PROBIOTICS IN HUMAN NUTRITION

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What are probiotics?

“Live microorganisms which when administered in adequate amount confer a health benefits on the host”
What they should be like?

- Generally Recognized As Safe (GRAS)/ Qualified Presumption of Safety (QPS)
- Isolated from safe environment
- Genetically stable
- Nonpathogenic
- Resistant to bile acids and low pH
- Adhesive to epithelial cells
- Pathogens antagonists

Źródła: [1, 7]
What probiotics can do?

- **Antimicrobial effect**
  - Synthesizing antimicrobial products
  - Competitive exclusion

- **Enhancement of mucosa barrier integrity**
  - Mucin production regulation
  - Proper tight junction proteins expression

- **Immune modulation**
  - Activation of lymphocytes
  - Production of antibodies
  - Stimulation of cells involved in innate and adaptive immunity

- **Detoxification properties**
  - Absorption
  - Metabolism

Źródła: [3, 4, 6]
Impact of probiotics on human health

Altered GI tract microecology

Inhibit pathogen growth and translocation. Reduce risk of infection from common pathogens (*Salmonella, Shigella*)

Detoxify carcinogens
Suppress tumours

Decrease faecal mutagenicity

Decrease faecal bacterial enzyme activity

Relieve constipation

Shortage the duration of rotavirus diarrhoea

Improve digestion of lactose and reduce intestinal bloating, flatulence and discomfort

Reduce risk of obesity

Lower serum cholesterol concentrations

Enhance specific and non-specific immune response

Increase nutrient bioavailability, increase mineral absorption

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Probiotics

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Sources: [4]
Route to become a probiotic microorganism

1. Isolation from selected environment
2. Bile and acids tolerance
3. Adherence to epithelial cells
4. Antagonistic activity
5. In vitro testing
6. Designation of target population
7. Toxicology
8. Genome description
9. In vivo testing

Źródła: [5, 8, 9]
# Probiotics used in human nutrition

<table>
<thead>
<tr>
<th>Lactobacillus species</th>
<th>Bifidobacterium species</th>
<th>Other Lactic Acid Bacteria</th>
<th>Other Microorganisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>L. acidophilus (a),*</td>
<td>B. adolescentis (a)</td>
<td>Enterococcus faecium (a)</td>
<td>Bacillus clausii (a),*</td>
</tr>
<tr>
<td>L. amylovorus (b),*</td>
<td>B. animalis (a),*</td>
<td></td>
<td>Escherichia coli Nissle 1917 (a)</td>
</tr>
<tr>
<td>L. casei (a),(b),*</td>
<td>B. bifidum (a)</td>
<td>Lactococcus lactis (b),*</td>
<td>Saccharomyces cerevisiae (boulardi) (a),*</td>
</tr>
<tr>
<td>L. gasseri (a),*</td>
<td>B. breve (b)</td>
<td>Streptococcus thermophilus (a),*</td>
<td></td>
</tr>
<tr>
<td>L. helveticus (a),*</td>
<td>B. infantis (a)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. johnsonii (b),*</td>
<td>B. longum (a),*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. pentosus (b),*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. plantarum (b),*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. reuteri (a),*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L. rhamnosus (a),(b),*</td>
<td></td>
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</tr>
</tbody>
</table>

(a) Mostly as pharmaceutical products; (b) mostly as food additives; * QPS (Qualified Presumption of Safety) microorganisms.

Źródła: [4]
### Examples of commercial probiotic products

<table>
<thead>
<tr>
<th>Strain</th>
<th>Commercial products</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saccharomyces cerevisiae boulardii</td>
<td>Florastor</td>
<td>Biocodex (Creswell, OR)</td>
</tr>
<tr>
<td>Bifidobacterium infantis 35,264</td>
<td>Align</td>
<td>Procter and Gamble (Mason, OH)</td>
</tr>
<tr>
<td>Lactobacillus casei strain Shirota</td>
<td>Yakult</td>
<td>Yakult (Tokyo, Japan)</td>
</tr>
<tr>
<td>Bifidobacterium breve strain Yakult</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactobacillus casei DN-114 001</td>
<td>DanActive</td>
<td>Danone (Paris, France)</td>
</tr>
<tr>
<td>Bifidobacterium animalis DN173 010</td>
<td>Activia</td>
<td>Danone (Paris, France)</td>
</tr>
<tr>
<td>Lactobacillus johnsonii Lj-1 (same as</td>
<td>LC1</td>
<td>Nestle (Lausanne, Switzerland)</td>
</tr>
<tr>
<td>Lactobacillus acidophilus La-1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactobacillus reuteri ATCC 55,730</td>
<td>BioGaia Probiotic chewable tablets or</td>
<td>Biogaia (Stockholm, Sweden)</td>
</tr>
<tr>
<td>(“L. reuteri Protectis”)</td>
<td>drops</td>
<td></td>
</tr>
<tr>
<td>Lactobacillus rhamnosus GG (“LGG”)</td>
<td>Culturelle; Dannon</td>
<td>Danimals Valio Dairy (Helsinki, Finland)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The Dannon Company (Tarrytown, NY)</td>
</tr>
</tbody>
</table>

The 2015 global probiotic market size by revenue exceeded 35 billion USD
Probiotic food products

- Dairy products such as yoghurt and kefir, cottage cheese or ripened cheese fermented with probiotic strains. About 2-5x10^{10} cells/100 gram portion.

- Ice cream or frozen dessert. Probiotic bacteria concentration of about 10^{7} cells/g.

- Chocolates or cakes with lyophilised probiotic bacteria at concentration of about 10^{7} cells/g.

- Soft drinks with probiotic bacteria (CocoBiotic – fermented with *Lactobacillus acidophilus*; *Lactobacillus delbrueckii*; *Saccharomyces cerevisiae boulardii*): 4 billion cfu)
### Probiotic products

<table>
<thead>
<tr>
<th>Product</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>In lyophilised form</td>
<td>Usually $10^{10}$ cells/g. Shelf life about 1 year. Sold as drugs or dietary supplements. Sometimes encapsulated.</td>
</tr>
<tr>
<td>Infant formula (powdered milk)</td>
<td>With lyophilised probiotic bacteria at concentration of about $10^7$ cells/g.</td>
</tr>
<tr>
<td>Probiotic BioGaia chewing gum</td>
<td>With <em>Lactobacillus reuteri</em> Prodentis. Balancing the oral flora and reducing the level of harmful bacteria associated with oral problems.</td>
</tr>
<tr>
<td>A screw cap for use on PET bottles</td>
<td>Which releases probiotic bacteria into the beverage.</td>
</tr>
<tr>
<td>LifeTop Straw</td>
<td>Which releases probiotic bacteria into drink upon piercing with the straw.</td>
</tr>
<tr>
<td>Probiotic sticks</td>
<td>Contain a blend of <em>Lactobacillus acidophilus</em> Rossell-52 and <em>Bifidobacterium longum</em> Rossell-175 in a micro-encapsulated fruit flavoured powder form.</td>
</tr>
</tbody>
</table>
There are more beings in the world than just us, humans...
“Synbiotic preparation for monogastric animals health prophylaxis and prevention of bacterial diseases and mycotoxin-related intoxications, as well as to improve animal nourishment and animal breeding efficiency” (PBS3/A8/32/2015)

Research funded by The National Center for Research and Development

Collaboration:
- Department of Swine Diseases of National Veterinary Research Institute placed in Pulawy
- Department of Biotechnology and Food Microbiology, Poznan University of Life Sciences
- Department of Pathology and Veterinary, Warsaw University of Life Science – SGGW
- Department of Animal Nutrition and Feed Science, University of Warmia and Mazury in Olsztyn
- JHJ Sp. z o. o. company
If we succeed...

Designed synbiotic for livestock

- Less pathogenic bacteria in intestinal microflora
- Less contaminated food products
- Less zoonotic diseases in humans
- Better breeding efficiency
- Higher detoxification of mycotoxin administrated with feed
- Less intoxications in humans
References