

# Der Einfluss der Darmbakterien und kurzkettige Fettsäuren (SCFA) auf die Barrierefunktion des Darms: ein Scoping-Review

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- Aguirre, M., Bussolo de Souza, C. & Venema, K. (2016). The Gut Microbiota from Lean and Obese Subjects Contribute Differently to the Fermentation of Arabinogalactan and Inulin. *PLoS one*, 11(7), e0159236. <https://doi.org/10.1371/journal.pone.0159236>
- Bajaj, J. S., Sikaroodi, M., Fagan, A., Heuman, D., Gilles, H., Gavis, E. A., Fuchs, M., Gonzalez-Maeso, J., Nizam, S., Gillevet, P. M. & Wade, J. B. (2019). Posttraumatic stress disorder is associated with altered gut microbiota that modulates cognitive performance in veterans with cirrhosis. *Am J Physiol Gastrointest Liver Physiol*, 317(5), G661-G669. <https://doi.org/10.1152/ajpgi.00194.2019>
- Balamurugan, R., Pugazhendhi, S., Balachander, G. M., Dharmalingam, T., Mortimer, E. K., Gopalsamy, G. L., Woodman, R. J., Meng, R., Alpers, D. H., Manary, M., Binder, H. J., Brown, I. L., Young, G. P. & Ramakrishna, B. S. (2019). Effect of Native and Acetylated Dietary Resistant Starches on Intestinal Fermentative Capacity of Normal and Stunted Children in Southern India. *Int J Environ Res Public Health*, 16(20). <https://doi.org/10.3390/ijerph16203922>
- Bisgaard, H., Li, N., Bonnelykke, K., Chawes, B. L. K., Skov, T., Paludan-Müller, G., Stokholm, J., Smith, B. & Krogfelt, K. A. (2011). Reduced diversity of the intestinal microbiota during infancy is associated with increased risk of allergic disease at school age. *J Allergy Clin Immunol*, 128(3), 646-52.e1-5. <https://doi.org/10.1016/j.jaci.2011.04.060>
- Bui, T. P. N., Mannerås-Holm, L., Puschmann, R., Wu, H., Troise, A. D., Nijse, B., Boeren, S., Bäckhed, F., Fiedler, D. & deVos, W. M. (2021). Conversion of dietary inositol into propionate and acetate by commensal *Anaerostipes* associates with host health. *Nat Commun*, 12(1), 4798. <https://doi.org/10.1038/s41467-021-25081-w>
- Bui, T. P. N., Schols, H. A., Jonathan, M., Stams, A. J. M., Vos, W. M. de & Plugge, C. M. (2019). Mutual Metabolic Interactions in Cocultures of the Intestinal *Anaerostipes rhamnosivorans* With an Acetogen, Methanogen, or Pectin-Degrader Affecting Butyrate Production. *Front Microbiol*, 10, 2449. <https://doi.org/10.3389/fmicb.2019.02449>
- Bull, M. J. & Plummer, N. T. (2014). Part 1: The Human Gut Microbiome in Health and Disease. *Integr Med (Encinitas)*, 13(6), 17–22.
- Chen, Y., Zhou, J. & Wang, L. (2021). Role and Mechanism of Gut Microbiota in Human Disease. *Front Cell Infect Microbiol*, 11, 625913. <https://doi.org/10.3389/fcimb.2021.625913>
- Collins, S. M., Gibson, G. R., Kennedy, O. B., Walton, G., Rowland, I. & Commane, D. M. (2021). Development of a prebiotic blend to influence in vitro fermentation effects, with a focus on propionate, in the gut. *FEMS Microbiol Ecol*, 97(8). <https://doi.org/10.1093/femsec/fiab101>
- Cummings, J. H., Pomare, E. W., Branch, W. J., Naylor, C. P. & Macfarlane, G. T. (1987). Short chain fatty acids in human large intestine, portal, hepatic and venous blood. *Gut*, 28(10), 1221–1227. <https://doi.org/10.1136/gut.28.10.1221>
- Deyaert, S., Poppe, J., Dai Vu, L., Baudot, A., Bubeck, S., Bayne, T., Krishnan, K., Giusto, M., Moltz, S. & van den Abbeele, P. (2024). Functional Muffins Exert Bifidogenic Effects along with Highly Product-Specific Effects on the Human Gut Microbiota Ex Vivo. *Metabolites*, 14(9). <https://doi.org/10.3390/metabo14090497>
- El Hage, R., Hernandez-Sanabria, E., Calatayud Arroyo, M., Props, R. & van de Wiele, T. (2019). Propionate-Producing Consortium Restores Antibiotic-Induced Dysbiosis in a Dynamic in vitro Model of the Human Intestinal Microbial Ecosystem. *Front Microbiol*, 10, 1206. <https://doi.org/10.3389/fmicb.2019.01206>
- Emenaker, N. J., Calaf, G. M., Cox, D., Basson, M. D. & Qureshi, N. (2001). Short-chain fatty acids inhibit invasive human colon cancer by modulating uPA, TIMP-1, TIMP-2, mutant p53, Bcl-2, Bax, p21 and PCNA protein expression in an in vitro cell culture model. *J Nutr*, 131(11 Suppl), 3041S-6S. <https://doi.org/10.1093/jn/131.11.3041S>
- Eufic. (2023). Empfohlene tägliche Aufnahme von Ballaststoffen und ballaststoffreichen Lebensmitteln, um Ihnen zu helfen, dieses Ziel zu erreichen. Europäische Informationszentrum für Lebensmittel (EUFIC). <https://www.eufic.org/de/in-unserem-essen/artikel/empfohlene-taegliche-aufnahme-von-ballaststoffen-und-ballaststoffreichen-lebensmitteln-um-ihnen-zu-helfen-dieses-ziel-zu-erreichen>
- Ferreira, C. M., Vieira, A. T., Vinolo, M. A. R., Oliveira, F. A., Curi, R. & Martins, F. d. S. (2014). The central role of the gut microbiota in chronic inflammatory diseases. *J Immunol Res*, 2014, 689492. <https://doi.org/10.1155/2014/689492>

- Fukuda, S., Toh, H., Hase, K., Oshima, K., Nakanishi, Y., Yoshimura, K., Tobe, T., Clarke, J. M., Topping, D. L. [David L.], Suzuki, T., Taylor, T. D., Itoh, K., Kikuchi, J., Morita, H., Hattori, M. & Ohno, H. (2011). Bifidobacteria can protect from enteropathogenic infection through production of acetate. *Nature*, 469(7331), 543–547. <https://doi.org/10.1038/nature09646>
- Ghimire, S., Wongkuna, S., Sankaranarayanan, R., Ryan, E. P., Bhat, G. J. & Scaria, J. (2021). Positive Synergistic Effects of Quercetin and Rice Bran on Human Gut Microbiota Reduces Enterobacteriaceae Family Abundance and Elevates Propionate in a Bioreactor Model. *Front. Microbiol.*, 12, 751225. <https://doi.org/10.3389/fmicb.2021.751225>
- Hayashi, K., Uchida, R., Horiba, T., Kawaguchi, T., Gomi, K. & Goto, Y. (2024). Soy sauce-like seasoning enhances the growth of *Agathobacter rectalis* and the production of butyrate, propionate, and lactate. *Biosci Microbiota Food Health*, 43(3), 275–281. <https://doi.org/10.12938/bmfh.2023-103>
- Hosseini, E., Grootaert, C., Verstraete, W. & van de Wiele, T. (2011). Propionate as a health-promoting microbial metabolite in the human gut. *Nutr Rev*, 69(5), 245–258. <https://doi.org/10.1111/j.1753-4887.2011.00388.x>
- Høverstad, T. & Midtvedt, T. (1986). Short-Chain Fatty Acids in Germfree Mice and Rats. *The Journal of Nutrition*, 116(9), 1772–1776. <https://doi.org/10.1093/jn/116.9.1772>
- Hoyles, L., Snelling, T., Umm-Kulthum Umlai, Nicholson, J., Carding, S., Glen, R. & McArthur, S. (2018). Microbiome–host systems interactions: protective effects of propionate upon the blood–brain barrier. *BioMedCentral. Vorab-Onlinepublikation*. <https://doi.org/10.6084/M9.FIGSHARE.C.4038713.V1>
- Huang, Y., Wang, Y. F., Miao, J., Zheng, R. F. & Li, J. Y. (2024). Short-chain fatty acids: Important components of the gut-brain axis against AD. *Biomedicine & Pharmacotherapy*, 175, 116601. <https://doi.org/10.1016/j.biopha.2024.116601>
- Human Microbiome Project Consortium (2012). Structure, function and diversity of the healthy human microbiome. *Nature*, 486(7402), 207–214. <https://doi.org/10.1038/nature11234>
- Kabisch, M., Ruckes, C., Seibert-Grafe, M. & Blettner, M. (2011). Randomized controlled trials: part 17 of a series on evaluation of scientific publications. *Dtsch Arztebl Int*, 108(39), 663–668. <https://doi.org/10.3238/arztebl.2011.0663>
- Karlsson, F., Tremaroli, V., Nielsen, J. & Bäckhed, F. (2013). Assessing the human gut microbiota in metabolic diseases. *Diabetes*, 62(10), 3341–3349. <https://doi.org/10.2337/db13-0844>
- Kennedy, P. J., Cryan, J. F., Dinan, T. G. & Clarke, G. (2014). Irritable bowel syndrome: a microbiome-gut-brain axis disorder? *World J Gastroenterol*, 20(39), 14105–14125. <https://doi.org/10.3748/wjg.v20.i39.14105>
- Keshari, S., Balasubramaniam, A., Myagmardoolonjin, B., Herr, D. R., Negari, I. P. & Huang, C.-M. (2019). Butyric Acid from Probiotic *Staphylococcus epidermidis* in the Skin Microbiome Down-Regulates the Ultraviolet-Induced Pro-Inflammatory IL-6 Cytokine via Short-Chain Fatty Acid Receptor. *Int J Mol Sci*, 20(18). <https://doi.org/10.3390/ijms20184477>
- Koh, A., Molinaro, A., Ståhlman, M., Khan, M. T., Schmidt, C., Mannerås-Holm, L., Wu, H., Carreras, A., Jeong, H., Olofsson, L. E., Bergh, P.-O., Gerdes, V., Hartstra, A., Brauw, M. de, Perkins, R., Nieuwdorp, M., Bergström, G. & Bäckhed, F. (2018). Microbially Produced Imidazole Propionate Impairs Insulin Signaling through mTORC1. *Cell*, 175(4), 947–961.e17. <https://doi.org/10.1016/j.cell.2018.09.055>
- Li, B., Schroyen, M., Leblais, J., Wavreille, J., Soyeurt, H., Bindelle, J. & Everaert, N. (2018). Effects of inulin supplementation to piglets in the suckling period on growth performance, postileal microbial and immunological traits in the suckling period and three weeks after weaning. *Arch Anim Nutr*, 72(6), 425–442. <https://doi.org/10.1080/1745039X.2018.1508975>
- Mahowald, M. A., Rey, F. E., Seedorf, H., Turnbaugh, P. J., Fulton, R. S., Wollam, A., Shah, N., Wang, C. [Chunyan], Magrini, V., Wilson, R. K., Cantarel, B. L., Coutinho, P. M., Hennissat, B., Crock, L. W., Russell, A., Verberkmoes, N. C., Hettich, R. L. & Gordon, J. I. (2009). Characterizing a model human gut microbiota composed of members of its two dominant bacterial phyla. *Proc Natl Acad Sci U S A*, 106(14), 5859–5864. <https://doi.org/10.1073/pnas.0901529106>
- McNeil, N. I., Cummings, J. H. & James, W. P. (1978). Short chain fatty acid absorption by the human large intestine. *Gut*, 19(9), 819–822. <https://doi.org/10.1136/gut.19.9.819>
- Mercenier, A., Vu, L. D., Poppe, J., Albers, R., McKay, S. & van den Abbeele, P. (2024). Carrot-Derived Rhamnolacturonan-I Consistently Increases the Microbial Production of Health-Promoting Indole-3-Propionic Acid Ex Vivo. *Metabolites*, 14(12). <https://doi.org/10.3390/metabo14120722>
- Müller, M., Hernández, M. A. G., Goossens, G. H., Reijnders, D., Holst, J. J., Jocken, J. W. E., van Eijk, H., Canfora, E. E. & Blaak, E. E. (2019). Circulating but not faecal short-chain fatty acids are related to insulin sensitivity, lipolysis and GLP-1 concentrations in humans. *Sci Rep*, 9(1), 12515. <https://doi.org/10.1038/s41598-019-48775-0>
- Munn, Z., Peters, M. D. J., Stern, C., Tufanaru, C., McArthur, A. & Aromataris, E. (2018). Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*, 18(1), 143. <https://doi.org/10.1186/s12874-018-0611-x>
- Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T. [Tianjing], Loder, E. W., Mayo-Wilson, E., McDonald, S., Moher, D. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*, 372, n71. <https://doi.org/10.1136/bmj.n71>

- Peters, M. D. J., Godfrey, C. M., Khalil, H., McInerney, P., Parker, D. & Soares, C. B. (2015). Guidance for conducting systematic scoping reviews. *Int J Evid Based Healthc*, 13(3), 141–146. <https://doi.org/10.1097/XEB.0000000000000050>
- Pomare, E. W., Branch, W. J. & Cummings, J. H. (1985). Carbohydrate fermentation in the human colon and its relation to acetate concentrations in venous blood. *J Clin Invest*, 75(5), 1448–1454. <https://doi.org/10.1172/JCI111847>
- Qin, J., Li, R., Raes, J., Arumugam, M., Burgdorf, K. S., Manichanh, C., Nielsen, T., Pons, N., Levenez, F., Yamada, T., Mende, D. R., Li, J [Junhua] Xu, J., Li, S [Shaochuan] Li, D., Cao, J., Wang, B., Liang, H., Zheng, H., Wang, J [Jun] (2010). A human gut microbial gene catalogue established by metagenomic sequencing. *Nature*, 464(7285), 59–65. <https://doi.org/10.1038/nature08821>
- Reichardt, N., Duncan, S. H., Young, P., Belenguer, A., McWilliam Leitch, C., Scott, K. P., Flint, H. J. & Louis, P. (2014). Phylogenetic distribution of three pathways for propionate production within the human gut microbiota. *ISME J*, 8(6), 1323–1335. <https://doi.org/10.1038/ismej.2014.14>
- Roy, C. C., Kien, C. L., Bouthillier, L. & Levy, E. (2006). Short-chain fatty acids: ready for prime time? *Nutr Clin Pract*, 21(4), 351–366. <https://doi.org/10.1177/0115426506021004351>
- Scheppach, W., Christl, S. U., Bartram, H. P., Richter, F. & Kasper, H. (1997). Effects of short-chain fatty acids on the inflamed colonic mucosa. *Scand J Gastroenterol Suppl*, 222, 53–57. <https://doi.org/10.1080/00365521.1997.11720719>
- Sekirov, I., Russell, S. L., Antunes, L. C. M. & Finlay, B. B. (2010). Gut microbiota in health and disease. *Physiol Rev*, 90(3), 859–904. <https://doi.org/10.1152/physrev.00045.2009>
- Tirosh, A., Calay, E. S., Tuncman, G., Claiborn, K. C., Inouye, K. E., Eguchi, K., Alcalá, M., Rathaus, M., Hollander, K. S., Ron, I., Livne, R., Heianza, Y., Qi, L., Shai, I., Garg, R. & Hotamisligil, G. S. (2019). The short-chain fatty acid propionate increases glucagon and FABP4 production, impairing insulin action in mice and humans. *Sci Transl Med*, 11(489). <https://doi.org/10.1126/scitranslmed.aav0120>
- Topping, D. L [D. L.] & Clifton, P. M. (2001). Short-chain fatty acids and human colonic function: roles of resistant starch and nonstarch polysaccharides. *Physiol Rev*, 81(3), 1031–1064. <https://doi.org/10.1152/physrev.2001.81.3.1031>
- Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garrity, C., Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med*, 169(7), 467–473. <https://doi.org/10.7326/M18-0850>
- Vadder, F. de, Kovatcheva-Datchary, P., Goncalves, D., Vinera, J., Zitoun, C., Duchamp, A., Bäckhed, F. & Mithieux, G. (2014). Microbiota-generated metabolites promote metabolic benefits via gut-brain neural circuits. *Cell*, 156(1-2), 84–96. <https://doi.org/10.1016/j.cell.2013.12.016>
- van den Abbeele, P., Kunkler, C. N., Poppe, J., Rose, A., van Hengel, I. A. J., Baudot, A. & Warner, C. D. (2024). Serum-Derived Bovine Immunoglobulin Promotes Barrier Integrity and Lowers Inflammation for 24 Human Adults Ex Vivo. *Nutrients*, 16(11). <https://doi.org/10.3390/nu16111585>
- Vancamelbeke, M. & Vermeire, S. (2017). The intestinal barrier: a fundamental role in health and disease. *Expert Rev Gastroenterol Hepatol*, 11(9), 821–834. <https://doi.org/10.1080/17474124.2017.1343143>
- Voigt, R. M., Engen, P. A., Villanueva, M., Bambi, S. A., Green, S. J., Naqib, A., Raeisi, S., Shaikh, M., Hamaker, B. R., Cantu-Jungles, T. M., Pridden, S. A., Held, P. & Keshavarzian, A. (2024). Prebiotics as an adjunct therapy for posttraumatic stress disorder: a pilot randomized controlled trial. *Front Neurosci*, 18, 1477519. <https://doi.org/10.3389/fnins.2024.1477519>
- Voigt, R. M., Zalta, A. K., Raeisi, S., Zhang, L., Brown, J. M., Forsyth, C. B., Boley, R. A., Held, P., Pollack, M. H. & Keshavarzian, A. (2022). Abnormal intestinal milieu in posttraumatic stress disorder is not impacted by treatment that improves symptoms. *Am J Physiol Gastrointest Liver Physiol*, 323(2), G61-G70. <https://doi.org/10.1152/ajpgi.00066.2022>
- Wanders, D., Graff, E. C. & Judd, R. L. (2012). Effects of high fat diet on GPR109A and GPR81 gene expression. *Biochem Biophys Res Commun*, 425(2), 278–283. <https://doi.org/10.1016/j.bbrc.2012.07.082>
- Westermann, P., Ahring, B. K. & Mah, R. A. (1989). Acetate production by methanogenic bacteria. *Appl Environ Microbiol*, 55(9), 2257–2261. <https://doi.org/10.1128/aem.55.9.2257-2261.1989>
- Wong, J. M. W., Souza, R. de, Kendall, C. W. C., Emam, A. & Jenkins, D. J. A. (2006). Colonic health: fermentation and short chain fatty acids. *J Clin Gastroenterol*, 40(3), 235–243. <https://doi.org/10.1097/00004836-200603000-00015>
- Yamamura, R., Nakamura, K [Koshi], Kitada, N., Aizawa, T., Shimizu, Y., Nakamura, K [Kiminori], Ayabe, T., Kimura, T. & Tamakoshi, A. (2020). Associations of gut microbiota, dietary intake, and serum short-chain fatty acids with fecal short-chain fatty acids. *Biosci Microbiota Food Health*, 39(1), 11–17. <https://doi.org/10.12938/bmfh.19-010>
- Yan, J., Pan, Y., Shao, W., Wang, C [Caiping], Wang, R., He, Y., Zhang, M., Wang, Y., Li, T [Tangzhiming], Wang, Z [Zhefeng], Liu, W., Wang, Z [Zhenmin], Sun, X. & Dong, S. (2022). Beneficial effect of the short-chain fatty acid propionate on vascular calcification through intestinal microbiota remodelling. *Microbiome*, 10(1), 195. <https://doi.org/10.1186/s40168-022-01390-0>
- Yang, M., Cai, W., Li, X [Xinxin], Deng, Y., Li, J [Jinjun], Wang, X., Zhu, L., Wang, C [Chong] & Li, X [Xiaoqiong] (2024). The Effect of Type 2 Resistant Starch and Indole-3-Propionic Acid on Ameliorating High-Fat-Diet-Induced Hepatic Steatosis and Gut Dysbiosis. *Foods*, 13(11). <https://doi.org/10.3390/foods13111625>