Probiotics: a new miracle treatment?

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In the past few years the use of and number of probiotic products (food with additives of helpful bacteria) on the market has grown remarkably, as has the general and scientific knowledge about them. The potential positive effects of probiotics on the human body have been known since the early nineties. But it wasn't until after the development of microencapsulating techniques in the early twenty-first century that the full potential of probiotics started to be realised. The different positive effects shown from consumption of probiotics include a boost to the immune system, as well as a decrease in bacterial pathogens in the large intestine. Probiotics has also shown to help alleviate both allergies and some forms of intestinal ulcers and cancer. A number of genetically modified strains of probiotics have also shown to lower cholesterol and as a result also lower the risk of heart diseases. The field of probiotics is an exiting area of biology where more and more information about potential treatments for diseases is discovered every year.

Probiotics: an introduction

Bacteria that when consumed in sufficient quantities exert positive health effects on its host are called probiotics. The human intestines contain over 500 different species of bacteria from 20 different genera. Of these bacteria there are two that dominate; *Lactobacillus* spp. and *Bifidobacterium* spp. Both of these bacterial genera have shown an astounding ability to induce a number of positive health effects for their host. One of the many diseases that probiotics have shown to alleviate is irritable bowel syndrome. Irritable bowel syndrome is the most common of all intestinal diseases and more then 10% of the worlds adult population will experience some symptoms during there lifetime. The cause of irritable bowel syndrome is still somewhat unclear but available scientific information points towards an irregularity of the intestinal bacteria. Symptoms of irritable bowel syndrome as well as the symptoms for many other intestinal diseases have shown to subside with an introduction of probiotics to the intestines. How and why the introduction of new probiotic bacteria would have theses effects are still not completely known. Most researchers though give one of three different physiological theories. The first theory states that the intestines have a limited surface and when this surface is filled with helpful or non-toxic bacteria most bacterial pathogens can't compete and spread in sufficient numbers to induce negative health effects. Another theory says that because some probiotic bacteria induce the excretion of immunoglobulin A, which is an immune booster, most bacterial pathogens will be unable to spread in sufficient numbers to induce negative health effects. The most popular theory for why probiotics can alleviate many intestinal distresses however is that most probiotic species excrete acidic metabolites. Acidic metabolites lower the pH in the intestines and make the intestinal ecosystem less friendly for most bacterial pathogens that are not very tolerant for high acidity. The probiotics themselves however, as well as many helpful bacterial species in the intestines are very tolerant for high acidity and are therefore mostly unaffected by these metabolites.

One of the main problems associated with probiotic consumption is the fact that a large portion of the consumed bacteria never reaches the intestines because of the catabolic processes in the digestive tract. Therefore researchers began in the late nineties to develop different microencapsulating techniques for probiotics to allow them to survive the digestive

tract. Today thanks to these techniques a much larger percentage of consumed probiotics reaches the intestines.

***Lactobacillus* spp.**

Lactobacillus spp. is a large genus with over 125 species of gram-positive and mainly anaerobic bacteria. They are among those bacteria that produce lactic acid and are one of the dominating bacteria in the human intestines. Many researchers speculated that *Lactobacillus* spp. had a better chance of working as a probiotic because of its tolerance for high acidity. They believed that *Lactobacillus* spp. could survive the hydrochloric acid in the stomach and reach the intestines. A number of studies however showed that this was not the case and before the development of microencapsulating techniques the number of studies with clear and non contradictory results was practically none.

Studies with microencapsulated *Lactobacillus* spp. bacteria have shown that they can alleviate and cure diarrhoea, both acute and induced by antibiotics. *Lactobacillus* spp. has also been shown to treat lactose intolerance, ulcers, irritable bowl syndrome as well as stimulate both the general and local immune system of the intestinal lining.

As probiotics *Lactobacillus* spp. have been evaluated in a number of studies and a few potential side effects have been detected. Among these side effects is a potential production of histamine, which has been shown in a few studies. Histamine can irritate the immune system of the intestinal lining and as a result disrupt the normal intestinal rhythm. A potential development towards resistance against antibiotics have also been theorised by many researchers. Theses side effect are however rare and *Lactobacillus* spp. is considered a safe probiotic genus.

In recent years more and more studies have shown the cancer inhibiting properties of several genetically modified strains of *Lactobacillus* spp. Many of these cancer inhibiting effects are contributed by researchers to the excretion of different exopolysaccharides by these genetically modified bacterial strains.

Collection of probiotic species of the genus *Lactobacillus* and the positive health effects that's been shown from their consumption.

Bacterial species	Health effects
L. acidophilus, *L. casei,* *L. delbrueckii,* *L. lactis,* *L. plantarum,* *L. rhamnosus*	Stimulation of the immune system in the intestinal lining.
L. acidophilus (L1 and ATCC43211)	Decrease in the concentration of bad cholesterol.
L. casei Shirota	Stimulation of the intestinal immune system and inhibition of immunoglobulin E.
L. citreum	Allergy alleviation through inhibition of immunoglobulin E.
L. fermentum CECT5716	Stimulation of the general immune system.
L. plantarum L137	Increased protection from influenza infections.
L. salivarius CECT5713	Anti inflammatory effects.

***Bifidobacterium* spp.**

Bifidobacterium spp. is a small genus with less then 30 species of gram-positive and exclusively anaerobic bacteria. They produce just as *Lactobacillus* spp. lactic acid and are the dominating bacteria in the human intestines, comprising around 25% of all the intestinal bacteria. *Bifidobacterium* spp. is especially equipped to break down and extract energy from long chained polysaccharides that the human body has difficulties digesting. This allow them to be supplied with an abundance of nourishment which can be the main reason they comprise such a high percentage of all intestinal bacteria. Studies preformed on *Bifidobacterium* spp. before the late nineties and without microencapsulating have shown, unlike studies on *Lactobacillus* spp., a number of positive health effect associated with their consumption.

One of the possible reasons why *Bifidobacterium* spp. have shown positive effects in studies even before the late nineties and without the use of microencapsulating could be because *Bifidobacterium* spp. excrete several metabolites besides lactic acid that has antibacterial properties.

A large portion of the positive health effect that's been shown by *Bifidobacterium* spp. has been with genetically modified strains. Among the most prominent and perhaps the most important results from consumption of genetically modified strains could be the alleviation of *Escherichia coli* induced diarrhoea. Especially since this type of diarrhoea often afflict people in the third world where it can become a life threatening disorder if the person can't restore lost fluid and water soluble vitamins.

Another positive effect known from consumption of some strains of *Bifidobacterium* spp., that have been known for quite some time, is there ability to conjugate cholesterol lipids which prevent these from being absorbed by the body. These strains of bacteria can thus lower the concentration of bad cholesterol and as a result also lower the risk of heart disease.

Collection of probiotic species of the genus *Bifidobacterium* and the positive health effects that's been shown from their consumption.

Bacterial species	Health effects
B. animalis ATCC2552, *B. bifidum*	Decrease in the concentration of bad cholesterol.
B. bifidum Bb12, *B. longum* SBT2928	Stimulation of the immune system in the intestinal lining.
B. breve YIT4064	Stimulation of B-lymphocytes and an increased protection from influenza infections.
B. infantis, *B. thermophilus*	Antibacterial effects on pathogens in the large intestine.
B. lactis HN019	Alleviation in the intensity of *E. coli* induced diarrhoea.
B. longum	Tumour and intestinal cancer inhibiting effects.

Microencapsulating techniques

Many researchers before the late nineties doubted that many probiotic strains would be able to survive the human digestive tract and reach the intestines in sufficient quantities to stimulate positive health effects. The results of many studies on several probiotic strains before the late nineties also seemed to support the researcher's doubts. Analysis of the faeces of patients that

consumed different probiotic strains showed that between 5-11% of the bacteria survived the digestive tract, depending on genus and species. The survival rate of un-capsulated *Bifidobacterium* spp. bacteria was around 11% while the survival rate for *Lactobacillus* spp. bacteria was around 5%. It wasn't until the development of microencapsulating techniques that researchers started to see stronger and more clearly defined positive health effects from consumption of probiotics. Between 51-65% of consumed probiotics that hade been microencapsulated survived the digestive tract, depending on genus and species. With a survival rate of around 65% for *Bifidobacterium* spp. bacteria and around 51% for *Lactobacillus* spp. bacteria.

One of the most successful microencapsulating techniques that have been developed in recent years is encapsulation of bacteria with alginate. Alginate can be easily extracted from brown algae and forms small hydrogel spheres in the presence of calcium ions. The alginate hydrogel spheres become a protective shell for the probiotic bacteria. Unfortunately alginate is sensitive to high acidity, like the hydrochloric acid in the stomach. This problem however was solved by encasing the hydrogel spheres in chitosan which is resistant to high acidity. The chitosan encased alginate hydrogel spheres are a perfect transport vehicle for probiotics because they are resistant to most of the catabolic processes in the digestive tract but not immune to them and will therefore slowly dissolve after a few hours. Because of the delay in the dissolving of the hydrogel spheres by the digestive tract most of the consumed probiotics will reach the intestines.

Overconfidence in probiotics

While many probiotic strains have shown to alleviate and even cure several different intestinal and systemic diseases there will never be the miracle treatment that many probiotic advocates argue. Even genetically modified probiotic strains can never be modified to such a point that they will be able to synthesise anything more then simple bio molecules. And while they might be able to induce several immune responses in the human body, they will never be able to act themselves as ether a primary or even a secondary immune system.

Currently there exist a large number of dairy products with added probiotics. Theses products however often have such a low concentration of probiotics, coupled with only a 5-11% survival rate after consumption that they usually only show minimal positive results, if even that. If one also takes in to account the fact that these probiotic products often cost much more then ordinary dairy products, they become not worth buying at all.

Want more information about probiotics?

More detailed information can be found in the Swedish review article:
Wäneskog M. 2011. Kan intag av probiotika ge positiva effekter för hälsan? Självständigt arbete i biologi 2011.