Effects of probiotics on immunity and iron homeostasis: A minireview

by Bachril Fikry

Submission date: 23-Apr-2022 07:26AM (UTC+0700)
Submission ID: 1817745817
File name: genital_Cystic_Adenomatoid_Malformations_Type_1-_Case_Report.pdf (439.31K)
Word count: 3277
Character count: 18713

Clinical Nutrition ESPEN xxx (xxxx) xxx

Contents lists available at ScienceDirect

Clinical Nutrition ESPEN

journal homepage: http://www.clinicalnutritionespen.com

Narrative Review

Effects of probiotics on immunity and iron homeostasis: A mini-review

Bahrul Fikri [a, b, *], Nadhirah Rasyid Ridha [a, b], Sri Hardiyanti Putri [a], Setia Budi Salekede [a, b], Aidah Juliaty [a, b], Conny Tanjung [c], Nasrum Massi [d]

[a] Department of Pediatrics, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[b] DR Wahidin Sudirohusodo Hospital, Makassar, Indonesia
[c] Graduate School of Medicine, Hasanuddin University, Makassar, Indonesia
[d] Department of Microbiology, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia

ARTICLE INFO

Article history:
Received 6 October 2021
Accepted 19 March 2022

Keywords:
Probiotics
Immunity
Iron homeostasis

SUMMARY

Iron deficiency remains a major problem in both developed and developing countries. Iron supplementation has been used as a standard intervention for the prevention and treatment of iron deficiency anemia (IDA). There are many factors affecting the efficacy, including stunting, infections or inflammations, and genetics. Recently, some studies have been conducted to further investigate the effects of probiotics on immunity and iron homeostasis. This mini review discusses about some important factors that can improve the management of IDA.

1. Introduction

Anemia and stunting pose significant challenges to the healthcare system as well as children's survival [1]. Despite a general decrease in global prevalence, stunting continues to affect one-third of children under the age of five in developing countries [2]. According to the 2018 Indonesian Basic Health Survey, the prevalence of stunting in Indonesia reached 31% [3].

Stunting is a chronic nutritional problem that causes growth retardation in children. It is mostly caused by poor parenting and inadequate food intake. Low intake of macronutrients and micronutrients contributes to an increase in childhood stunting. Anemia and stunting both have an impact on immune response, which impacts the duration and severity of infections or inflammations [1].

Anemia and stunting are multiple overlapping influences originating from various levels [4,5]. A study from Ethiopia showed that there was a concerning high level of anemia and stunting clustering among infants and young children [6]. In another study, 1008 children determined that severely stunted children aged 6–59 months are significantly associated with anemia [3]. In our preliminary study, we found 40 stunting patients out of a total of 240 children examined (16.6%). 26 out of the 40 stunting patients (65%) had iron deficiency and 4 (10%) had anemia of chronic diseases (ACD) [7].

Optimizing iron status can be challenging. Iron supplementation is currently a standard intervention for iron deficiency anemia (IDA). However, there are some barriers to body iron repletion via oral supplementation including underlying systemic inflammation from chronic conditions such as chronic infection or other inflammatory conditions, autoimmune diseases, renal failure, dietary factors such as phytate, and patient-reported symptoms including gastrointestinal distress. Furthermore, iron bioavailability should be considered to increase the effectiveness of iron supplementation [8,9].

The high cases of IDA require special strategies. Iron supplementation combined with vitamin C administration shows unsatisfactory result in the treatment of IDA. There are numerous studies showing the effectiveness of probiotics in enhancing iron absorption that succeed to improve of IDA [10–13].

2. Probiotic, immunity, and iron homeostasis

The International Scientific Association for Probiotics and Prebiotics defined probiotics as "live microorganisms that, when

* Corresponding author. Department of Pediatrics, Faculty of Medicine Hasanuddin University, Makassar, 90245, Indonesia.
E-mail address: bahrulfikri@unhas.ac.id (B. Fikri).

https://doi.org/10.1016/j.clnesp.2022.03.031

Please cite this article as: B. Fikri, N.R. Ridha, S.H. Putri *et al.*, Effects of probiotics on immunity and iron homeostasis: A mini-review, Clinical Nutrition ESPEN, https://doi.org/10.1016/j.clnesp.2022.03.031

administered in adequate amounts, confer a health benefit on the host." [14] Probiotics have gained popularity due to their potential preventative and therapeutic effects, low cost, and accessible. Moreover, in this COVID-19 pandemic era, probiotics and synbiotics are a promising strategy to reduce the severity of respiratory infection symptoms, reduce the duration of disease, improve QOL, and induce and maintain remission in patients with Respiratory Tract Infection (RTI) [15]. Some studies shows that probiotics improve iron absorption [16–18].

Iron absorption is a complex process, influenced by some factors such as bioavailability, the presence of dietary enhancers, and/or inhibitors [19]. Probiotics directly affect epithelial cells by increasing the expression and excretion of mucin from goblet cells, as well as defensin, which inhibits the proliferation of pathogenic or commensal germs and affects the mucosal barrier's integrity. Probiotics also enhance tight junction stability, which reduces permeability of the pathogens and their products. Moreover, probiotics affect mucosal immunity by increasing the number of sIgA-producing cells in the lamina propria, which prevents colonization on epithelium by binding to bacteria and antigens [20–22].

The prebiotic supplement galactooligosaccharide, selectively used by commensal Bifidobacterium spp, has been shown to enhance dietary iron absorption [23]. The study also reported the increase of *Bifidobacterium* spp and short-chain fatty acid (SCFAs) production linked to decreased fecal pH that likely to play a role in iron enhancement. Meanwhile, fermented foods (e.g., yogurt, vegetables) have also been shown to enhance dietary iron absorption [17,24].

Immune responses that emerge after infection or inflammation enhance pro-inflammatory cytokines particularly IL-6 and TNF-α release and suppress the production of anti-inflammatory cytokines. IL-6 induces the hepatocytes to release hepcidin which increases the iron deposit in cells and disturbs the iron absorption in the intestines. The accumulated iron deposit in the cell leads to prolonged infection or inflammation. In addition, it will also affect T cell proliferation and maturation through iron-dependent Trf-1 [25]. This will impact on more prolonged infection or inflammation. The iron homeostasis and immune response seem to have a two-way relationship [25]. Overcoming the infection or the inflammation is the key to maintain iron homeostasis. However, it is not easy to diagnose and treat the infection or inflammation. The longer the infection or the inflammation lasts, the longer iron homeostasis disruption will be, and vice versa. In this complex situation, probiotics might give solutions by: 1. Increasing mucin production and antimicrobial peptides (AMPS), 2. Stimulating the epithelial cell to release TGF-β and IL-10 which induce the Treg maturation and proliferation, 3. suppressing pro-inflammatory cytokines such as IL-6 reduces hepcidin production [26,27] (see Table 1).

Lactic acid-forming bacteria, including lactobacilli, are thought to increase dietary iron bioavailability through several mechanisms such as reducing intestinal pH shifts in gut microbiota metabolism, metabolite formation, and promotion of anti-inflammatory immunomodulation [29]. This suggests that probiotic has an important role in optimizing dietary iron bioavailability and improving iron status without the gastrointestinal burden of additional supplemental iron [32].

Several studies show positive effect of *Lactobacillus plantarum* 299v on non-haem iron absorption [16]. A meta-analysis of eight studies observed that *L. plantarum* 299v significantly improved non-heme dietary iron absorption in humans [33]. The Lp299v has been shown to increase the amount of ferric iron in vitro digested meals and drinks. This, in combination with the ability of Lp299v to increase levels of a ferric reductase (duodenal cytochrome B, DcytB) in human intestinal cells (Caco-2/HT29 MTX cells), may explain the positive effect on iron absorption [18].

Lp299v improve iron status in a non-anemic, iron-deficient population when administered in combination with a low dose of iron [34]. Lp299v can suppress inflammatory parameters [35–37]. Thus, it could lead to a change in hepcidin expression and iron absorption [18]. It also might reduce GI side effects during intense exercise and/or following consumption of iron supplements. Intake of Lp299v has previously been shown to increase the expression of the activation marker CD25 on CD8+ T-cells [38].

Another cause of unsuccessful iron therapy in IDA is the presence of gene mutation [39]. Several studies have identified several gene variants related to iron balance in the body, which can cause

Table 1
Mechanism of probiotics on the iron bioavailability.

Author	Year	Sampling	Mechanism
Bergqvist et al. [28]	2006	An in vitro digestion/Caco-2 cell model was applied to explore the impact of lactic acid (LA) fermentation by *Lactobacillus pentosus* and *Leuconostoc mesenteroides*.	The difference in pH before and after digestion as the acid environment favors the $Fe2^{+}$ rather than the $Fe3^{+}$ state.
Scheers et al. [18]	2016	Human iron absorption from lactic-fermented vegetables: 17 volunteers consumed lactic-fermented vegetable with *Lactobacillus plantarum* for 2 weeks, and followed by consumed Fe solution orally for 2 weeks. Lactate and fermented vegetable experiments in the Caco-2/HepG2 cell system *L. plantarum*, *L. mesenteroides*, and *L. pentosus* in Human Caco-2 cells (HTB37) and human HepG2 cells.	Ferric iron is more stable in an acidic water solution than ferrous iron - mucus layer binds Fe3+ under acidic conditions and less reactive.
Mack et al. [29]	2003	HT29 cells grown to enhance expression of MUC3 mucins were incubated with selected *Lactobacillus* strains.	Selected probiotic *Lactobacillus* species have the ability to adhere to intestinal epithelial cells and rapidly induce eukaryotic MUC3 mucin expression. The upregulated MUC3 mucin gene product is a secreted mucin that has the ability to inhibit enteric pathogen epithelial cell adherence.
Natanzi et al. [30]	2017	In Vitro assay, using *Lactobacillus acidophilus* in Caco-2 cells	The phytases are a group of enzymes that can degrade phytic acid. Phytic acid decreased ferritin formation in the cell line.
González et al. [31]	2017	*L. fermentum* CECT5716 was grown in anaerobic conditions in a synthetic medium	*L. fermentum* excreting molecules called p-hydroxyphenyllactic acid (HPLA). HPLA effectively reduces Fe (III) to Fe (II) and in the gastrointestinal tract can mimic the functionality of the DcytB ferric-reducing protein by promoting iron uptake by enterocytes.

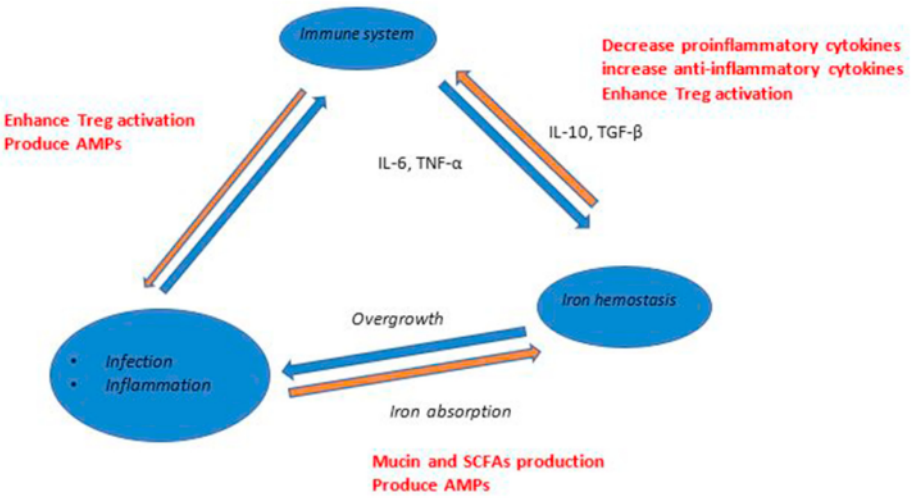

Fig. 1. Effect of probiotic on iron homeostasis (red color).

iron deficiency or overload [40,41]. The single-nucleotide polymorphism most strongly associated with lower serum iron concentration was the transmembrane protease serine 6 (TMPRSS6) gene, which produces matriptase-2, that concurrently increased the hepcidin level in the liver [42,43]. A recent study in Lombok, Indonesia showed that variant alleles (A) and (G) at rs855791 and rs4820268 of the TMPRSS6 gene, respectively, are associated with a lower SF concentration in iron deficiency anemia in under-two-year-old children [44].

3. Conclusion

The understanding of probiotics, immunity, and iron homeostasis may be the key to providing new, better iron supplementation. The effects of probiotics on iron homeostasis are summarized in Fig. 1. Future clinical trials related to a certain strain of probiotics and iron status both in healthy children and in IDA are needed.

Funding

This study contains no financial grants or funding that can be reported.

Author contribution

Bahrul Fikri: Conceptualization and writing the manuscript (MS), Nadhirah Rasyid Ridha: Writing the MS, Sri Hardiyanti Putri: writing the MS, Setia Budi Salekede: Review the MS, Aidah Juliaty: Review the MS, Conny Tanjung: Conceptualization and Review the MS, Nasrum Massi: Review the MS.

Declaration of competing interest

The authors have no conflicts of interest.

References

[1] Reinhardt K, Fanzo J. Addressing chronic malnutrition through multi-sectoral, sustainable approaches: a review of the causes and consequences. Front Nutr 2014;1(August):1–11.
[2] Habib MA, Black K, Soofi SB, Hussain I, Bhatti Z, Bhutta ZA, et al. Prevalence and predictors of iron deficiency anemia in children under five years of age in Pakistan, a secondary analysis of National Nutrition Survey data 2011-2012. PLoS One 2016;11(5):1–13.
[3] Ernawati F, Syauqy A, Arifin AY, Soekatri MYE, Sandjaja S. Micronutrient deficiencies and stunting were associated with socioeconomic status in Indonesian children aged 6–59 months. Nutrients 2021;13(6).
[4] Lopez A, Cacoub P, Macdougall IC, Peyrin-Biroulet L. Iron deficiency anaemia. Lancet 2016;387(10021):907–16.
[5] Akombi BJ, Agho KE, Hall JJ, Wali N, Renzaho AMN, Merom D. Stunting, wasting and underweight in Sub-Saharan Africa: a systematic review. Int J Environ Res Publ Health 2017;14(8):1–18.
[6] Mohammed SH, Larijani B, Esmaillzadeh A. Concurrent anemia and stunting in young children: prevalence, dietary and non-dietary associated factors. Nutr J 2019;18(1):1–10.
[7] Bahagia Febriani AD, Daud D, Rauf S, Nawing HD, Ganda IJ, Salekede SB, et al. Risk factors and nutritional profiles associated with stunting in children. Pediatr Gastroenterol Hepatol Nutr 2020;23(5):457–63.
[8] Beck KL, Conlon CA, Kruger R, Coad J. Dietary determinants of and possible solutions to iron deficiency for young women living in industrialized countries: a review. Nutrients 2014;6(9):3747–76.
[9] Tolkien Z, Stecher L, Mander AP, Pereira DIA, Powell JJ. Ferrous sulfate supplementation causes significant gastrointestinal side-effects in adults: a systematic review and meta-analysis. PLoS One 2015;10(2):1–20.
[10] Rosen GM, Morrissette S, Larson A, Stading P, Griffin KH, Barnes TL. Use of a probiotic to enhance iron absorption in a randomized trial of pediatric patients presenting with iron deficiency. J Pediatr 2019;207:192–197.e1.
[11] Agustina R, Bovee-Oudenhoven IMJ, Lukito W, Fahmida U, Van De Rest O, Zimmermann MB, et al. Probiotics lactobacillus reuteri dsm 17938 and lactobacillus casei crl 431 modestly increase growth, but not iron and zinc status, among Indonesian children aged 1-6 years. J Nutr 2013;143(7):1184–93.
[12] Manoppo J, Tasiringan H, Wahani A, Umboh A, Mantik M. The role of Lactobacillus reuteri DSM 17938 for the absorption of iron preparations in children with iron deficiency anemia. Korean J Pediatr 2019;62(5):173–8.
[13] Tremblay A, Xu X, Colee J, Tompkins TA. Efficacy of a multi-strain probiotic formulation in pediatric populations: a comprehensive review of clinical studies. Nutrients 2021;13(6):1–19.
[14] Hill C, Guarner F, Reid G, Gibson GR, Merenstein DJ, Pot B, et al. Expert consensus document: the international scientific association for probiotics and prebiotics consensus statement on the scope and appropriate use of the term probiotic. Nat Rev Gastroenterol Hepatol 2014;11(8):506–14.
[15] Darbandi A, Asadi A, Ghanavati R, Roghayeh A. Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID- 19 . The COVID-19 resource centre is hosted on Elsevier Connect , the company ' s public news and information. Int J Infect Dis 2020;105(January):91–104.
[16] Hoppe M, Önning G, Berggren A, Hulthén L. Probiotic strain Lactobacillus plantarum 299v increases iron absorption from an iron-supplemented fruit drink: a double-isotope cross-over single-blind study in women of reproductive age. Br J Nutr 2015;114(8):1195–202.
[17] Bering S, Suchdev S, Sjøltov L, Berggren A, Tetens I, Bukhave K. A lactic acid-fermented oat gruel increases non-haem iron absorption from a phytate-rich meal in healthy women of childbearing age. Br J Nutr 2006;96(1):80–5.

[18] Scheers N, Rossander-Hulthen L, Torsdottir I, Sandberg AS. Increased iron bioavailability from lactic-fermented vegetables is likely an effect of promoting the formation of ferric iron (Fe3+). Eur J Nutr 2016;55(1):373–82.
[19] Gulec S, Anderson GJ, Collins JF. Mechanistic and regulatory aspects of intestinal iron absorption. Am J Physiol Gastrointest Liver Physiol 2014;307(4).
[20] Ohland CL, MacNaughton WK. Probiotic bacteria and intestinal epithelial barrier function. Am J Physiol Gastrointest Liver Physiol 2010;298(6).
[21] Sandes S, Alvim L, Silva B, Acurcio L, Santos C, Campos M, et al. Selection of new lactic acid bacteria strains bearing probiotic features from mucosal microbiota of healthy calves: looking for immunobiotics through in vitro and in vivo approaches for immunoprophylaxis applications. Microbiol Res 2017;200:1–13.
[22] Sazawal S, Dhingra U, Hiremath G, Sarkar A, Dhingra P, Dutta A, et al. Prebiotic and probiotic fortified milk in prevention of morbidities among children: community-based, randomized, double-blind, controlled trial. PLoS One 2010 Aug;5(8):e12164.
[23] Dold S, Zimmermann MB, Jeroense F, Zeder C, Habeych E, Galaffu N, et al. Iron bioavailability from bouillon fortified with a novel ferric phytate compound: a stable iron isotope study in healthy women (part II). Sci Rep 2020;10(1):1–9.
[24] Asemi Z, Esmaillzadeh A. Effect of daily consumption of probiotic yoghurt on serum levels of calcium, Iron and liver enzymes in pregnant women. Int J Prev Med 2013;4(8):949–55.
[25] Cherayil BJ. Iron and immunity: immunological consequences of iron deficiency and overload. Arch Immunol Ther Exp 2010;58(6):407–15.
[26] Ramezani A, Raj DS. The gut microbiome, kidney disease, and targeted interventions. J Am Soc Nephrol 2014;25(4):657–70.
[27] Llewellyn A, Foey A. Probiotic modulation of innate cell pathogen sensing and signaling events. Nutrients 2017;9:1–31.
[28] Bergqvist SW, Andlid T, Sandberg A-S. Lactic acid fermentation stimulated iron absorption by Caco-2 cells is associated with increased soluble iron content in carrot juice. Br J Nutr 2006 Oct;96(4):705–11.
[29] Mack DR, Ahrne S, Hyde L, Wei S, Hollingsworth MA. Extracellular MUC3 mucin secretion follows adherence of. Gut 2003;52:827–34.
[30] Ghaderian S. Iron absorption improvement: an additional health benefit for certain probiotics, in vitro and in vivo study. Acta Med Mediterr 2017 Jan;33(2):301.
[31] González A, Gálvez N, Martín J, Reyes F, Pérez-Victoria I, Dominguez-Vera JM. Identification of the key excreted molecule by Lactobacillus fermentum related to host iron absorption. Food Chem 2017 Aug;228:374–80.
[32] Wells JM. Immunomodulatory mechanisms of lactobacilli. Microb Cell Factories 2011;10(SUPPL 1):1–15.
[33] Vonderheid SC, Tussing-Humphreys L, Park C, Pauls H, Hemphill NO, Labomascus B, et al. A systematic review and meta-analysis on the effects of probiotic species on iron absorption and iron status. Nutrients 2019;11(12).
[34] Axling U, Önning G, Combs MA, Bogale A, Högström M, Svensson M. The effect of lactobacillus plantarum 299v on iron status and physical performance in female iron-deficient athletes: a randomized controlled trial. Nutrients 2020;12(5):1–14.
[35] Domínguez R, Sánchez-Oliver AJ, Mata-Ordoñez F, Feria-Madueño A, Grimaldi-Puyana M, López-Samanes Á, et al. Effects of an acute exercise bout on serum hepcidin levels. Nutrients 2018;10(2):1–22.
[36] McNaught CE, Woodcock NP, Anderson ADG, MacFie J. A prospective randomised trial of probiotics in critically ill patients. Clin Nutr 2005;24(2):211–9.
[37] Naruszewicz M, Johansson ML, Zapolska-Downar D, Bukowska H. Effect of Lactobacillus plantarum 299v on cardiovascular disease risk factors in smokers. Am J Clin Nutr 2002;76(6):1249–55.
[38] Rask C, Adlerberth I, Berggren A, Ahrén IL, Wold AE. Differential effect on cell-mediated immunity in human volunteers after intake of different lactobacilli. Clin Exp Immunol 2013;172(2):321–32.
[39] Heeney MM, Finberg KE. Iron-refractory iron deficiency anemia (IRIDA). Hematol Oncol Clin N Am 2014;28(4):637–52.
[40] Athiyarath R, Shaktivel K, Abraham V, Singh D, Bondu JD, Chapla A, et al. Association of genetic variants with response to iron supplements in pregnancy. Genes Nutr 2015;10(4):4–11.
[41] McLaren CE, Garner CP, Constantine CC, McLachlan S, Vulpe CD, Snively BM, et al. Genome-wide association study identifies genetic loci associated with iron deficiency. PLoS One 2011;6(3).
[42] Tanaka T, Roy CN, Yao W, Matteini A, Semba RD, Arking D, et al. A genome-wide association analysis of serum iron concentrations Brief report A genome-wide association analysis of serum iron concentrations. Blood 2013;115(1):94–6.
[43] Gichohi-Wainaina WN, Towers GW, Swinkels DW, Zimmermann MB, Feskens EJ, Melse-Boonstra A. Inter-ethnic differences in genetic variants within the transmembrane protease, serine 6 (TMPRSS6) gene associated with iron status indicators: a systematic review with meta-analyses. Genes Nutr 2015;10(1):1–15.
[44] Shinta D, Asmarinah Adhiyanto C, Htet MK, Fahmida U. The association of TMPRSS6 gene polymorphism. 2019.

Effects of probiotics on immunity and iron homeostasis: A minireview

ORIGINALITY REPORT

29%	18%	23%	9%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	nozdr.ru Internet Source	2%
2	digibug.ugr.es Internet Source	2%
3	Dewi Shinta, Chris Adhiyanto, Min Htet, Umi Fahmida. "The Association of TMPRSS6 Gene Polymorphism and Iron Intake with Iron Status among Under-Two-Year-Old Children in Lombok, Indonesia", Nutrients, 2019 Publication	2%
4	Submitted to University of Arizona Student Paper	2%
5	Submitted to University of Wisconsin, La Crosse Student Paper	2%
6	www.ncbi.nlm.nih.gov Internet Source	2%
7	Atieh Darbandi, Arezoo Asadi, Roya Ghanavati, Roghayeh Afifirad, Amir Darb	1%

	Emamie, Maryam kakanj, Malihe Talebi. "The effect of probiotics on respiratory tract infection with special emphasis on COVID-19: Systemic review 2010–20", International Journal of Infectious Diseases, 2021 Publication	
8	core-cms.prod.aop.cambridge.org Internet Source	1 %
9	coek.info Internet Source	1 %
10	Gerald M. Rosen, Sue Morrissette, Amy Larson, Pam Stading, Kristen H. Griffin, Timothy L. Barnes. "Use of a Probiotic to Enhance Iron Absorption in a Randomized Trial of Pediatric Patients Presenting with Iron Deficiency", The Journal of Pediatrics, 2019 Publication	1 %
11	Sitti Aizah Lawang, Idham Jayaganda, Dasril Daud. "TNF-Alpha Serum Level as Prognostic Factor in Pediatric Sepsis Patients", Global Journal of Health Science, 2021 Publication	1 %
12	C. L. Ohland. "Probiotic bacteria and intestinal epithelial barrier function", AJP Gastrointestinal and Liver Physiology, 06/01/2010 Publication	1 %

13	core.ac.uk Internet Source	1 %
14	"Nijkamp and Parnham's Principles of Immunopharmacology", Springer Science and Business Media LLC, 2019 Publication	1 %
15	Submitted to Bemidji State University Student Paper	1 %
16	www.dickyricky.com Internet Source	1 %
17	Toshiko Tanaka, Cindy N. Roy, Wenliang Yao, Amy Matteini et al. "A genome-wide association analysis of serum iron concentrations", Blood, 2010 Publication	1 %
18	cejpaediatrics.com Internet Source	1 %
19	nutritionj.biomedcentral.com Internet Source	1 %
20	research.chalmers.se Internet Source	1 %
21	Submitted to Monash University Student Paper	1 %
22	brief.land Internet Source	1 %

23	Bahareh Nikooyeh, Tirang R. Neyestani. "Using Fortified Milk as a Vehicle for Nutrients", Elsevier BV, 2017 Publication	<1 %
24	Rask, C., I. Adlerberth, A. Berggren, I. L. Ahrén, and A. E. Wold. "Differential effect on cell-mediated immunity in human volunteers after intake of different lactobacilli : Lactobacilli and cell-mediated immunity", Clinical & Experimental Immunology, 2013. Publication	<1 %
25	espace.library.uq.edu.au Internet Source	<1 %
26	archive-ouverte.unige.ch Internet Source	<1 %
27	researchmap.jp Internet Source	<1 %
28	worldwidescience.org Internet Source	<1 %
29	researchonline.lshtm.ac.uk Internet Source	<1 %
30	E. Arvidsson Nordström, C. Teixeira, C. Montelius, B. Jeppsson, N. Larsson. " 299v (LP299V): three decades of research ", Beneficial Microbes, 2021 Publication	<1 %

Exclude quotes	On	Exclude matches	< 5 words
Exclude bibliography	On		