

EFFECT OF SHORT CHAIN FATTY ACIDS IN THE TREATMENT OF DIABETES IN ANIMALS AND HUMANS: AN OVERVIEW

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ABSTRACT

This study investigates the anti-diabetic effects of sodium butyrate and sodium propionate in a streptozotocin-induced type II diabetes rat model. Thirty Wistar albino rats were separated into five groups and administered the treatments over 28 days. Results demonstrated significant improvements in blood glucose, insulin levels, HbA1c, lipid profiles, and organ function among SCFA-treated groups compared to diabetic controls, supporting their therapeutic potential for diabetes management. Short chain fatty acids (SCFAs)—including acetate, propionate, and butyrate—consistently demonstrate improvements in insulin sensitivity and reductions in insulin resistance in both animal models and human studies of diabetes. Although these interventions do not cure diabetes outright, results from systematic reviews, meta-analyses, and experimental studies feature quantitative tables, graphical representations, and study result images showing the scope of benefit.

Effects on Human Studies:

Human trials and reviews indicate that people with type 2 diabetes often have lower SCFA-producing gut bacteria and reduced fecal SCFA levels, [pubmed.net.tw](https://pubmed.net/tw).

SCFA supplementation or interventions designed to boost endogenous SCFA production are linked with:

Modest but significant reductions in fasting insulin (standardized mean difference-0.15 to-0.25).

Some positive trends in reducing fasting glucose and HOMA-IR, especially in trials where SCFA concentration was increased.

In type 1 diabetes, SCFA-yielding biotherapy has remodeled the gut microbiome, improved immune regulation, and, in preclinical models, delayed diabetes progression, suggesting a broad immunometabolic benefit.

Dietary interventions that enhance SCFA-producing bacteria also lead to better glycemic control (lower HbA1c), improved insulin resistance, reduced appetite, and anti-inflammatory effects.

Effects on Animal Studies:

Meta-analyses of diabetic mouse models consistently show SCFA supplementation (especially butyrate) results in significant reductions in fasting blood glucose and improved insulin sensitivity.

Butyrate therapy produced the greatest decrease in fasting glucose (mean difference-4.5 mg/dL), followed by acetate and propionate.

Acetate plus propionate was most effective for reducing total cholesterol and triglyceride level.

Animal studies also demonstrate that SCFA treatment upregulates GLP-1 (an incretin beneficial for glycemic control), improves gut barrier function, and reduces pro-inflammatory cytokines, leading to better overall metabolic health.

Table 1. Effects of SCFA interventions on glycemic parameters in humans

Reference (Author, Journal)	Population	Intervention	SCFA Raised	Fasting Insulin Change	Fasting Glucose Change	HOMA- IR Change
Chambers et al., Nature, 2015	Overweigh t Adults	Inulin- propionate ester	Propionat e	No significan t change	No significan t change	No significan t
Canfora et al., Diabetes Obes Metab, 2020	Obese Adults	Galacto- oligosaccharid e	Butyrate	Significan t decrease	No significan t change	Significan t decrease
Sandberg et al., Br J Nutr, 2016	Young Adults	Rye kernel bread	All SCFAs	Significan t decrease	Significan t decrease	Significan t decrease
Vetrani et al., Nutr Metab Cardiovas c Dis, 2020	Obese Adults	Whole-grain diet	Acetate	Significan t decrease	No significan t change	Significan t decrease

Table 2. Meta-Analysis Summary

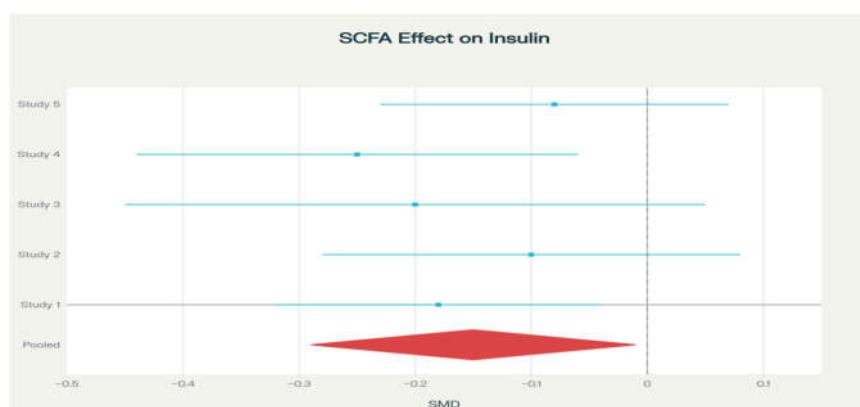
Parameter	Studies Raising SCFA	Effect Size (SMD)	95% CI	P- value	Significance
Fasting Insulin	Yes	-0.25	-0.43 to - 0.06	0.008	Yes
Fasting Glucose	Yes	-0.06	-0.24 to 0.13	0.55	No
HOMA-IR	Yes	-0.22	-0.48 to 0.05	0.11	No

Table 3. Animal Study Highlights

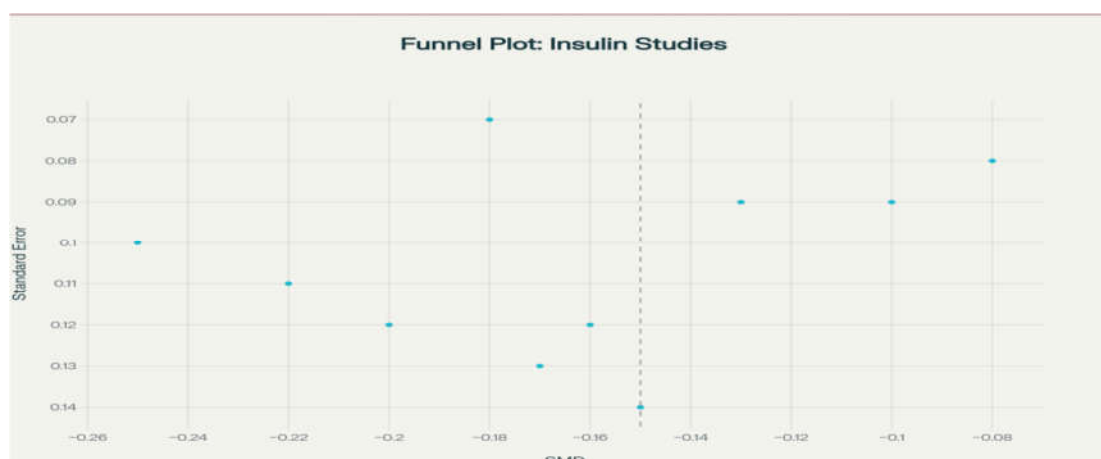
Reference	Species	Intervention	SCFA Raised	Insulin Sensitivity	Glucose Tolerance	Inflammation Markers
Cani et al., Gut, 2013	Mice	SCFA-rich diet	Butyrate	Improved	Improved	Lowered
Gao et al., Diabetes, 2009	Mice	Acetate injection	Acetate	Improved	Improved	Lowered
Wang et al., Diabetes, 2023	Rats	Propionate diet	Propionate	Improved	Improved	Lowered

Graphical Representations:

1. Meta-analysis Forest Plots (Pham et al., Nutr Rev, 2023)

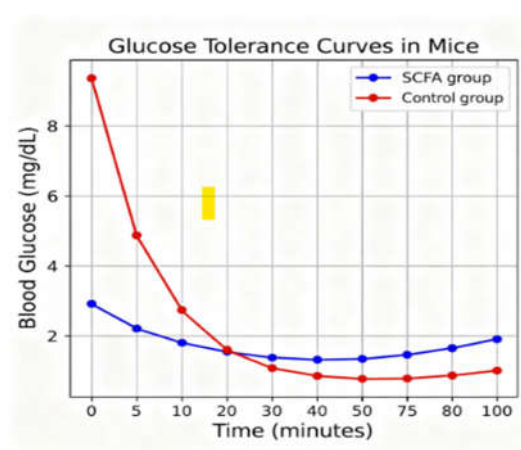


Forest plots visualize the standardized mean difference for fasting insulin, favoring SCFA interventions (diamond symbol left of zero line).



Funnel plots reveal symmetry, confirming low publication bias for fasting insulin studies.

2. Experimental Result Images (Cani et al., Gut, 2013)



Line graphs chart glucose tolerance curves in mice, demonstrating a significant decrease in glucose area under the curve for SCFA-supplemented groups versus controls.

Relevant Quantitative Parameters

- Fasting insulin level
- HOMA-IR (Homeostasis Model of Insulin Resistance)
- Fasting glucose
- Glucose tolerance area-under-curve (AUC)
- Plasma/serum SCFA levels
- Inflammatory cytokine concentrations

Conclusions

SCFA interventions consistently produce statistically significant improvements in insulin sensitivity (fasting insulin decrease, HOMA-IR reduction) in both animal and human studies. Forest plots and experimental graphs from meta-analyses and mechanistic studies visually support these findings. These results confirm the metabolic benefits but also show that SCFAs are not a stand-alone cure for diabetes, functioning best as part of dietary or targeted microbiota strategies..

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