Simulating the impact of drinking water microbiomes on the human gut microbiome

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Motivation

Drinking water is an important source of hydration and a vehicle of microorganisms[1]. Environmental conditions at the source and water treatment methods[2] shape the microbial load of the drinking water microbiome (DWM) (Fig.1). Upon consumption, the DWM can interact with the gut microbiome (GM) which is composed of an ensemble of microorganisms and their genomic repertoire (bacteria, archaea, unicellular eukaryotes, viruses) that influence the human host through a range of physiological functions[3]. While DWM has been suggested to influence the GM via several ways[4,5] (Fig.1), the mechanistic impact of DWM on the GM remains unexplored. The advent of *in-vitro* fermentation models coupled to high throughput analysis may reveal how the DWM may be modulating the GM and inform on the microbiological quality of water.

Technological challenge

Given the complexity and ethical constraints surrounding *in-vivo* models, an *in-vitro* bioreactor system is a lucrative option to study fecal GM at conditions that recapitulate those of the human gut. However, there are numerous challenges associated with simulating gut-derived microbial metabolic interactions in an *in-vitro* fermentation model such as uncultured species with unknown functions and retaining native functions in the simulator (Fig.2). In parallel, amplicon-sequencing and flow cytometry approaches will be used to trace and monitor bacterial members of the DWM[6]. Compositional and functional changes in the *in-vitro* bacterial culture will be determined via high throughput techniques and will be compared to a baseline model. Other measurable parameters reflecting a response in the GM culture will be determined and measured such as production of short chain fatty acids[7] .
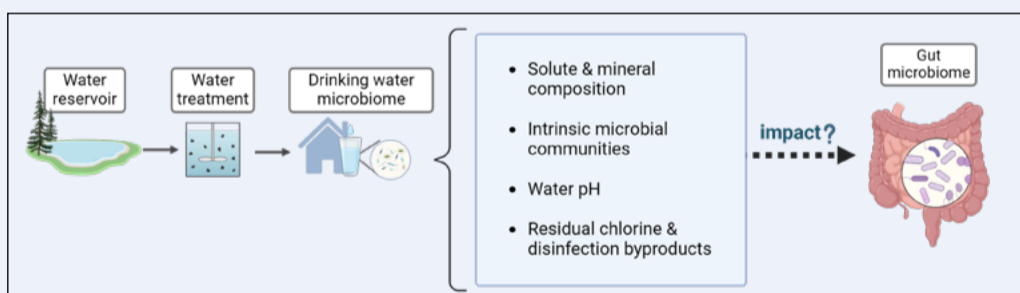

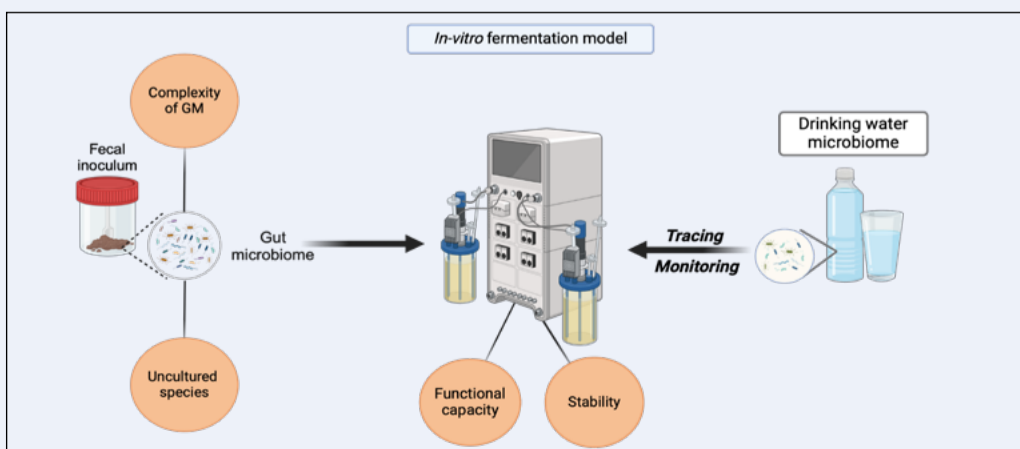*Figure 1. Factors shaping the drinking water microbiome (DWM) and how it may impact the gut microbiome.*

Figure 2. Challenges associated with studying the impact of drinking water microbiomes on the GM in an in-vitro fermentation model. GM: gut microbiome
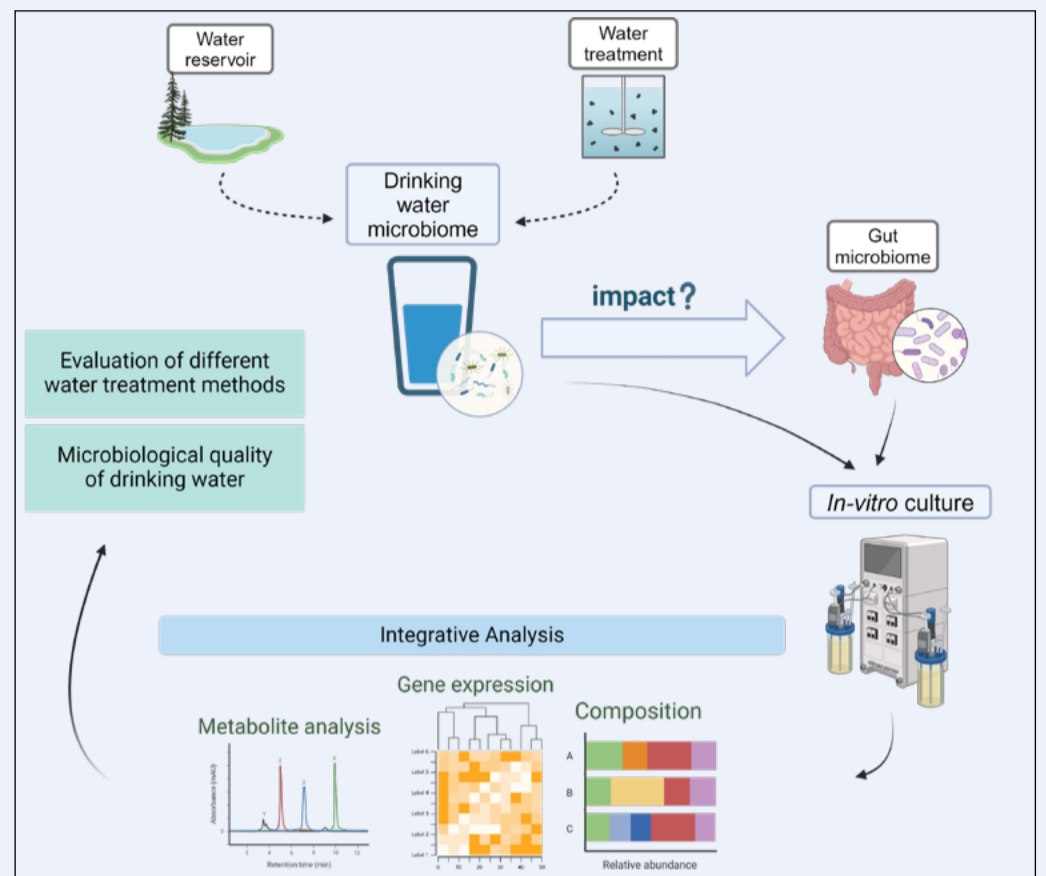

Figure 3. The drinking water microbiome (DWM) may interact with the gut microbiome (GM) which influences host health. By culturing gut-derived bacterial species under conditions that mimic the gut, the impact of DWM on the GM can be simulated. High throughput techniques including next generation sequencing can reveal changes over time to the composition and function of the gut-derived bacterial culture in the presence of the drinking water microbiome.

Research goals

The aim of this project is to evaluate the impact of different drinking water sources and treatment methods on the GM in an *in-vitro* fermentation model. By integrating high throughput analyses on the composition, gene expression, proteins and metabolites produced, a characterization of the synthetic bacterial culture in response to the different drinking water samples can be performed and a conclusion on the microbiological quality of the latter can be made. Understanding how the DWM influences health via the GM will further advise on water treatment methods to improve drinking water quality.

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