Medical University of Graz

Microplastic and the Microbiome

Summary

Division of Gastroenterology and Hepatology, Department of Medicine, Medical University of Graz

Supervisor:	Prof. Dr. Vanessa Stadlbauer-Köllner
Availability:	This position is available.
Offered by:	Medical University of Graz
Application deadline:	Applications are accepted between February 15, 2022 00:00 and March 28, 2022 23:59 (Europe/Zurich)

Description

Background:

Humans ingest approximately 5g of plastic particles per week. Microplastic (MP) particpes have been detected in human stool samples. It is currently suggested but not completely proven that MP may affect human health negatively. To consider a potential pathogenic role in humans, one should consider the routes of exposure and the cells with which MP may interact. Humans are estimated to take up around 5g of MP particles every week and MP particles are detectable in human stool samples. [1]. On ingestion in the diet, MPs move through the gastrointestinal tract where they have been shown to interact with the microbiome. MP in the gastrointestinal tract have been shown to be degraded by microbes (and fungus) [2], whilst plastic particles themselves induce changes to the composition of the gut microbiome (recently reviewed by Fackelmann et al. [3]). For example, MP exposure in the diet was associated with a decrease in the diversity of the gut microbiome as well as taxonomic changes in mice. In the same study, increased intestinal permeability and changes in amino acid and bile acid metabolism, and hepatic lipid metabolism [4,5] were shown. Interestingly, the effects of MP on the mammalian gut microbiome, including changes in microbiome diversity, an increase in potentially pathogenic bacteria, a decrease in commensal gut bacteria and resulting metabolic dysfunction, resemble common findings in chronic human diseases such as diabetes, obesity or chronic liver disease [6]. On the other hand, it has been shown that bacteria are capable of degrading MP, [7] however, it is completely unknown, whether bacteria that are gut commensals or safe for human use (probiotic bacteria) are capable to degrade MP. Taken together, it is of urgent scientific relevance to study the influence of MP on the human gut microbiome.

Hypothesis and Objectives:

We hypothesize that the presence of MP is associated with a distinct structural and functional signature of the gut microbiome in humans and that MP can be modified by human gut bacteria that can be used for human application.

Methodology:

The PhD student will conduct a cross sectional study to investigate the presence, type and physico-chemical characteristics of MP in human stool samples from patients with colorectal adenoma or cancer and compare findings to healthy controls and other diseases with known associations of gut microbiome composition and disease state (e.g. liver cirrhosis, diabetes, dementia;). The student will perform an intervention study in healthy volunteers who are asked to reduce MP intake for one week to obtain samples with high and low MP exposure. Within this project the PhD stundnt will develop a medium-to-high-throughput method for MP detection in complex matrices based on and assess microbiome structure and function will be assessed by 16s sequencing and NMR metabolomics.

To go beyond the mere description of associations, the student will also model these alterations in vitro by anaerobic culture of stool microbiomes with different types of manufactured MP. In an in vitro anaerobic microbiome cultivation model stool samples from healthy controls will be treated with different types of MP. The bioreactors will be monitored by flow cytometry and/or gel-electrophoreses. To study whether gut bacteria can degrade microplastic, data from full genome sequencing will be screen for the presence of enzymes that can potentially modify/degrade MP. Bacteria that have the potential capability to modify MP and can be safely used in humans will be cultivated and the expression of these enzymes will be assessed on protein level. Identified probiotic bacteria and/or bacterial consortia that show promising functions – e.g. from in-silico or protein expression screenings – will be anaerobically cultivated with different types of MP in a mini bioreactor system and physico-chemical properties alteration and modification of the MP particles will be assessed.

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References:

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