Probiotics and Obesity: Benefit or Harm?

Beatriz Gómez Solsona, Autonomous University of Barcelona. Biomedical Sciences Degree.

Introduction

The human being is a super-organism composed of both human and microbial cells (microbiota). In fact, the genes encoded in our microbiome exceed human genes (99% of our genes have a microbial origin). Microbial cells play an important role in our organism; their functions include: the digestion and processing of otherwise indigestible components from our diet for posterior absorption, vitamin synthesis (vitamin K and B12), immune system stimulation, formation of a barrier-like structure, which prevents the adhesion and colonization of pathogens, etc. They determine the health, physiology and development of the host.

Both human and microbial cells must live in symbiosis; any dysregulation (dysbiosis) will mean a risk for the host's health. For example, obesity – a worldwide epidemic – can be caused by a disruption in the gastrointestinal tract (GIT) microbiota or by the increment of specific bacterial species in the GIT.

Currently, new treatments for diseases with a dysbiosis etiology are being developed. One of the therapies that is being considered and evaluated are probiotics; due to their capacity of modifying host microbiota, they could efficiently supplant those microbes causing the disease.

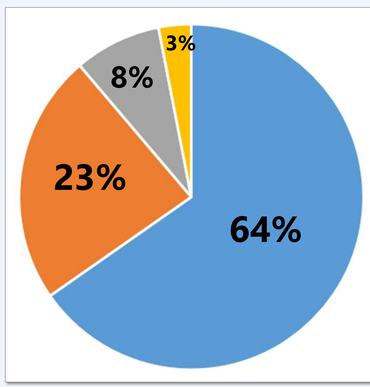


Figure 1. Relative proportion of the four most abundant bacterial phyla in the human gut, which represent 98% of all of the bacteria found in the gut.

Firmicutes ***Bacteroidetes*** ***Proteobacteria*** ***Actinobacteria***

Objectives

The **final objectives** of this project were:

- ❖ To create an informative leaflet with the aim of transmitting scientific knowledge to the general population.
- ❖ To simplify the scientific information found in reviews and papers to a broadly understandable language without technical terminology.
- ❖ To clearly define the microbiota, probiotics and show their possible impact on obesity.

Materials and Methods

- ❖ **Scientific literature search on PubMed database**: keywords used: "microbiota" (or specific bacterial species), "obesity", "probiotics" or a combination of them. The scientific articles were selected depending on their quality and publication date. Sensationalist articles were also revised.
- ❖ **Development of a Survey:** the objective was to know the general understanding of the population about the subject. The survey was uploaded to a social network and was answered by 115 people. Subsequently, the results were analysed.

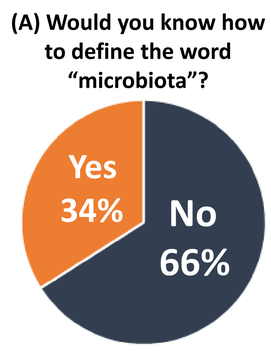


Figure 2. Survey results. (A) People acknowledge having heard the word before, but the majority don't know how to define it.

(B) Only 56% of the surveyed answered affirmatively. This proves the lack of knowledge from the general population of the risks of having obesity.

Results

There are numerous hypotheses that support the role of microbiota in the development of obesity. The establishment of microbiota in the gut would:

- ❖ Promote the formation of new capillaries in the GIT, allowing a major absorption of nutrients.
- ❖ Inhibit AMPK-dependent fatty acid oxidation.
- ❖ Increase the formation of short chain fatty acids (SCFA), which would reduce Fiaf levels. This would stimulate the increase of lipoprotein lipase (LPL), that boosts fat accumulation in adipose tissue.
- ❖ Promote the transformation of indigestible carbohydrates to SCFA, which stimulate liver lipogenesis and increase fat storage and adipogenesis through GPR41/43 receptors.

However, other investigations have demonstrated that SCFA produced by the microbiota also promote the secretion of intestinal peptides such as peptide YY and GLP-1, which generate satiety.

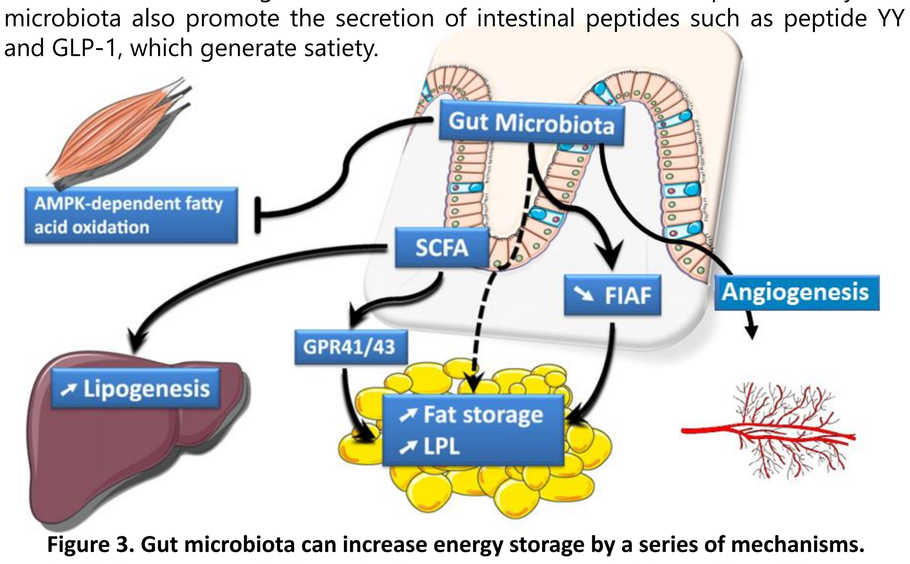
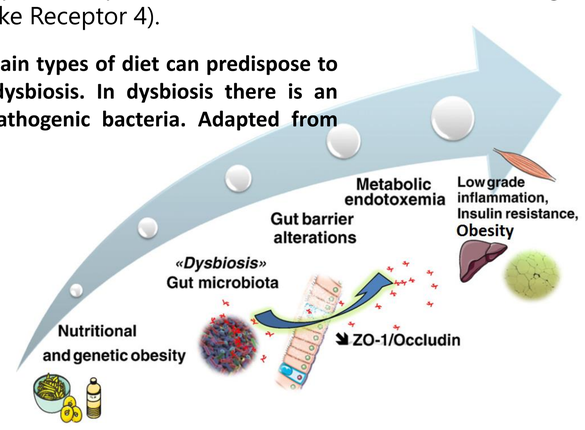


Figure 3. Gut microbiota can increase energy storage by a series of mechanisms. In this image some of this mechanisms are represented. Adapted from [3].

The two most popular hypothesis claim that:

1) The dysbiosis caused by the excess in fat consumption will alter the epithelial gut barrier, allowing a leakage of LPS (lipopolysaccharide from gram-negative bacteria). The LPS will promote adipose cell proliferation and insulin resistance through TLR4 (Toll-Like Receptor 4).

Figure 4. Certain types of diet can predispose to obesity and dysbiosis. In dysbiosis there is an increase in pathogenic bacteria. Adapted from [3].



2) Microbiota present in the GIT of obese individuals is different and less diverse. Nevertheless, a clear microbial profile for each physical condition still has to be established. The main difference is that the proportion of *Firmicutes* is higher in obese individuals, while their proportion of *Bacteroidetes* is lower.

- *Lactobacillus reuteri*
- *Enterobacteriaceae*
- Desulfovibrionaceae
- Eubacterium rectale
- Roseburia intestinalis

- *Bifidobacterium animalis*
- *Methanobrevibacter smithii* (Archaea)

Figure 4. Specific bacterial and archaeal communities that have been seen to be increased or diminished in obese subjects. *Actinobacteria* can also be increased in obese individuals.

Treatment approach

Currently, the effect of probiotics on weight loss is being tested, because some sensationalist articles claim that this products are also used in animal fattening.

In theory, the bacteria in these products would be able to displace pathogenic microbes and specific microbes with an increased capacity on calorie extraction, returning the normal balance to the gut microbiota.

Major objective: promote a change in the microbiota in order to favour the presence of microbial strains that are normally found in non-obese individuals, thus facilitating weight loss.

Promising results seen with: *Lactobacillus gasseri.*

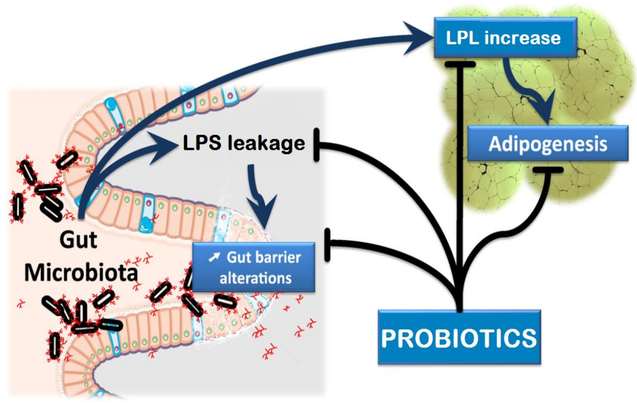
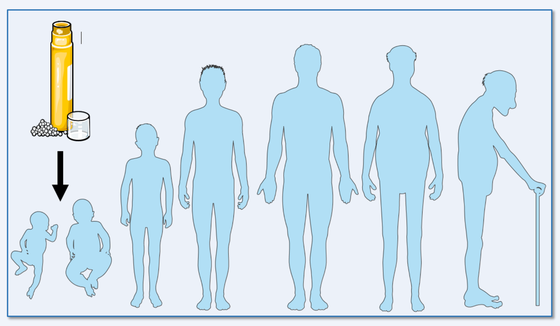


Figure 5. Probiotics may be able to inhibit most of the microbiotic mechanisms that promote weight and fat increase. Adapted from [3].

Conclusions

- ❖ It is clear that microbiota plays a role in the development of obesity. One of the main causes of gaining weight more easily could be the inter-individual differences in microbiota. Although obesity has been related to the increased presence of specific bacterial species, this is still widely discussed.
- ❖ Studies with much larger cohorts should be conducted, to accurately establish the specific microbial profile of individuals with different physical characteristics.
- ❖ It would be crucial to standardize the methods that should be used in microbiota and probiotic studies. As a result, a clear understanding and general acceptance of their implications could be achieved.
- ❖ To make people more aware of the dangers of suffering from obesity, the health system should promote consciousness-raising programmes.
- ❖ Finally, since the microbiota mainly develops during the first years of life, it would be essential to assess if probiotic treatment would be more effective if administered at an earlier stage in life.

Figure 6. An early treatment with probiotics might increase the effectiveness of microbiota modification, preventing the development of metabolic diseases such as obesity.



References

[1] Turnbaugh PJ, Ley RE, Mahowald M a, Magrini V, Mardis ER, Gordon JI. An obesity-associated gut microbiome with increased capacity for energy harvest. Nature. 2006;444:1027–31

[2] Zhao L. The gut microbiota and obesity: from correlation to causality. Nat Rev Microbiol. 2013;11(9):639–47.

[3] Cani PD, Delzenne NM. The gut microbiome as therapeutic target. Pharmacol Ther. 2011;130(2):202–12.