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SHORT COMMUNICATION

Assessment of the Microbiological Status of Probiotic Products

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Abstract

The aim of this study was to perform the microbiological analysis of quality of 25 probiotic products, available on the Polish market. Analysis of bacterial viability in probiotic products showed that not all of these preparations possess a suitable number of bacteria. Moreover, some of the tested probiotic products contained bacterial strains other than those declared by the manufacturer. All tested strains recovered from probiotic products were found to be resistant to metronidazole and susceptible to nitrofurantoin. The susceptibility to other antibiotics was strain specific. Probiotic products should be subject to regular and thorough inspection by appropriate institutions.

Key words: antimicrobial resistance, dietary supplement, FSMP, medicinal product, probiotics

Probiotics can be defined as "live microorganisms which when administered in adequate amounts confer a health benefit on the host", according to the Food and Agriculture Organization of the United Nations and World Health Organization definition (FAO/WHO, 2001). A probiotic preparation must contain a specified minimal number of bacterial cells-colony forming units (cfu) per dose. A daily intake of minimum $10^8 – 10^{10}$ cfu per day is required to show the beneficial health effects (Czinn and Blanchard, 2009; Sanders and Huis in't Veld, 1999). These effects seem to be strain specific and dose dependent. A number of probiotic strains, particularly those belonging to species of lactic acid bacteria (LAB) group, are used to induce health benefits for a variety of conditions and diseases throughout the world (Czinn and Blanchard, 2009). Many of these effects have been scientifically supported (FAO/WHO, 2001). These include improving the condition of the intestinal tract (traveller's diarrhoea, antibiotic-associated diarrhoea) (FAO/WHO, 2001; Holzapfel *et al.*, 2001; Chapman *et al.*, 2011) decreasing the prevalence of vaginal infections (FAO/WHO, 2001), increasing immune function (FAO/WHO, 2001), and decreasing cholesterol and lipid levels (Pereira *et al.*, 2003).

There are many probiotic preparations in the Polish market that are distributed as medicinal products, dietary supplements or food for special medical purposes (FSMP). These products contain live bacteria – mostly *Lactobacillus* and *Bifidobacterium* – that supposedly produce a beneficial effect on human health. Probiotics on the market are sold in multiple forms such as capsules containing single or multiple strains, liquids or powders. A description on the label of a probiotic should include: genus, species and strain designation, minimum viable number of each probiotic cells at the end of the shelf-life, suggested serving that must deliver the effective dose related to the health claims, proper storage conditions, and corporate contact details for consumer information (FAO/WHO, 2002). In Poland, there is no national governmental agency responsible for the control of dietary supplements and FSMP products including probiotics, so the quality of these products may not comply with the information accompanying the probiotic product. Particularly important is the actual number of viable organisms present in the commercial product, which may be lower than the declared value that guarantees its beneficial properties (Czinn and Blanchard, 2009).

Although the use of lactic acid bacteria has a long history and has acquired Generally Recognised as Safe (GRAS) status, the safety of selected strains should be evaluated before use, not only for virulence factors and other potential disease-causing traits, but also for their capability of acquiring and disseminating resistance determinants. The transfer of antibiotic-resistance genes from LAB reservoir strains to bacteria in the resident

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microflora of human gastrointestinal tract, and hence to pathogenic bacteria, has not been fully documented. Lactobacilli display a wide range of types of antibiotic resistance naturally, but in most cases antibiotic resistance is not of the transmissible type. Although plasmid-linked antibiotic resistance is not very common among lactobacilli, it does occur and its influence on safety should be taken into consideration (Ashraf and Shah, 2011; Liu *et al.*, 2009; Wiatrzyk *et al.*, 2007).

The purpose of this study was to evaluate the quality of selected probiotic preparations, primarily the count of bacteria present in the different batches of several preparations, stored before distribution at temperatures recommended by the manufacturers. Additional aims included identification of the bacterial strains and designation of antimicrobial susceptibility.

A total of 16 dietary supplements, seven FSMP and two medicinal products, from two or three different batches, available on the market were tested for the viability of probiotic bacteria (Table I). Fifteen of the products were tested 3–4 times to monitor viability of bacterial strains during validity time. In the case of the 10 other products, one or two series were tested once or twice. Samples were stored at room temperature or in the refrigerator, according to the manufacturers' recommendations.

Each tested preparation was suspended in peptone water (Buffered NaCl-Peptone Solutions, Heipha), diluted and plated onto De Man Rogosa and Sharpe Agar (MRS-Agar, Merck) for *Lactobacillus* and Transgalactio-Oligosaccharides (TOS) Propionate Agar (Merck) with MUP Selective Supplement (Merck) for *Bifidobacterium*. The plates were incubated for 48–72 h at 37°C with 5% CO_2 for *Lactobacillus* and in anaerobic conditions (GENbag anaer, bioMérieux) for *Bifidobacterium*. The microbial count was expressed as cfu per one dose (Fig. 1).

The strains isolated from probiotic products were identified by two methods – (i) API 50 CHL (bioMérieux) and API 20 A (bioMérieux) biochemical tests, (ii) Matrix-Assisted Laser Desorption/Ionization – Time of Flight Mass Spectrometry (MALDI-TOF MS), analysis was performed by ALAB Laboratories, Warsaw.

Identification of lactic acid bacteria showed different results depending on the method applied (Table I). Biochemical test API 50 CHL did not properly identify *Lactobacillus rhamnosus* strains and often recognised this species as *Lactobacillus paracasei.* Moreover, API 20 A test recognised *Bifidobacterium* only to genera. Therefore MALDI – TOF MS was used to confirm the biochemical identification. Not all results of identification confirmed the strain species declared by the manufacturers. For

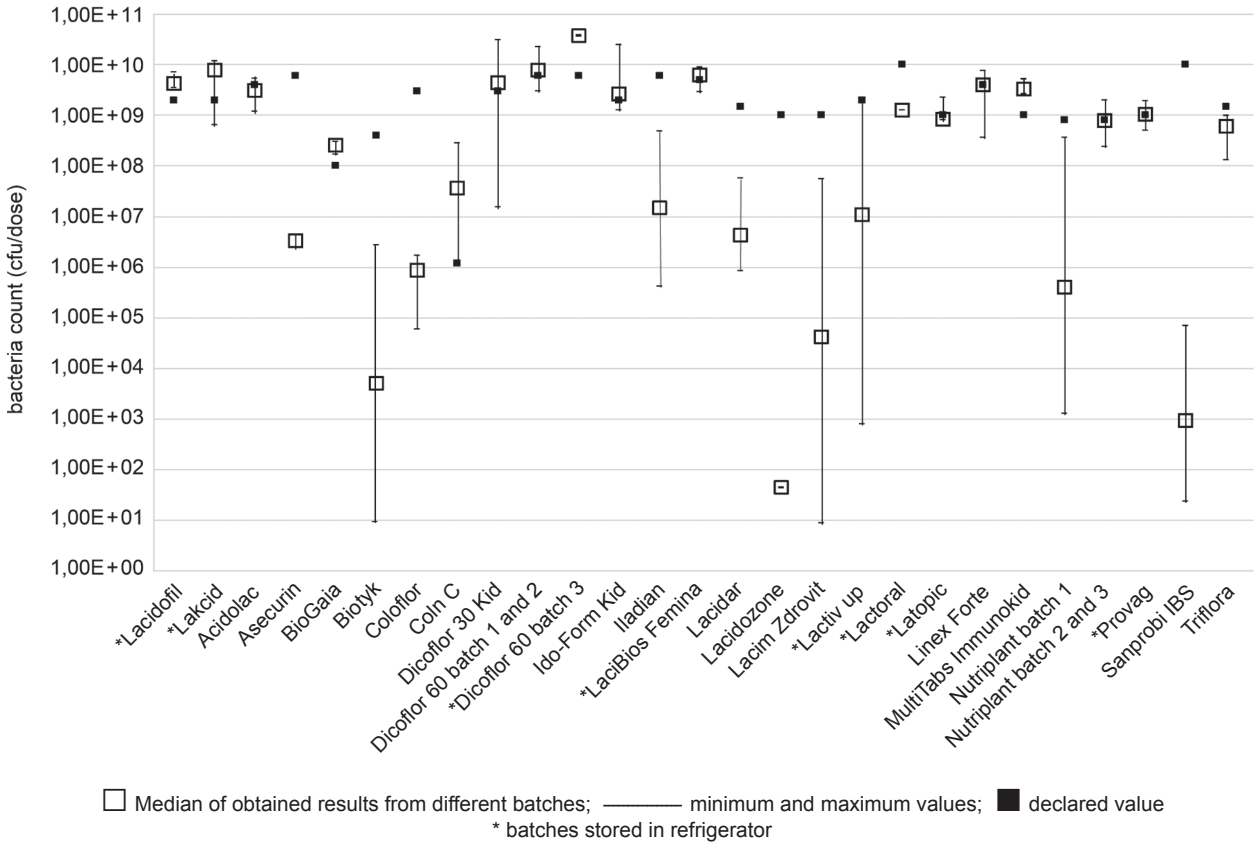

Fig. 1. Median of bacteria counts from different batches of the probiotic products (Table I) with marked minimum and maximum value of obtained result

Table I
Detailed information and results of bacterial strains` identification in analysed probiotic product.

Product	Manufacturer	Preparation form	Medicinal product/ Dietary supplement/ Food for Special Medical Purpose (FSMP)	Number of analysed batches	Time to expire when observed significant decrease in the number of bacteria (months)	Declared microorganism presented	Biochemical identification (API 50 CHL/ API 20A)	Identification MALDI-TOF MS
Lacidofil	Merck	Capsules	Medicinal product	3	Not observed	*Lactobacillus rhamnosus*, *Lactobacillus helveticus* (formerly *L. acidophilus*)	*L. rhamnosus*	*L. rhamnosus*
Lakcid	Biomed	Powder	Medicinal product	3	Not observed	*Lactobacillus rhamnosus*	*L. rhamnosus*	*L. rhamnosus*
Acidolac	Polpharma	Powder	FSMP	3	Not observed	*Lactobacillus acidophilus*, *Bifidobacterium BB-12*	*L. acidophilus* *Bifidobacterium* ssp. 1	*L. acidophilus* *B. animalis* ssp. *lactis*
Asecurin	Aflofarm	Capsules	Dietary supplement	1	11	*Lactobacillus gasseri*, *Lactobacillus reuteri* *Lactobacillus rhamnosus*	*L. rhamnosus* *L. paracasei* ssp. *paracasei* *L. debrueckii*	n.t.
BioGaia	Ewopharma	Tablets	FSMP	3	Not observed	*Lactobacillus reuteri Protectis*	*L. fermentum*	*L. reuteri*
Biotyk	Lekam	Capsules	Dietary supplement	3	21	*Lactobacillus casei*	*L. lactis* ssp. *lactis*/*L. brevis*	*L. rhamnosus**
Coloflor	Oleofarm	Capsules	FSMP	1	10	*Lactobacillus acidophilus DDS-1* *Bifidobacterium lactis VABLA-12*	*L. acidophilus* *Bifidobacterium*	n.t.
Colon C	A-Z Medica	Granulat	Dietary supplement	3	Not observed	*Lactobacillus acidophilus*, *Lactobacillus brevis*	*L. rhamnosus* *L. plantarum* *L. lactis* ssp. *lactis*	*L. rhamnosus*, *L. plantarum*
Dicoflor 30 Kid	Vitis Pharma	Capsules	FSMP	3	Depends on batch – 6 (batch 1)	*Lactobacillus rhamnosus GG*	*L. paracasei* ssp. *paracasei*	*L. rhamnosus*
Dicoflor 60	Vitis Pharma	Capsules	FSMP	3	Not observed	*Lactobacillus rhamnosus GG*	*L. paracasei* ssp. *paracasei*	*L. rhamnosus*
Ido-Form Kid	Ferrosan	Tablets	Dietary supplement	2	Not observed	*Lactobacillus rhamnosus GG*, *Bifidobacterium animalis* ssp. *lactis*	*L. paracasei* ssp. *paracasei* *Bifidobacterium* ssp.1	*L. rhamnosus*
Iladian	Aflofarm	Capsules	Dietary supplement	2	15	*Lactobacillus rhamnosus* *Lactobacillus reuteri* *Lactobacillus gasseri*	*L. rhamnosus*	n.t.
LaciBios Femina	Asa	Capsules	Dietary supplement	3	Not observed	*Lactobacillus rhamnosus GR-1*, *Lactobacillus reuteri RC-14*	*L. rhamnosus* *L. fermentum*	*L. rhamnosus*** *L. reuteri**
Lacidar	Tantus	Capsules	Dietary supplement	2	20	*Lactobacillus bulgaricus* *Lactobacillus rhamnosus* *Lactobacillus acidophilus*	*L. paracasei* ssp. *paracasei* *L. rhamnosus*	n.t.

Table I
Continued.

Product	Manufacturer	Preparation form	Medicinal product/ Dietary supplement/ Food for Special Medical Purpose (FSMP)	Number of analysed batches	Time to expire when observed significant decrease in the number of bacteria (months)	Declared microorganism presented	Biochemical identification (API 50 CHL/API 20A)	Identification MALDI-TOF MS
Lacidozone	Ozone Laboratories	Capsules	Dietary supplement	1	7	*Lactobacillus acidophilus* *Bifidobacterium breve*	*L. acidophilus*	n.t.
Lacium Zdrovit	Zdrovit	Capsules	Dietary supplement	3	17	*Lactobacillus plantarum*	*L. plantarum*	*L. plantarum*
Lactiv up	Farma-Projekt	Capsules	Dietary supplement	3	9	*Lactobacillus acidophilus*	*L. acidophilus*	*L. acidophilus*
Lactoral	Biomed	Capsules	Dietary supplement	1	8	*Lactobacillus plantarum PL 02* *Lactobacillus rhamnosus KL 53A* *Bifidobacterium longum PL 03*	*L. rhamnosus* *Bifidobacterium*	n.t.
Latopic	IBSS Biomed	Powder	FSMP	3	Not observed	*Lactobacillus paracasei ŁOCK 0919* *Lactobacillus casei ŁOCK 0900* *Lactobacillus casei ŁOCK 0908*	*L. rhamnosus* *L. paracasei* ssp. *paracasei*	n.t.
Linex Forte	Lek Pharmaceuticals	Capsules	Dietary supplement	3	Not observed	*Lactobacillus acidophilus*, *Bifidobacterium animalis* ssp. *lactis*	*L. acidophilus* *Bifidobacterium* ssp. 1	*L. acidophilus* *B. animalis* ssp. *lactis*
MultiTabs ImmunoKid	Ferrosan	Tablets	Dietary supplement	3	Not observed	*Lactobacillus rhamnosus GG*	*L. paracasei* ssp. *paracasei*	*L. rhamnosus*
Nutriplant	Agropharm	Capsules	Dietary supplement	3	3 (room temp.)	*Lactobacillus plantarum*	*L. plantarum*	*L. plantarum*
Provag	Biomed	Capsules	FSMP	2	Not observed	*Lactobacillus gasseri 57C* *Lactobacillus fermentum 57A* *Lactobacillus plantarum 57B*	*L. fermentum* *L. plantarum*	n.t.
Sanprobi IBS	Sanum Poland	Capsules	Dietary supplement	3	13	*Lactobacillus plantarum 299v*	*L. plantarum*	n.t.
Triflora	Farmapia	Capsules	Dietary supplement	2	Depends on batch – 19 (batch 2)	*Lactobacillus acidophilus* *Lactobacillus paracasei* *Bifidobacterium bifidum*	*L. acidophilus* *L. paracasei* *Bifidobacterium*	n.t.

* Good identification to genus, possible identification to species;
** Possible identification to genus
n.t. – not tested

example dietary supplement (Biotyk) was declared to contain *Lactobacillus casei* but API 50 CHL identified this strain as *Lactococcus lactis* ssp. *lactis* and MALDI-TOF as *L. rhamnosus* with good identification to genus and possible identification to species. Other case was identification of *Lactobacillus reuteri* with API 50 CHL from BioGaia and LaciBios Femina, while manufacturer declared *Lactobacillus fermentum*. However, this might be caused by a change in the nomenclature, *L. reuteri*, *L. fermentum* biotype II and *L. fermentum* subsp. *reuteri* are used sometimes as synonyms.

Several strains described on the label by manufacturers were not identified, *e.g. Lactobacillus helveticus* from Lacidofil or *Lactobacillus gasseri* and *L. reuteri* from dietary supplements (Asecurin, Iladian, Provag). In some products, the identified strains were different from those specified on the label. Dietary supplement Colon C contained *L. rhamnosus*, *Lactobacillus plantarum* and *L. lactis* ssp. *lactis*, while the manufacturer declared that preparation contains *Lactobacillus acidophilus* and *Lactobacillus brevis.* In Asecurin, we identified the *Lactobacillus delbrueckii* strain, not declared by the manufacturer. Analysis of the viability of probiotic strains (Fig. 1) showed that not all of the tested preparations contained a suitable number of lactic acid bacteria, as declared on the label. Analysis of three different batches of medicinal products – Lakcid and Lacidofil, showed a decrease in the bacteria number during the specified time interval. In the case of Lacidofil, an adequate number of living cells was maintained until the end of the validity period, while in the case of the Lakcid, cfu decrease was too far below the declared value, at the end of the validity time. A decrease in cfu values at the end of validity period was observed among all tested batches, reaching 32–78% of the declared value. Only four of the tested probiotic products (MultiTabs Immunokid, BioGaia, Colon C, Latopic), which were stored at room temperature, showed proper bacterial survival during the investigated time period. In all tested batches of these preparations, the numbers of living bacterial cells were above the minimum level declared by the manufacturers. Seven other probiotic products (Ido Form Kid, Dicoflor 30 Kid, LaciBios Femina, Acidolac, Linex Forte, Provag, Triflora) were characterised as having different levels of bacterial viability depending on the batch. In some product batches, at the date of expiry, the numbers of bacteria were above the level declared by the manufacturer – however, other batches were characterised by a large decrease in the amount of probiotic bacteria. All of these batches were kept at room temperature, except for LaciBios Femina and Provag, which were stored in a refrigerator, according to the manufacturers' recommendations.

Ten of the tested products showed a decrease in the bacteria count in all of the tested batches. In these products, which were stored in different conditions (room temperature or refrigerator), the number of live microbial cells was very low (< 10% of the declared value) at all expiry dates, which would probably result in low or no therapeutic properties. In the case of two preparations (Nutriplant and Dicoflor 60), the tested batches were stored at different temperatures (room temperature or refrigerator), depending on the storage temperature used at the time of purchase (manufacturers' recommendation below 20°C). Generally, batches of products stored in the refrigerator were characterised by better bacterial survival than preparations kept at room temperature.

Antibiotic susceptibility for 16 antibiotics was assayed using disc-diffusion method according to The European Committee on Antimicrobial Susceptibility Testing (EUCAST) recommendations (www.eucast.org). Plates, with Mueller-Hinton Agar, were incubated for 48 h at 37°C in anaerobic conditions (GENbag anaer, bioMérieux). The diameter of the bacterial growth inhibition zone was measured and interpreted according to Clinical and Laboratory Standards Institute (CLSI) Table II. Experiments were performed in duplicate.

All bacterial strains were resistant to metronidazole (lack on any growth inhibition zone) and sensitive to nitrofurantoin. Tested probiotic preparations were resistant to colistin and fusidic acid (except Biotyk). Most of the tested bacterial strains were also resistant to vancomycin (except strains from Linex Forte and Biotyk) and trimethoprim/sulfametoxazole (except strains from Linex Forte, Biotyk, Nutriplant, Lacium Zdrovit and Colon C). Bacterial strains from medicinal product Lacidofil – *L. rhamnosus* and *L. helveticus*, the only of tested strains, showed resistance to cefuroxime – II generation cephalosporin. Cefotaxime, a third-generation cephalosporin, inhibited the growth of most probiotic strains – only bacteria from Lacidofil and Dicoflor 60 preparations (*L. rhamnosus* GG) were resistant. CLSI guidelines for *Staphylococcus* and *Enterococcus*, in the case of ampicilin, are different, so it cannot be clearly defined which tested strains from the probiotic products were resistant or sensitive to this antibiotic. Basing on the CLSI guidelines for reference strains, it can be concluded that strains from probiotic products Lakcid (*L. rhamnosus)*, Lactiv up (*L. acidophilus*) and Acidolac (*L. acidophilus, Bifidobacterium* BB-12) were resistant to ampicillin. In the case of clindamycin and erythromycin, only strains from preparations Lakcid, Colon C and Lacium Zdrovit (only to clindamycin) were resistant. Trimethoprim/sulfamethoxazole inhibited the growth of all *L. plantarum* strains contained in the probiotic products: Nutriplant, Lacium Zdrovit, Colon C and also the strains from Linex Forte and Biotyk.

Considering the significant increase in the annual consumption of probiotic products, it is very impor-

Table II
Susceptibility of microbial strains present in tested probiotic products to antimicrobial agents according to CLSI guidelines for *Enterococcus* spp. and *Staphylococcus* spp.

Product/antibiotic	Lakcid	Lacidofil	LaciBios Femina	Lactiv up	Acidolac	Linex Forte	IdoForm Kid	Biotyk	Nutriplant	Dicoflor 30 Kid	Dicoflor 60	Lacium Zdrovit	BioGaia	MultiTabs ImmunoKid	Colon C
Ampicillin AMP (10 µg)	R	S	S	R	R	S	S	S	S	S	S	S	S	S	S
Cefaclor CEC (30 µg)	R	R	R	R	R	S	I	S	S	R	R	I	I	R	R
Ciprofloxacin CIP (5 µg)	S	S	S	R	I	I	I	S	R	S	S	R	S	I	S
Gentamycin GEN (10 µg)	S	S	S	S	S	R	R	S	S	S	S	S	I	S	S
Colistin CST (10 µg)*	10	6	12	6	6	6	6	21	12	6	6	6	6	6	6
Cefotaxime CTX (30 µg)	S	R	I	S	S	S	I	S	S	S	R	S	I	I	I
Cefuroxime CXM (30 µg)	S	R	S	S	S	S	S	S	S	S	S	I	S	I	S
Clindamycin CLI (2 µg)	R	S	S	S	S	S	I	S	I	S	I	R	I	S	R
Doxycycline DOX (30 µg)	R	I	S	I	S	S	S	S	R	S	S	R	S	S	R
Erythromycin ERY (15 µg)	R	S	S	S	S	S	S	S	S	S	S	S	S	S	R
Nitrofurantoin NIT (300 µg)	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
Fusidic acid FA (10 µg)	R	R	R	R	R	R	R	S	R	R	R	R	R	R	R
Cefazolin CFZ (30 µg)	R	R	S	R	R	S	R	S	S	R	R	I	I	R	R
Metronidazole MTZ (50 µg)*	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Trimethoprim/sulfametoxazole SXT (1.25/23.75 µg)	R	R	R	R	R	S	R	S	S	R	R	S	R	R	S
Vancomycin VAN (30 µg)	R	R	R	R	R	S	R	S	R	R	R	R	R	R	R

* Lack in CLSI guidelines, presented diameter (mm) of growth inhibition zones. Resistant strains are shaded background.
S – susceptible; I – intermediately susceptible; R – resistant

tant that these products should be of proper quality, containing probiotic strains that are well documented regarding safety and functionality (Sanders and Huis in't Veld, 1999). However, the analysis of the obtained microbiological results clearly shows that the quality of tested probiotic products is far from ideal.

Bacteria viability of probiotic medicinal products in the Polish market were previously analysed by Szajewska *et al.* (2002). From five tested products, four possessed the bacteria count in accordance with the manufacturer's declaration. One product had a low number of probiotic bacteria. Szajewska *et al.* (2004) also investigated the quality of probiotic products licensed for medicinal purposes. Microbiological and genetic analysis showed that, in terms of quality, only three of five products contained the bacterial strains claimed on the label. Quantitative analysis demonstrated that 89% (57 of 64) of samples contained bacterial counts at the cell densities (doses) claimed on the label. Coeuret *et al.* (2004) performed some analyses of European probiotic products. In food supplements, the numbers of colonies were in accordance with data declared on the label – however, in the tested nutritional supplements, there were no viable lactobacilli found, even though the labels claimed that the product contained high numbers of various lactic acid bacteria. A recent study made by Temmerman *et al.* (2002) showed that numbers of viable bacteria were generally lower in food supplements than in dairy products, with no viable bacteria being found in 37% of food supplements. Moreover, 9 of 30 tested food supplements contained microorganism species other than those indicated on the product label. Research carried out by Hamilton-Miller *et al.* (1998) on 21 different kinds of supplements showed that only seven UK products completely fulfilled their label quantitative claims. Moreover, only 9 of 21 products contained exclusively the species stated on the label, with the other 12 products lacking one or more of the stated species. Sometimes the species have been incorrectly identified, or a contaminant strain was present. Only 7 of 21 products tested were both qualitatively and quantitatively bacteriologically satisfactory (Hamilton-Miller *et al.*, 1998).

The profiles of antimicrobial susceptibility of LAB have been documented in many countries (Liu *et al.*, 2009). *Lactobacillus* strains are usually susceptible to cell-wall-targeting penicillins, but are more resistant to cephalosporins. Many *Lactobacillus* species showed a high level of resistance to vancomycin. On the other hand, lactobacilli are generally susceptible to low concentrations of many inhibitors of protein synthesis, such as chloramphenicol, macrolides, lincosamides,

and tetracyclines, but their resistance to aminoglycosides is often high (Gueimonde *et al*., 2013), which was not confirmed by our studies (only strains from product Linex Forte were resistant to gentamicin). *Lactobacillus* strains are naturally resistant to nalidixic acid, trimethoprim/sulfametoxazole and metronidazole (Hummel *et al*., 2007). Resistance of lactobacilli to metronidazole might be caused by the absence of hydrogenase activity (Danielsen and Wind, 2003). Moreover, *L. rhamnosus* strains are resistant to vancomycin, which distinguishes them from vancomycin-sensitive *L. acidophilus* (Wiatrzyk *et al*., 2007). Research carried out by Temmerman *et al.* (2002) on 187 strains isolated from probiotic products subjected to antibiotic susceptibility testing showed that 79% and 65% of these isolates were resistant to kanamycin and vancomycin, respectively. In our study, in 2 of 15 tested probiotic products, bacteria susceptible to vancomycin were observed. Wiatrzyk *et al*. (2013) confirmed that all tested *L. rhamnosus* were resistant to vancomycin. Moreover, this study demonstrated resistance of probiotic strains present in products Lakcid and Lakcid forte to: penicillin, ampicillin, amoxicillin, piperacillin, cefuroxime, cefotaxime, ceftazidime, cefepime, cefradine, cloxacillin, imipenem, meropenem, gentamicin, neomycin, netilmicin, tobramycin, streptomycin, erythromycin, vancomycin, teicoplanin, doxycycline, trimethoprim/sulfamethoxazole, nalidixic acid, metronidazole, clindamycin and colistin. Investigations conducted in our laboratory have not confirmed resistance of bacterial strains from Lakcid to ampicillin, cefotaxime, cefuroxime and gentamicin. In the case of colistin, there are no guidelines from the CLSI for the interpretation of bacterial sensitivity. Moreover, sensitivity to nitrofurantoin was observed. Strains from products Lacidofil and EcoVag tested by Wiatrzyk *et al.* (2013) were resistant to aminoglycosides, glycopeptides and clindamycin, colistin and chemotherapeutics (trimethoprim/sulfamethoxazole, metronidazole, nalidixic acid). These results are also not entirely consistent with ours, where probiotic strains from Lacidofil were sensitive to gentamicin and clindamycin, and as above there were no CLSI guidelines for colistin. Wiatrzyk *et al.* (2013) used European Food Safety Authority (EFSA) guidelines for the interpretation of their results. Moreover, comparison of the antimicrobial susceptibility of *L. rhamnosus* PEN to gentamycin was assayed by two methods, disc diffusion and the E-test, which showed different results. In the disc-diffusion method, the *L. rhamnosus* PEN strain was susceptible to gentamycin, but when using the E-test, this strain was resistant. Similarly, contradictory results were obtained in the case of *L. delbrueckii* subsp. *bulgaricus* strain. Nawaz *et al*. (2011) also observed resistance of lactic acid bacteria to nalidixic acid, vancomycin and kanamycin, while susceptibility of all tested strains to ampicillin was noted. In our study, bacteria in 3 of 15 tested probiotic products showed resistance to ampicillin.

Many probiotic products from the Polish market (medicinal products, dietary supplements and food for special medical purposes) contain too few probiotic bacteria cells, which probably cause low or even no beneficial effect on health. In addition some of the tested probiotic products contained different bacterial strains than those declared by the manufacturer. Taking into account the fact that each strain is characterised by different properties, such situations should not occur. Each strain has a different antibiotic resistance profile, and incorrect labelling of strains will also results in no beneficial effect on health. Only one medicinal product, two dietary supplements and two FSMP of all tested 25 different products showed a good quality with respect to the number of bacterial cells. In 15 of 25 tested products, compliance of species with the label was proved. Products with inappropriate number of bacterial cells or with not confirmed properties, which may even cause serious health problems, should be withdrawn from the market. On the basis of the obtained results, it can be concluded that all probiotic products available on the market should be subjected to routine and thorough inspection by appropriate institutions.

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