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Biography

My career has always been related to the wide set of applications that biotechnology could provide for designing novel foods while helping in human health through nutrition.

I received my Ph.D. degree in Food Science with an emphasis in Biotechnology, at the University of California, Davis in 2012, and previously I obtained a Molecular Biotechnology degree in my Bachelor. My Ph.D. studied the influence of breast milk, especially prebiotic human milk oligosaccharides, on the infant gut microbiome. We focused on the molecular and physiological mechanisms of certain *Bifidobacterium* species, providing key evidence for their adaptations to the infant gut. This research also found new enzymes and tools to increase the value of certain bovine milk fractions.

I am currently appointed as an Assistant Professor at the Department of Chemical and Bioprocess Engineering, at the Pontificia Universidad Catolica de Chile, since 2013. In this position I teach courses in Biotechnology, Systems Biology and Bioprocessing. My research group includes postdoctoral researchers, four Ph.D. students, four master students and several undergraduates in from Biological Engineering.

My current research is aimed to study the influence of diet on health through the gut microbiome, applying systems biology tools such as mathematical or metabolic models. We are interested in predicting the composition of the gut microbiome according to diet, and simulating the impact of dietary changes in the microbiome using bioreactors and models. This research has also the potential to design potential microbiome-based therapeutic tools. Finally, we are interested in contributing to the understanding of how the gut microbiome influence metabolic

diseases. For this, we have studied how different obesity treatments, ranging from bariatric surgery to sweetener consumption, could modulate microbiome composition.

Abstract

Metabolic Interactions in the Gut Microbiome: Modeling, Simulation and Applications in Foods and Health

The human intestine harbors a dense and complex community of microorganisms that directly impacts our health. Understanding the forces that guide microbiome development and composition is important to determine its role in health and in the application of the gut microbiome as a therapeutic tool.

Diet is one of the main factors guiding microbiome composition especially in the newborn. We recently developed a mathematical model based on microbial growth equations that incorporate metabolic interactions terms of cross-feeding. The model used experimental data from a simple system comprising four microorganisms, one substrate (fructooligosaccharides, FOS), and quantifying two metabolites (acetate and lactate). The model accurately predicted bacterial abundance, suggesting that changes in microbial abundance and activities in a small set of gut microbes are explained by metabolic interactions.

We have set-up a continuous bioreactor to simulate the impact of dietary changes in the gut microbiome, for example from formula to breast milk. Transitioning from FOS to 2-fucosyllactose (2FL) required a long transition phase for microbial adaptation. Accordingly, relative abundances and SCFA profiles changed with the dietary switch. Mathematical modeling of a multi-species consortium in continuous culture was capable to explain in great part the behavior of the system, which could be used for predictive modeling of dietary changes in the gut microbiome.

Finally, we are interested in understanding of how the gut microbiome influence metabolic diseases. We have analyzed the impact of bariatric procedures on the microbiome of Chilean obese patients, identifying important changes in the structure of the community and key differences between sleeve gastrectomy and gastric bypass. We have also studied the impact of sucralose consumption among healthy subjects in the short term. While no significant changes were observed in metabolic markers or their gut microbiome, we observed that subjects with a higher glycemic value displayed an altered microbiome.

Engagement with ILSI

This year I joined the International Life Sciences Institute ILSI South-Andean. I was happy to give a public seminar titled "Gut Microbiome, Nutrition and Health: New Tendencies". This talk had almost 50 people attending, mainly professionals from nutrition and food industry. It was a very interactive presentation and people were really engaged.