FOLIA POMERANAE UNIVERSITATIS TECHNOLOGIAE STETINENSIS
Folia Pomer. Univ. Technol. Stetin., Agric., Aliment., Pisc., Zootech. 2015, 320(35)3, 73–80

Wojciech NEJA, Mariusz BOGUCKI, Joanna A. ZIÓŁKOWSKA, Małgorzata JANKOWSKA, Sylwia KRĘŻEL-CZOPEK

USE OF PROBIOTICS AND PREBIOTICS IN MILK PRODUCTS

ZASTOSOWANIE PROBIOTYKÓW I PREBIOTYKÓW W PRODUKTACH MLECZNYCH

Department of Cattle Breeding and Animal Feeding, University of Science and Technology in Bydgoszcz, Poland

Streszczenie. Probiotyki i prebiotyki, zawarte w produktach mlecznych, mogą dawać wiele pozytywnych efektów prozdrowotnych. Probiotyki to jako żywe mikroorganizmy stanowią suplement diety, a ich spożycie wpływa pozytywnie na mikroflorę jelitową gospodarza. Pozytywne efekty prozdrowotne probiotyków dla przewodu pokarmowego to m.in. przywrócenie mikroflory przewodu pokarmowego do jej prawidłowego stanu. Ponadto zapobiegają procesowi karcynogenezy oraz rozrostowi nowotworów oraz obniżają nietolerancję na laktozę. Prebiotyki jako związki, które nie są trawione przez enzymy trawienne przewodu pokarmowego, wykazują zdolność do stymulowania wzrostu bakterii probiotycznych. Prebiotyki poprawiają pracę jelit, działają przeciwcukrzycowo, przeciwmiażdżycowo oraz wpływają na biodostępność składników pokarmowych. Produkty zawierające probiotyki i prebiotyki zaliczamy do żywności funkcjonalnej, suplementów diety lub leków.

Słowa kluczowe: prebiotyki, probiotyki, produkty mleczne, składniki odżywcze.
Key words: milk products, nutrients, prebiotics, probiotics.

INTRODUCTION

The positive aspects of consuming fermented milk products have been known from ancient times. This type of food was prepared in many regions of the world, from the Near East to western Europe and north Africa. In India, knowledge of how to prepare fermented milk products dates back to the 9th century before Christ. They were believed to have health benefits of treating gastrointestinal (stomach and intestinal) diseases, stimulating appetite and preventing atherosclerosis (Nowak et al. 2010a).

Probiotics have been scientifically documented since the early 20th century and the name probiotic was first used in the 1960s (Nowak et al. 2010b). Prebiotics are compounds naturally found in many plants, but the interest in these health-promoting substances is small. The word prebiotic was first used by Gibson and Roberfroid (1995) .

The aim of the study was to describe the health beneficial properties of probiotics and prebiotics used in dairy products based on the latest research.

Corresponding author – Adres do korespondencji: PhD Wojciech Neja, Department of Cattle Breeding and Animal Feeding, University of Science and Technology in Bydgoszcz, Mazowiecka 28, 85-084 Bydgoszcz, Poland, e-mail: nejaw@utp.edu.pl

DEFINITION AND LEGAL REGULATIONS ON PROBIOTICS AND PREBIOTICS

The most popular definition of a probiotic is that by Fuller. According to his definition, probiotics are a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance. FAO/WHO extended this definition by including the fact that the microorganisms must be alive and improve health (Głąbska and Guzek 2007).

The number of bacteria that a product must contain throughout its shelf life is 10^8/1 g and the cells must be viable and active. In freeze-dried products, this number is much greater and should range between 10^{10} and 10^{11} colony forming units per g (Moneta 2006; Zaręba et al. 2008; Nowak et al. 2010a; Nowak et al. 2010b;).

A probiotic must have certain characteristics to be marketed. Several aspects have to be considered when selecting probiotic microorganisms: safety, functional and technological characteristics. Safety of use includes accurate diagnostic identification, human origin (intended for human consumption), isolation from healthy humans, no negative consequences of use, no antibiotic resistance. Functional characteristics include adherence and ability to colonize certain parts of the gastrointestinal tract, immunomodulation, tolerance of substances produced by the natural human gut flora, antagonistic activity against intestinal pathogens, resistance to different gastrointestinal pH (acidic in the stomach and alkaline further down the digestive tract), health-promoting effects. Technological characteristics include high survival in the end product, bacteriophage resistance, efficient biomass production, no organoleptic changes in the product, genetic stability, resistance to pressure and temperature changes associated with the production process, and moderate acid-forming activity (Achremowicz and Łukasiewicz 2006; Krajewska-Kamińska et al. 2007; Le Thanh and Lewandowicz 2007; Libudzisz 2007; Gajewska and Błaszczyk 2012).

Prebiotics are compounds that pass undigested by the enzymes of the gastrointestinal tract and have the ability to stimulate the growth of probiotic bacteria. Prebiotics should be resistant to hydrolysis and digestive enzymes, serve as a substrate for selected gut microflora, reduce digesta pH, resist absorption in the gastrointestinal tract, have a positive effect on the gut environment, and be stable during technological processes (Pietrzyk 2011; Śliżewska et al. 2013).

Products that contain probiotics and prebiotics are classified as functional foods, dietary supplements, or medicines. Regardless of their classification, they have to show health benefits that have been clinically proven and contain sufficient microorganisms or substances to produce a therapeutic effect. Probiotic bacteria and prebiotics that we consume in dairy products are classified as functional foods (Świderski and Waszkiewicz-Robak 2005; Gajda 2007).

No regulations concerning probiotics and prebiotics have been developed in the European Union. Foods that contain these components are governed by the provisions laid down in food directives that deal with such aspects as product health safety, proper labelling, exact names of probiotics and prebiotics given on the package, not misleading the consumer, advertising and presentation that conform to the properties of the food, and making no reference in the product name to the component with which the product has been enriched (e.g. probiotic yoghurt). At the same time, it is forbidden to declare that a product has disease preventing properties (Gajda 2007).

CHARACTERISTICS OF PROBIOTIC BACTERIA

Lactobacillus, or lactic acid bacteria, are a large and heterogeneous group of 106 species. They are shaped like rods that often cluster together to form short chains. They are found on the epithelium of animals (in the vagina and along the whole length of the gastrointestinal tract), on the surface of plants, in non-fresh and fermenting foods, in feces and in sewage. At present 9 *Lactobacillus* species are considered probiotic, and each strain has the desired properties. These include *L. plantarum, L. acidophilus, L. paracasei, L. casei, L. rhamnosus, L. reuteri, L. salivarius, L. johnosonii, L. fermentum* (Moneta 2006; Libudzisz 2007; Gajewska and Błaszczyk 2012).

Bifidobacterium are bacteria characterized by a peculiar Y shape. Most often they occur as single microorganisms or diplococci, less often they cluster together to form chains and palisades. The genus *Bifidobacterium* includes 28 species and 4 subspecies. The natural habitat of these microorganisms is the epithelium of animals (in the genital tract and along the whole length of the gastrointestinal tract). At present 8 *Bifidobacterium* species are considered probiotic, in which specific strains have the desired properties. These include *B. adolescentis, B. bifidum, B. animals, B. breve, B. longun, B. lactus* and *B. infantis* (Moneta 2006; Libudzisz 2007; Steinka 2011; Gajewska and Błaszczyk 2012).

Probiotic strains are found in microorganisms such as *Lactococcus lactis*, *Enterococcus faecalis*, *Enterococcus faecium, Bacillus cereus, Bacillus subtilis Saccharomyces boulardii* and *Aspergillus niger* (Libudzisz 2007; Steinka 2011).

HEALTH-PROMOTING PROPERTIES OF PROBIOTICS

The main habitat of probiotic bacteria in humans is the middle and lower sections of the gastrointestinal tract. The health benefits for the gastrointestinal tract include bringing gut microflora back into bacterial balance; alleviating the effects and shortening the duration of viral and bacterial diarrhoeas (*Salmonella, Shigella, E.coli*) as well as acute and radiation diarrhoea; re-establishment of normal intestinal microflora after antibiotic therapy; helping to reduce traveller's diarrhoea; decreasing lactose intolerance (effect of bacterial β-galactosidase on milk sugar). In addition, probiotics can be used in gastrointestinal diseases such as *Helicobacter pylori* infection, colitis, irritable bowel syndrome, necrotic enteritis, and colitis ulcerosa. Probiotics also act on the immune system, stimulating it through macrophage activation, modulation of the cytokine profile, increased secretion of IgA, leukocytes, lymphocytes, natural killer cells, plasma cells, and interferon γ.

They prevent carcinogenesis and cancers from developing. This is possible through proper stimulation of the intestinal immune system, binding and degradation of potentially carcinogenic compounds, reducing the turnover of bile acids to secondary bile acids, producing anticarcinogenic substances (acetic or butyric acid), reducing the activity of bacterial enzymes with potential carcinogenic effects (e.g. β-glucuronidase, nitroreductase).

Other health-promoting properties of probiotics include antiallergic effects, preventing atopic dermatitis, reducing cholesterol levels, enhancing activity of the hydrolase enzyme which affects bile salts, reducing arterial blood pressure, restoring bacterial balance in the urogenital tract, and

preventing dental caries (Jeznach 2003; Heczko et al. 2005; Waszkiewicz-Robak 2005; Moneta 2006; Krajewska-Kamińska et al. 2007; Cichy et al. 2010; Nowak et al. 2010a; Pietrzyk 2010; Świderski and Zmarlicki 2010; Schmidt and Olejnik-Schmidt 2011; Szajewska 2012; Cybulska 2013).

CHARACTERISTICS OF PREBIOTICS

Galacto-oligosaccharides are made of the two simple sugars glucose and galactose. Their natural sources are fruit, vegetables and honey. These compounds are characterized by water solubility and low sweetness (in relation to saccharose), their optimum pH is acidic, and they are not digested in the gastrointestinal tract. One of the characteristics most desired by the consumer is their low calorie content of 1.75 kcal · g^{-1}. The production of galacto-oligosaccharides is most common in Japan (Demczuk et al. 2004; Adamczak and Bednarski 2008; Kozioł and Gustaw 2011; Śliżewska et al. 2013).

Fructooligosaccharides are also called oligofructose, oligofructans or inulo-oligosaccharides. They are composed of fructopyranose residues joined together by a glycoside bond having the proper configuration, whereas a glucose molecule joined by a α-1-2 glycoside bond is found at the end of each chain. They naturally occur in products such as wheat, garlic, onions, leeks, artichoke and chicory roots, asparagus, Jerusalem artichoke, and bananas. They are soluble in water and slightly sweet, similar in taste to saccharose. They have a low calorie content of 9.5 kj · g^{-1}. Heat treatment and acid environment in the stomach cause 20% hydrolysis and absorption of simple sugars into the bloodstream. The most common compound from this group is inulin, which was discovered in 1804. It is extracted from natural sources (chicory, agave). In the dairy industry, it is used as a substitute for gelatin, caseinates, and starch derivatives. It is found in dairy products such as fermented milk beverages, milk drinks and cocktails, processed cheese, whey drinks, cream, and low-fat products. Technologically positive characteristics include lending a creamy texture to foods, texture formation, flavour and aroma enhancement, improvement of consistency and spreadability, moisture retention ability, stabilization of foams and emulsions. The compound commonly used in the dairy industry is oligofructose. Compared to saccharose it has low sweetening properties (30% of saccharose sweetness), which is why it is often combined with aspartame to produce foods low in sugar (Jakubczyk and Kosikowska 2000; Demczuk et al. 2004; Florowska et al. 2004; Nastaj and Gustaw 2008; Kozłowicz 2010; Pietrzyk 2011; Kozioł and Gustaw 2013; Śliżewska et al. 2013).

Soybean oligosaccharides are a mixture of stachyose, raffinose and saccharose, which are extracted directly from soya. Their most common commercial form is a mixture of saccharides with different degrees of polymerization. They can be bought as a powder or syrup. Their taste resembles saccharose (lower degree of sweetness) (Demczuk et al. 2004).

Lactulose is a disaccharide composed of galactose and fructose, connected by a β-1, 4-glycoside bond. It is not present in natural sources and occurs in nature in a very small amount (10–12 mg/100 ml) only during heat treatment of milk. In the gastrointestinal tract it is completely metabolized by *Lactobacillus* and *Bifidobacterium*. Lactulose is used as a food additive in products such as baby foods, non-alcoholic beverages, sweets and dairy products.

It is used in pharmaceutical form due to proven therapeutic properties (Demczuk et al. 2004; Modzelewska et al. 2008; Pietrzyk 2011; Kozioł and Gustaw 2013; Śliżewska et al. 2013).

Isomalto-oligosaccharides are made of α–D–glucose residues connected by α-1-6 and α-1-4 glycoside bonds. They are partly digested in the small intestine, the rest being consumed by gut microorganisms. Fermentation is very slow. These natural compounds are found in honey (Demczuk et al. 2004; Kozioł and Gustaw 2011; Śliżewska et al. 2013).

According to these authors, the other prebiotic substances include xylose, raffinose, lacto--saccharose, xylo-oligosaccharides, pectic oligosaccharides, lactosucrose, the sugar alcohols, gluco-oligosaccharides, and levans.

HEALTH-PROMOTING PROPERTIES OF PREBIOTICS

Prebiotics improve intestinal function, have antidiabetic and antiatherosclerotic action, and influence nutrient bioavailability. Prebiotic substances are fermented in the large intestine, providing a substrate for *Bifidibacterium* and *Lactobacillus*. The fermentation results in short-chain fatty acids, which reduce pH in the lower intestinal segment, thus producing an optimum environment for probiotic bacteria. It has a negative effect on *Clostridium* and *Bacteroides* pathogenic microorganisms. By displacing bacteria that secrete toxic substances they have a positive effect on large intestine mucosa. Most of the undigested fraction accelerates intestinal transit and increases the amount of loosened fecal mass. With increasing prevalence of obesity and overweight, those on a slimming diet are advised to consume prebiotic fortified foods because they give a sense of satiety, improve intestinal function, and are low in calories. They are also recommended for constipation in children, adults and the elderly. Because prebiotics are low in calories and have hypoglycemic properties, they are recommended in diabetic diets. They act by slowing the growth of glucose and insulin levels postprandially. They delay the transit of food from the stomach and decrease the degradation and absorption of carbohydrates, thus restricting the access of amylolytic enzymes.

They have antiatherosclerotic action by binding cholesterol deposited in blood vessel walls. They bind bile acids in the small intestine, thus preventing the formation of cholesterol. Regular consumption of prebiotic foods reduces LDL and VLDL fractions. The amount consumed has no effect on HDL levels. They exert anti-cancer activity by protecting intestinal mucosa from the action of harmful metabolites and prevent the formation of toxic substances.

Prebiotics increase the bioavailability of magnesium, calcium, iron and zinc, which are often deficient nutrients in the diet. Increasing the absorption of nutrients derived from natural sources is often more optimal for the body. These are natural forms to which the organism is genetically adapted, and there is no hypervitaminosis. Increasing the supply of prebiotics should be particularly recommended for children, adolescents, pregnant women, those at risk of anemia or osteoporosis, and men of reproductive age.

Prebiotic compounds stimulate the immune system, inhibit dental caries, prevent the inflammation of the urinary tract. The only contraindications for consuming prebiotics is acute inflammation of the gastrointestinal tract (e.g. diarrhoea) (Demczuk et al. 2004; Florkowska et al. 2004; Adamczak and Bednarski 2008; Bodera 2008; Modzelewska et al. 2008; Szwengiel et al. 2009; Nowak et al. 2010a, b; Kozioł and Gustaw 2011; Sobolewska et al. 2012; Kozioł and Gustaw 2013; Śliżewska et al. 2013).

CONCLUSION

The mode of action of probiotics and prebiotics is not completely understood. There is every indication, however, that their consumption has a positive effect on the human body. It is essential to educate consumers on the potential health benefits of consuming products rich in probiotics and prebiotics, especially during or after antibiotic therapy.

REFERENCES

Achremowicz B., Łukasiewicz M. 2006. Probiotyki w profilaktyce zdrowia [Probiotics in the prevention of health]. Zdr. Żywn. Zdr. Styl Życia 1, 4–6. [in Polish]

Adamczak M., Bednarski W. 2008. Enzymatyczna synteza galaktooligosacharydów i laktulozy w permeacie po ultrafiltracji serwatki [Enzymatic synthesis of galactooligosaccharides and lactulose in whey-permeate after the ultrafiltration of whey]. Żywn. Nauka Technol. Jakość 6(61), 105–117. [in Polish]

Bodera P. 2008. Wpływ prebiotyków na układ odpornościowy człowieka [Influence of prebiotics on the human immune system (GALT)]. Nauka Praktyka 12(180), 18–26. [in Polish]

Cichy W., Gałęcka M., Szachta P. 2010. Probiotyki jako alternatywne rozwiązanie i wsparcie terapii tradycyjnych [Probiotics as an alternative and support of traditional therapies]. Zakażenia 6, 2–8. [in Polish]

Cybulska A. 2013. Wpływ fermentowanego produktu zawierającego Bifidobacterium DN – 173 010 (ACTIVIA) na związaną ze zdrowiem jakość życia oraz objawy zespołu jelita drażliwego u dorosłych [The effect of fermented product containing Bifidobacterium DN – 173 010 (ACTIVIA) on health-related quality of life and symptoms of irritable bowel syndrome in adults]. Żywn. Zdr. 18(6), 3–4. [in Polish]

Demczuk A., Bednarski W., Kowalewska-Piontas J. 2004. Aspekty technologiczne i żywieniowe enzymatycznego wzbogacenia mleka i jego przetworów w galaktooligosacharydy [Technological and nutritional aspects of enzymatic improvers of milk and dairy products in galactooligosaccharides]. Biotechnologia 3, 152–165. [in Polish]

Florowska A., Budyta A., Krygier K. 2004. Powstanie i właściwości żeli inulinowych [Forming inulin gels and their properties]. Żywn. Nauka Technol. Jakość 3(40) Supl. 56–67. [in Polish]

Gajda J. 2007. Żywność probiotyczna jako przykład żywności funkcjonalnej – wymagania i przepisy prawne [Probiotic foods as an example of functional foods – requirements and regulations]. Prz. Mlecz. 3, 26–28. [in Polish]

Gajewska J., Błaszczyk M.K. 2012. Probiotyczne bakterie fermentacji mlekowej [Probiotic lactic acid bacteria (LAB)]. Post. Mikrobiol. 51(1), 55–65. [in Polish]

Gibson G.R., Roberfroid M.B. 1995. Dietary modulation of the human colonic microbiota: introduction the concept of prebiotics. J. Nutrit. 125(6), 1401–1412.

Głąbska D., Guzek D. 2007. Znaczenie bakterii probiotycznych w produktach mlecznych na przykładzie gatunku Lactobacillus rhamnosus GG [The importance of probiotic bacteria in dairy products for example Lactobacillus rhamnosus GG]. Prz. Mlecz. 8, 4–5. [in Polish]

Heczko P., Strus M., Jawień M., Szymański H. 2005. Medyczne zastosowanie probiotyków [The medical application of probiotics]. Wiad. Lek. 58, 640–646. [in Polish]

Jakubczyk E., Kosikowska M. 2000, Nowa generacja mlecznych produktów fermentowanych z udziałem probiotyków i prebiotyków, produkty synbiotyczne [A new generation of fermented dairy products involving probiotics, products synbiotyczne]. Prz. Mlecz. 12, 397–400. [in Polish]

Jeznach M. 2003. Stan i perspektywy rozwoju rynku żywności funkcjonalnej [Status and prospects of market development of functional foods]. Warszawa, Wydaw. SGGW, 30–36, 43–53. [in Polish]

Kozioł J., Gustaw W. 2011. Kazeinomakropeptyd – właściwości technologiczne i żywieniowe [Casein – macropeptide technological and nutritional properties]. Żywn. Prozdr. Prz. Spoż. 65, 34–35. [in Polish]

Kozioł J., Gustaw W. 2013. Prebiotyki wykorzystywane w mleczarstwie [Prebiotics used in the dairy industry]. Prz. Mlecz. 5, 7–12. [in Polish]

Kozłowicz K. 2010. Skrócona ocena tekstury herbatników z mrożonego ciasta kruchego wzbogaconego prozdrowotnymi dodatkami [Shortened assessment of biscuit's texture from frozen shortcake dough enriched by healthy additives]. Acta Sci. Polon., Ser. Technica Agraria 9(1–2), 11–17. [in Polish]

Krajewska-Kamińska E., Śmietana Z., Bohdziewicz K. 2007. Bakterie probiotyczne w produkcji żywności [Probiotic bacteria in food production]. Przem. Spoż. 61(5), 36–41. [in Polish]

Le Thanh J., Lewandowicz G. 2007. Dietetyczne produkty skrobiowe [Dietary starch products]. Przem. Spoż. 61(8), 54–58. [in Polish]

Libudzisz Z. 2007. Mikrobiologia techniczna [Technical microbiology]. Warszawa, Wydaw. Nauk. PWN, 32–56. [in Polish.]

Modzelewska-Kapituła M, Kłębukowska L., Kornacki K. 2008. Wpływ inuliny TEX! i HPX na lepkość pozorną i wartość pH jogurtów produkowanych metodą termostatową [Effect of inulins TEX! and HPX on apparent viscosity and pH value of set-type yoghurts]. Acta Agrophys. 11(3), 693–701.

Moneta J. 2006. Fermentowane produkty mleczne suplementowane bakteriami probiotycznymi [Fermented dairy products supplemented with probiotic bacteria]. Prz. Mlecz. 1, 4–8. [in Polish]

Nastaj M., Gustaw W. 2008. Wpływ wybranych probiotyków na właściwości reologiczne jogurtu stałego [Effect of some selected prebiotics on rheological properties of set yoghurt]. Żywn. Nauka Technol. Jakość 5(60), 217–225. [in Polish]

Nowak A., Śliżewska K., Libudzisz Z., Socha J. 2010a. Probiotyki – efekty zdrowotne [Probiotics – health effects]. Żywn. Nauka Technol. Jakość 4(71), 20–36. [in Polish]

Nowak A., Śliżewska K., Libudzisz Z., Socha J. 2010b. Probiotyki – historia i mechanizmy działania [Probiotics – history and mechanisms of their effect]. Żywn. Nauka Technol. Jakość 4(71), 5–19. [in Polish]

Pietrzyk S. 2011. Prebiotyki i probiotyki – żywność funkcjonalna [Prebiotics and probiotics – functional food]. Laboratorium 9–10, 48–51. [in Polish]

Rozporządzenie Komisji (UE) nr 432/2012 z dnia 16 maja 2012 r. ustanawiające wykaz dopuszczalnych oświadczeń zdrowotnych dotyczących żywności, innych niż oświadczenia odnoszące się do zmniejszenia ryzyka choroby oraz rozwoju i zdrowia dzieci. DzUrz. UE L 136 z 25.05.2012 r. [in Polish]

Schmidt M., Olejnik-Schmidt A. 2011. Prozdrowotne właściwości mikroorganizmów probiotycznych [Health-promoting properties of probiotic microorganisms]. Przem. Spoż. 65(4), 32–33. [in Polish]

Sobolewska S., Grela R.E., Skomiał J. 2012. Inulina i jej oddziaływanie u ludzi i zwierząt. Zastosowanie lnu i inuliny w żywieniu i żywności: współczesne tendencje w produkcji żywności na tle wymogów zrównoważonego rozwoju obszarów wiejskichm (w: V Międzynarodowa Konferencja Naukowa, Lublin – Susiec, 30 maja – 1 czerwca 2012 r.) [Inulin and its impact on human and animal use of flax and inulin in nutrition and food: contemporary trends in food production against the requirements of sustainable rural development (in: 5th International Scientific Conference, Lublin – Susiec, 30th May – 1st June, 2012)]. Dzierdziówka, Stowarzyszenie Rozwoju Regionalnego i Lokalnego "Progress", 65–88. [in Polish]

Steinka I. 2011. Wybrane aspekty stosowania probiotyków [Choosen aspects of probiotics use]. Ann. Acad. Med. Gedan. 41, 97–108.

Szajewska H. 2012. Probiotyki: które, kiedy i jak stosować? [Probiotics: what, when and how to apply?]. Żywn. Zdr. 15(3), 16–20. [in Polish]

Szwengiel A., Czarnecka M., Gruchała L., Czarnecki Z. 2009. Właściwości i zastosowanie lewanu [Properties and application of levan]. Żywn. Nauka Technol. Jakość 5(66), 18–29. [in Polish]

Śliżewska K., Nowak A., Barczyńska R., Libudzisz Z. 2013. Prebiotyki – definicja, właściwości i zastosowanie w przemyśle [Prebiotics – definition, properties, and applications in industry]. Żywn. Nauka Technol. Jakość 1(86), 5–20. [in Polish]

Świderski F., Waszkiewicz-Robak B. 2005. Składniki bioaktywne w żywności funkcjonalnej [Bioactive components in functional foods industry]. Przem. Spoż. 4, 20–22. [in Polish]

Zaręba D., Ziarno M., Obiedziński M. 2008. Przeżywalność bakterii jogurtowych i probiotycznych w układach modelowych mleka niefermentowanego i fermentowanego [Viability of yoghurt bacteria and probiotic strains in models of fermented and non-fermented milk]. Med. Weter. 64(8), 1007–1011. [in Polish]

Zmarlicki S. 2010. Mleczne napoje fermentowane–wybrane aspekty zdrowotne [Cultured milks – chosen health aspects]. Przem. Spoż. 4, 30–33. [in Polish]

Abstract. Probiotics and prebiotics found in milk products can have many beneficial health-promoting effects. Probiotics are live organisms added to the diet and their consumption confers a positive effect on the host by improving the intestinal microflora balance. The health benefits of probiotics for the gastrointestinal tract include restoring normal intestinal microflora, preventing carcinogenesis and cancers from developing, and reducing lactose intolerance. Prebiotics are compounds that pass undigested by the enzymes of the gastrointestinal tract and have the ability to stimulate the growth of probiotic bacteria. Prebiotics improve intestinal function, exhibit antidiabetic and antiatherogenic effects, and influence nutrient bioavailability. Products that contain probiotics and prebiotics are classified as functional foods, dietary supplements, or medicines.