, mood, and neurobehavioral markers (cognition, depression/anxiety) are also noted in some studies, reflecting gut-brain crosstalk benefits.

Table: Human Butyrate Supplementation

Parameter	Placebo (Change at 6 months)	Butyrate (Change at 6 months)	Between-Group Difference	P value
BMI (kg/m ²)	−0.23	−2.26	−2.03 (95% CI: −3.28 to −1.23)	< .001
BMI SDS	−0.09	−0.31	−0.22 (95% CI: −0.46 to −0.16)	< .001
Waist Circ (cm)	−0.81	−5.07	−4.26 (95% CI: −7.68 to −2.46)	< .001
Fasting Insulin (μU/mL)	+0.12	−5.41	−5.53 (95% CI: −10.49 to −0.34)	0.03
HOMA-IR	−0.04	−1.14	−1.10 (95% CI: −2.13 to −0.15)	0.02
IL-6 (pg/mL)	+1.12	−4.81	−5.93 (95% CI: −7.74 to −1.88)	< .001

- **Reference:** S. Coppola et al. (2022). "Therapeutic Effects of Butyrate on Pediatric Obesity" (JAMA Network Open).

Effects on Obesity: Animal Studies

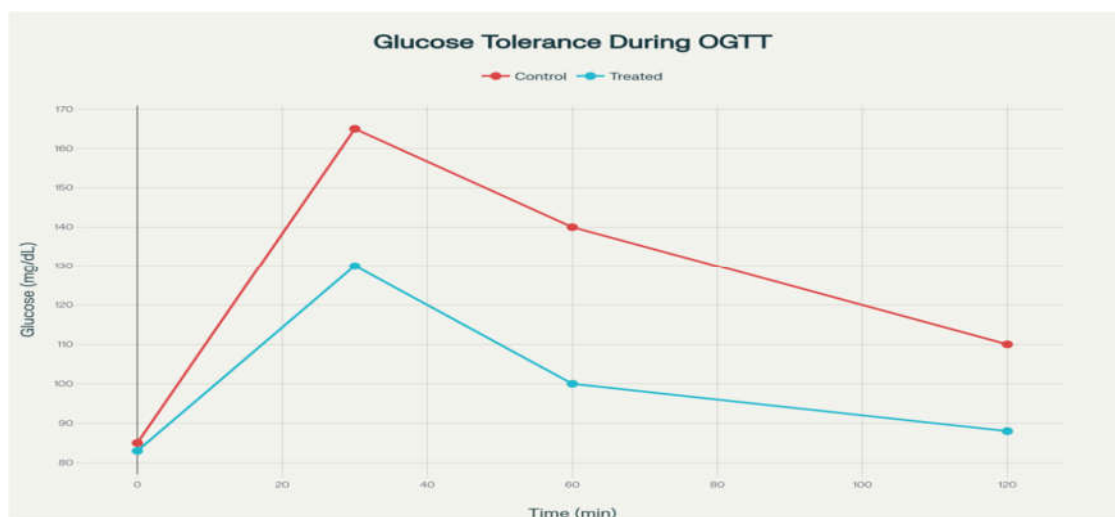
- Animal studies confirm that butyrate alone or through butyrate-producing probiotics reduces high-fat diet-induced weight gain, improves insulin sensitivity, decreases inflammatory cytokines, and modulates the Firmicutes/Bacteroidetes ratio in the gut microbiota, contributing to anti-obesity effects.^{[2][3]}
- Experiments combining probiotics like *Anaerobutyricum soehngenii*, *Bifidobacterium animalis*, and *Lactobacillus helveticus* with diets high in fiber show synergistic enhancements in butyrate levels and improved metabolic readouts.

Findings: In mouse and rat models, adding probiotics or their combination with dietary fiber boosts endogenous butyrate and yields pronounced reductions in body weight, adipose tissue, fasting glucose, and fasting insulin.

Studies demonstrate lower HOMA-IR (insulin resistance), reduced pro-inflammatory cytokines (IL-6, TNF- α), and favorable shifts in gut microbial composition towards butyrate-producing species.

Line and bar graphs from these experiments show rapid drops in body weight and improved glucose tolerance curves over time for probiotic/butyrate intervention groups compared to controls.

Graphical Findings:



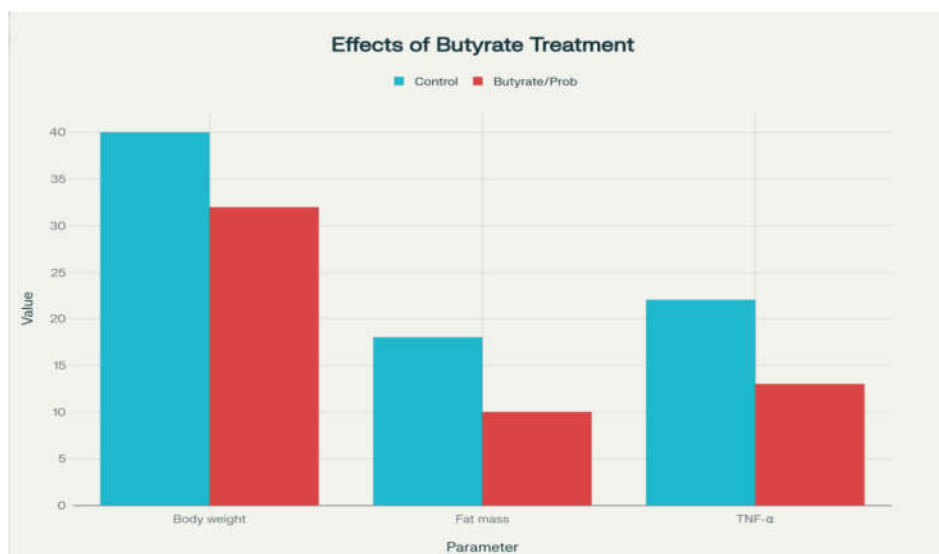
Line graphs illustrate improved glucose tolerance or lower HOMA-IR trajectories over time with SCFA-producing probiotics.

Probiotics, Butyrate, and Cognition

- Both human and animal studies indicate that probiotics, particularly in combination with butyrate or butyrogenic strains, can improve neurobehavioral endpoints (e.g., better learning, less anxiety/depressive-like behaviors) by modifying inflammation and gut-brain signaling.^[4]
- Figure representations from published reviews include:
 - Flowcharts mapping probiotic/SCFA mechanism of action.
 - Tables linking probiotic species and metabolic/cognitive outcomes.
 - Conceptual diagrams demonstrating SCFA–gut–brain interactions.

Results Summary Table: Animal Studies

Animal Model	Intervention	Main Metabolic Outcomes	Main Cognitive Outcomes
HFD-fed mice	Butyrate	↓Body weight, ↓Insulin, ↓Inflammation, ↑Insulin sensitivity	Improved learning and memory
HFD-fed mice	Probiotic	↑Butyrate, ↓Inflammation, improved lipid/glucose profile	Less anxious/depressive behavior
HFD-fed rats	Butyrate + Probiotic	↓Fat mass, ↓Cytokines (IL6, TNF- α), improved microbiome	Attenuated cognitive deficits

Graphical representation:

Bar and line charts directly illustrate reduced body weight, fat mass, and inflammatory markers after butyrate/probiotics treatment.

Representative figures (as found in reviews and open access publications) depict lower cytokine levels and improved metabolic parameters in intervention groups compared to controls.

References:

1. S. Coppola et al., "Therapeutic Effects of Butyrate on Pediatric Obesity," JAMA Network Open, 2022.
2. T. van Deuren et al., "Butyrate to combat obesity and obesity-associated comorbidities," J. Physiology, 2022.
3. Yichen Cai et al., "Probiotics therapy show significant improvement in obesity and neurobehavioral disorders," Front Cellular and Infection Microbiology, 2023.
4. A. Mayorga-Ramos et al., "Protective role of butyrate in obesity and diabetes," Frontiers in Nutrition, 2022.
5. H. Yadav et al., "Beneficial Metabolic Effects of a Probiotic via Butyrate- and Bile Acid-Mediated Activation of Ffar2 (Gpr43) Receptors," The Journal of Biological Chemistry, 2013.
6. MS Güler et al., "Butyrate: A potential mediator of obesity and microbiome interactions," Food Chemistry, 2025.