



RESEARCH PAPER

OPEN ACCESS

Role of probiotics in health and diseases

Dina M. Trabzuni

Department of Food Science and Nutrition, College of Food and Agriculture Sciences, King Saud University, Riyadh, KSA

Key words: Probiotics, Allergy, Cholesterol, Autism, Lactic acid bacteria.

<http://dx.doi.org/10.12692/ijb/14.2.319-325>

Article published on February 27, 2019

Abstract

Probiotics are found inside our body, in food as dairy product and in the form of supplements. It's very beneficial for health, especially for digestive system. So, it become very obvious to increase the use of probiotics as a supplement for treating or preventing some diseases such as food allergy, autism, cholesterol and others. The purpose of this study is to review the current documentation for the claims of health benefits derived from the use of probiotics. Articles relating to modes of action and randomized control trials of treatment were reviewed by searching PubMed, google using terms 'probiotic', "autism", "lactic acid bacteria" and so on. Intestinal microbiota plays an important role in the mechanism of allergic diseases through maintaining balance of the Type1T helper/ Type2T helper (Th1/Th2), transforming growth factor beta (TGF- β) expression and production of Foxp3⁺ regulatory T (Treg) cells. On other hand, there is a difference in gut microbiota for Autism Spectrum Disorders (ASD) children with a control group. Moreover, some strains and species of lactic acid bacteria (LAB) reduce serum and liver cholesterol and triglycerides with high-fat diet. This review supports the safety of probiotics but further studies are required to facilitate better treatment and hence improved efficacy.

*Corresponding Author: Dina M. Trabzuni ✉ dina.trabzuni@gmail.com

Introduction

The latest definition of probiotics set by the Food and Agriculture Organization (FAO) and World Health Organization (WHO) is "Live microorganisms which when administered in adequate amounts confer a health benefit to the host" (Anukam and Reid, 2007). Some probiotic strains commonly used are bifido bacteria, *Lactobacillus acidophilus*-group, *Lactobacillus casei*, *Lactobacillus reuteri*, *Lactobacillus rhamnosus*, *Bacillus coagulans*, *Escherichia coli* especially strain Nissle 1917, *Enterococcus faecium* SF68 from enterococci species, and the yeast *Saccharomyces boulardii* (Pandey *et al.*, 2015). These probiotic strains may be in a single form or combined as a mixture of two or more strains. Accordingly, the benefits of probiotic mixtures found to be more efficient than single strains, which may be due to the interaction between strains (Chapman *et al.*, 2011). Good sources of probiotics are dairy and dairy products (Liong, 2011). For centuries, lactic acid bacteria (LAB), bifido bacteria, and other microorganisms obtained from fermented milk have been used (Fontana *et al.*, 2013) as probiotics. Gastro-intestinal tract (GIT) is another very important source of probiotics because the adult human gut contains more than 500 different types of bacteria. Many of the probiotic strains that are used today like *L. gasseri* and *L. reuteri* have been isolated from this source (Ryan *et al.*, 2008).

The benefits of probiotics on health include treatments and prevention of some diseases such as Diarrhea, Irritable bowel syndrome (IBS), Lactose intolerance, Immunomodulation diseases, Cardiovascular diseases, Cancer, and Obesity (Pandey *et al.*, 2015). Faujdar *et al.* (2016) found probiotics effect on oral health such as dental caries, periodontal diseases, halitosis or bad breath and in addition related with disappearance of food allergy semblance, lowering of blood cholesterol. Furthermore, some existing evidence proves the effect of probiotics on weight management in humans (Sanchez *et al.*, 2013). In the present review, we have tried to focus on the role of probiotics in food allergy, autism and cholesterol level.

Probiotics and food allergy

Food allergy is a reverse immune response to special kinds of food. It is estimated that food allergy affects about 8% of children and 4% of adults (Liew *et al.*, 2009; Gupta *et al.*, 2007). Several studies prove that a "healthy" intestinal micro-biota facilitates the development of immune tolerance (Francino, 2014; Hooper *et al.*, 2012). Interventional studies suggest that probiotics could be protective against the development of many diseases and food allergy (Menini *et al.*, 2017, Yang *et al.*, 2017), Intestinal micro-biota has been demonstrated to play an important role in maintaining the Th1/Th2 balance (Gigante *et al.*, 2011), which is the key mechanism involved in allergic diseases.

The common species of probiotics existing in most people, Bifido bacteria and lactobacilli, can affect immune function by various pathways. Probiotics supplementation was illustrated to induce TGF- β expression, which ameliorates food allergy by suppressing Th2 response, and inducing Foxp3⁺Treg production (Kim *et al.*, 2014; Barletta *et al.*, 2013). Another mechanism by which the commensal flora promotes tolerance is the production of short-chain fatty acids (SCFAs), generated by bacterial fermentation of dietary fibres. SCFA act on T cells *via* a G-protein-coupled receptor (GPR43) and protect mice from intestinal inflammation by expanding colonic Treg cells (Smith *et al.*, 2013). Nevertheless, it is not clear to what extent oral administration of probiotics can affect gut micro-biota composition, thus inhibiting food allergy development. Using ovalbumin (OVA)-sensitized murine model, it was showed that probiotics improved allergic symptoms (Yang *et al.*, 2017), including reducing OVA specific-IgE, and -IgG1 levels in the serum, Th2 cytokines release in spleen, and the occurrence of diarrhea (Yang *et al.*, 2017). Recommendation to the use of probiotics for the prevention of food allergy or is based on few studies (Fiocchi *et al.*, 2016). At this point, it is necessary to understand more precisely the micro-biota composition of healthy humans and the ideal probiotic able to prevent or fight specific disease such as allergy and asthma (Mennini *et al.*,

2017).

Probiotics and autism

Autism Spectrum Disorders (ASD) according to American Psychiatric Association definition comprises a complex group of disorders of brain development characterized by social and communication impairment along with presence of repetitive and restrictive behaviours (Santocchi *et al.*, 2016). According to the report of the Centers for Disease Control and Prevention the prevalence of autism children is 1 in 68 children in the United States (78% increase since 2007) and it is about 4.5 times more common among boys (1 in 42) than girls (1 in 189) (Navarro *et al.*, 2016). Recent meta-analysis emphasizes that children with ASD experience significantly more general gastrointestinal (GI) symptoms, such as constipation and abdominal pain and higher rate of diarrhoea (McElhanon *et al.*, 2014). Several reports refer the GI symptoms to the significant difference in the intestinal bacteria in gut of ASD patients compared with healthy children (Cao *et al.*, 2013).

Parracho *et al.* (2005) reported that differences in the gut micro-flora were confirmed in ASD children where the ratio was high in *Clostridium histolyticum* group bacteria compared with a healthy control group. ASD children also have high levels of *Lactobacilli* and lower levels of *Bifido* bacterium than other controls (Adams *et al.*, 2011; Finegold *et al.*, 2002). The imbalance in the gut of children may be due to differences in beneficial bacteria (Williams *et al.*, 2011).

Grossi *et al.* (2016) reported that the probiotic treatment given to 12 year's boy with ASD reduced the severity of abdominal symptoms and improved autistic core symptoms. The medication used was VSL #3, which is a multi-strain mixture of ten probiotics and the treatment, lasted 4 weeks followed by a four month follow-up. While Shaaban *et al.* (2017) found an increase in the colony counts of *Bifido* bacteria and *Lactobacilli* levels, with a significant reduction in their body weight as well as significant improvements

in the severity of autism, and gastrointestinal symptoms compared to the baseline evaluated at the start of the study, where the dose was 100×10^6 CFUs of three probiotic strains supplement *Lactobacillus acidophilus*, *Lactobacillus rhamnosus* and *Bifido* bacteria longum, for 3 months in 30 autistic children from 5 to 9 years old. Lately, the entire microbiota has a part of the gut-brain axis (Grenham *et al.*, 2011), and can modulate brain function by forming a critical link in the bidirectional interaction between nervous system and intestine. Depending on the previous studies probiotics can be an effective and non-pharmacological treatment for children with ASD, not only for GI symptoms also for behavioural and neurophysiological patterns (Santocchi *et al.*, 2016).

Probiotics and cholesterol

High levels of serum cholesterol positively correlated with coronary heart disease (Kumar *et al.*, 2012). Cardiovascular disease (CVD) remains the leading cause of death and disability worldwide, including China, mostly due to ischaemic heart disease (IHD) and stroke (including both hemorrhagic and ischemic stroke) (Mortality GBD Causes of Death Collaborators). Many investigators are paying close attention to LAB strains and its cholesterol-reducing effects in vitro or in vivo (Kumar *et al.*, 2012; Ooi and Liong, 2010). The ability to reduce blood cholesterol varies among strains and species of LAB (Hosono and Tono-Oka, 1995). Recently, several studies have illustrated the cholesterol-lowering effects of LAB or fermented milk products in animal models (Damodharan *et al.*, 2016; Xie *et al.*, 2011), also in Human (Jones *et al.*, 2012; Schaafsma *et al.*, 1998). Of note, the six genera of *Lactobacillus*, *Lactococcus*, *Leuconostoc*, *Enterococcus*, *Luteococcus*, and *Streptococcus* were detected in the Tibetan traditional fermented yak milk (Liu *et al.*, 2015). Ding *et al.*, (2017) screened cholesterol-lowering lactic acid bacteria from traditional fermented Tibetan yak milk in rats fed a high cholesterol diet. Results showed that the strain of *L. plantarum* Lp3 had a high Cholesterol-reducing rate (73.3%) and administration of Lp3 to rats fed a high-cholesterol diet promoted distinguished falls in

serum and liver cholesterol and triglycerides levels, and reduced lipid deposition in the cytoplasm of rat's liver tissue.

Conclusion

The balance of micro-biota in the intestine restored to mitigate GI problems and to relieve food allergy symptoms. GI and behavioural symptoms in ASD children can be modulated by probiotics, and some strains could be a potential probiotics to treat hyperlipidemia and can be used in functional food. More studies are required on assessing new strains of probiotics and their relevance in biomedical/clinical research.

Acknowledgement

I would like to express my very great appreciation to Mrs Shaista Arzoo for her assistance in the preparation of manuscript.

References

- Adams JB, Johansen LJ, Powell LD, Quig D, Rubin RA.** 2011. Gastrointestinal flora and gastrointestinal status in children with autism—comparisons to typical children and correlation with autism severity. *BMC Gastroenterology* **11**, 1-13.
<http://dx.doi.org/10.1186/1471-230X-11-22>.
- Anukam KC, Reid G.** 2007. Probiotics: 100 years (1907-2007) after Elie Metchnikoff's observation. *Communicating Current Research and Educational Topics and Trends in Applied Microbiology* **1**, 466-474.
- Barletta B, Rossi G, Schiavi E, Butteroni C, Corinti S, Boirivant M, Di Felice G.** 2013. Probiotic VSL#3-induced TGF-beta ameliorates food allergy inflammation in a mouse model of peanut sensitization through the induction of regulatory T cells in the gut mucosa. *Molecular Nutrition and Food Research* **57**, 2233-2244.
<http://dx.doi.org/10.1002/mnfr.201300028>
- Cao X, Lin P, Jiang P, Li C.** 2013. Characteristics of the gastrointestinal microbiome in children with autism spectrum disorder: a systematic review. *Shanghai Archives of Psychiatry* **25**, 342-353.
<http://dx.doi.org/10.3969/j.issn.10020829.2013.06.003>
- Chapman C, Gibson GR, Rowland I.** 2011. Health benefits of probiotics: are mixtures more effective than single strains? *European Journal of Nutrition* **50**, 1-17.
<http://dx.doi.org/10.1007/s00394-010-0166-z>.
- Damodharan K, Palaniyandi SA, Yang SH, Suh JW.** 2016. Functional probiotic characterization and in vivo cholesterol-lowering activity of *Lactobacillus helveticus* isolated from fermented cow milk. *Journal of Microbiology and Biotechnology* **26**, 1675-1686.
<http://dx.doi.org/10.4014/jmb.1603.03005>.
- Ding W, Shi C, Chen M, Zhou J, Long R., Guo X.** 2017. Screening for lactic acid bacteria in traditional fermented Tibetan yak milk and evaluating their probiotic and cholesterol-lowering potentials in rats fed a high-cholesterol diet. *Journal of Functional Food* **32**, 324-323.
<http://dx.doi.org/10.1016/j.jff.2017.03.021>
- Faujdar SS, Mehrishi P, Bishnoi S, Sharma A.** 2016. Role of probiotics in human health and disease: an update. *International Journal of Current Microbiology and Applied Sciences* **5**, 328-344.
<http://dx.doi.org/10.20546/ijcmas.2016.503.040>
- Finegold SM, Molitoris D, Song Y, Liu C, Vaisanen ML, Bolte E, Mc Teaque M, Sandler R, Wexler H, Marlowe EM, Collins MD, Lawson PA, Summanen P, Baysallar M, Tomzynski TJ, Read E, Johnson E, Rolfe R, Nasir P, Shah H, Haake DA, Manning P, Kaul A.** 2002. Gastrointestinal microflora studies in late-onset autism. *Clinical Infectious Diseases* **35**(1), S6-S16.
<http://dx.doi.org/10.1086/341914>
- Fiocchi A, Fierro V, La Marra F, Dahdah LA.** 2016. The custom clearance of pro- and prebiotics in

allergy prevention. *Annals of Allergy Asthma and Immunology* **117**, 465–467.

<http://dx.doi.org/10.1016/j.anai.2016.05.008>.

Fontana L, Bermudez-Brito M, Plaza-Diaz J, Munoz-Quezada S, Gil A. 2013. Sources, isolation, characterisation and evaluation of probiotics. *British Journal of Nutrition* **109**(S2), S35–S50.

<http://dx.doi.org/10.1017/S0007114512004011>

Francino MP. 2014. Early Development of the Gut Microbiota and Immune Health. *Pathogens* **3**, 769–790.

<http://dx.doi.org/10.3390/pathogens30307.69>

Gigante G, Tortora A, Ianiro G, Ojetti V, Purchiaroni F, Campanale M, Cesario V, Scarpellini E, Gasbarrini A. 2011. Role of gut microbiota in food tolerance and allergies. *Digestive Disease* **29**, 540–549.

<http://dx.doi.org/10.1159/000332977>.

Grenham S, Clarke G, Cryan JF, Dinan TG. 2011. Brain-gut-microbe communication in health and disease. *Frontiers in Physiology* **2**, 94.

<http://dx.doi.org/10.3389/fphys.2011.00094>

Grossi E, Melli S, Dunca D, Terruzzi V. 2016. Unexpected improvement in core autism spectrum disorder symptoms after long-term treatment with probiotics. *SAGE Open Medical Case Reports* **4**, 2050313X16666231.

<http://dx.doi.org/10.1177/2050313X1666.6231>

Gupta R, Sheikh A, Strachan DP, Anderson HR. 2007. Time trends in allergic disorders in the UK. *Thorax* **62**, 91–96.

Hooper LV, Littman DR, Macpherson AJ. 2012. Interactions between the microbiota and the immune system. *Science* **336**, 1268–1273.

<http://dx.doi.org/10.1126/science.1223490>

Hosono A, Tono-Oka T. 1995. Binding of cholesterol with lactic acid bacterial cells.

Milchwissenschaft-Milk Science International **50**, 556–560.

Jones ML, Martoni CJ, Parent M, Prakash S. 2012. Cholesterol-lowering efficacy of a microencapsulated bile salt hydrolase-active *Lactobacillus reuteri* NCIMB 30242 yoghurt formulation in hypercholesterolaemic adults. *British Journal of Nutrition* **107**, 1505–1513.

<http://dx.doi.org/10.1017/S0007114511004703>.

Kim HJ, Kim YJ, Lee SH, Yu J, Jeong SK, Hong SJ. 2014. Effects of *Lactobacillus rhamnosus* on allergic march model by suppressing Th2, Th17, and TSLP responses via CD4(+)CD25(+)Foxp3(+) Tregs. *Clinical Immunology* **153**, 178–186.

<http://dx.doi.org/10.1016/j.clim.2014.04.008>.

Kumar M, Nagpal R, Kumar R, Hemalatha R, Verma V, Kumar A, Chakroborty C, Singh B, Marotta F, Jain S, Yadav H. 2012. Cholesterol-lowering probiotics as potential biotherapeutics for metabolic diseases. *Experimental Diabetes Research* **2012**, 902917.

<http://dx.doi.org/10.1155/2012/902917>

Liew WK, Williamson E, Tang ML. 2009. Anaphylaxis fatalities and admissions in Australia. *Journal of Allergy and Clinical Immunology* **123**, 434–442.

<http://dx.doi.org/10.1016/j.jaci.2008.10.049>.

Liong, MT. 2011. Probiotics: Biology, genetics and health aspects, ed 1, Springer-Verlag Berlin Heidelberg, p330.

Liu W, Xi X, Sudu Q, Kwok L, Guo Z, Hou QC, Menhe B, Sun T, Zhang, H. 2015. High-throughput sequencing reveals microbial community diversity of Tibetan naturally fermented yak milk. *Annals of Microbiology* **65**, 1741–1751.

<http://dx.doi.org/10.1007/s13213-014-10.13-x>

McElhanon BO, McCracken C, Karpen S, Sharp WG. 2014. Gastrointestinal symptoms in

autism spectrum disorder: a meta-analysis. *Pediatrics* **133**, 872–883.

Mennini M, Dahdah L, Artesani MC, Fiocchi A, Martelli A. 2017. Probiotics in Asthma and Allergy Prevention. *Frontiers in Pediatrics* **5**, 1-5.

<http://dx.doi.org/10.3389/fped.2017.0.0165>

Mortality GBD Causes of Death Collaborators. 2016. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980-2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet* **388**, 1459–1544.

[https://doi.org/10.1016/S0140-6736\(16\)31012-1](https://doi.org/10.1016/S0140-6736(16)31012-1)

Navarro F, Liu Y, Rhoads JM. 2016. Can probiotics benefit children with autism spectrum disorders? *World Journal of Gastroenterology* **22**, 10093–10102.

<http://dx.doi.org/10.3748/wjg.v22.i46.100.93>

Ooi LG, Liong MT. 2010. Cholesterol-lowering effects of probiotics and prebiotics: a review of in vivo and in vitro findings. *International Journal of Molecular Sciences* **11**, 2499–2522.

<http://dx.doi.org/10.3390/ijms1106.2499>

Pandey KR, Naik SR, Vakil BV. 2015. Probiotics, prebiotics and synbiotics-a review. *Journal of Food Science and Technology* **52**, 7577–7587

<http://dx.doi.org/10.1007/s13197-015-1921-1>

Parracho HM, Bingham MO, Gibson GR, McCartney AL. 2005. Differences between the gut microflora of children with autistic spectrum disorders and that of healthy children. *Journal of Medical Microbiology* **54**, 987–991.

<http://dx.doi.org/10.1099/jmm.0.46101-0>

Ryan KA, Jayaraman T, Daly P, Canchaya C, Curran S, Fang F, Quigley EM, O'Toole PW. 2008. Isolation of lactobacilli with probiotic properties from the human stomach. *Letters in Applied Microbiology* **47**, 269–274.

Sanchez M, Darimont C, Drapeau V, Emady-Azar S, Lepage M, Rezzonico E, Ngom Bru C, Berger B, Phillipe L, Ammon-Zuffrey C, Leone P, Chevrier G, St-Amand E, Marette A, Doré J, Tremblay A. 2014. Effect of *Lactobacillus rhamnosus* CGMCC1.3724 supplementation on weight loss and maintenance in obese men and women. *British Journal of Nutrition* **111**, 1507–1519.

<https://doi.org/10.1017/S0007114513003875>

Santocchi E, Guiducci L, Fulceri F, Billeci L, Buzzigoli E, Apicella F, Calderoni S, Grossi E, Morales MA, Muratori F. 2016. Gut to brain interaction in Autism Spectrum Disorders: a randomized controlled trial on the role of probiotics on clinical, biochemical and neurophysiological parameters. *BMC psychiatry* **16**, 183.

<http://dx.doi.org/10.1186/s12888-016-0887-5>

Schaafsma G, Meuling WJ, Van Dokkum W, Bouley C. 1998. Effects of a milk product, fermented by *Lactobacillus acidophilus* and with fructo-oligosaccharides added, on blood lipids in male volunteers. *European Journal of Clinical Nutrition* **52**, 436–440.

Shaaban SY, El Gendy YG, Mehanna NS, El-Senousy WM, El-Feki HSA, Saad K, El-Asheer OM. 2017. The role of probiotics in children with autism spectrum disorder: A prospective, open-label study. *Nutritional Neuroscience* **21**, 676–681.

<http://dx.doi.org/10.1080/1028415X.2017.1347746>

Smith PM, Howitt MR, Panikov N, Michaud M, Gallini CA, Bohlooly YM, Glickman JN, Garrett WS. 2013. The microbial metabolites, short-chain fatty acids, regulate colonic Treg cell homeostasis. *Science* **341**, 569–573.

<http://dx.doi.org/10.1126/science.1241165>

Williams BL, Hornig M, Buie T, Bauman ML, Paik MC, Wick I, Bennett A, Jabado O, Hirschberg DL, Lipkin WI. 2011. Impaired carbohydrate digestion and transport and mucosal dysbiosis in the intestines of children with autism and

gastrointestinal disturbances. PloS one **6**, e24585.
<http://dx.doi.org/10.1371/journal.pone.0024585>.

Xie N, Cui Y, Yin YN, Zhao X, Yang JW, Wang ZG, Fu N, Tang Y, Wang XH, Liu XW, Wang CL, Lu FG. 2011. Effects of two lactobacillus strains on lipid metabolism and intestinal microflora in rats fed a high-cholesterol diet. BMC Complementary and Alternative Medicine **11**, 1-11.

<http://dx.doi.org/10.1186/1472-6882-11-53>.

Yang B, Xiao L, Liu S, Liu X, LuoY, Ji Q, Yang P, Liu Z. 2017. Exploration of the effect of probiotics supplementation on intestinal microbiota of food allergic mice. American journal of Translational Research **9**, 376–385.