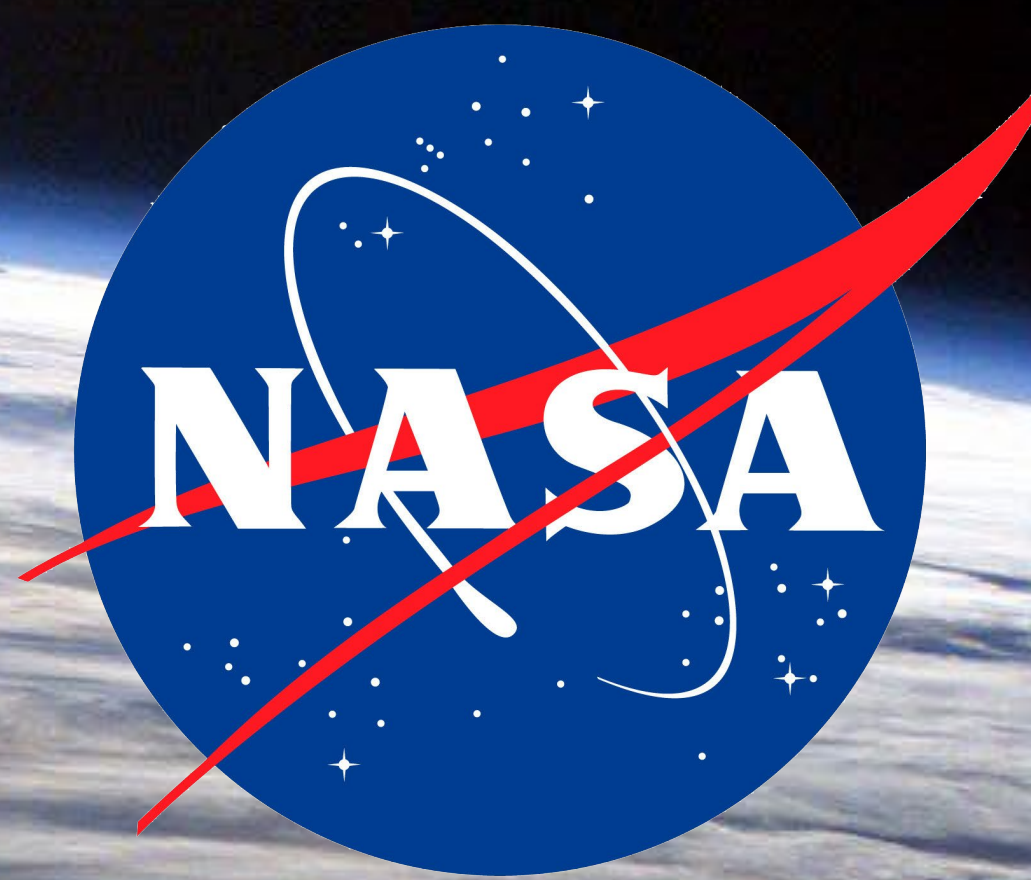




# Endogenous Microbial Survival in Brewed Tea

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## Abstract

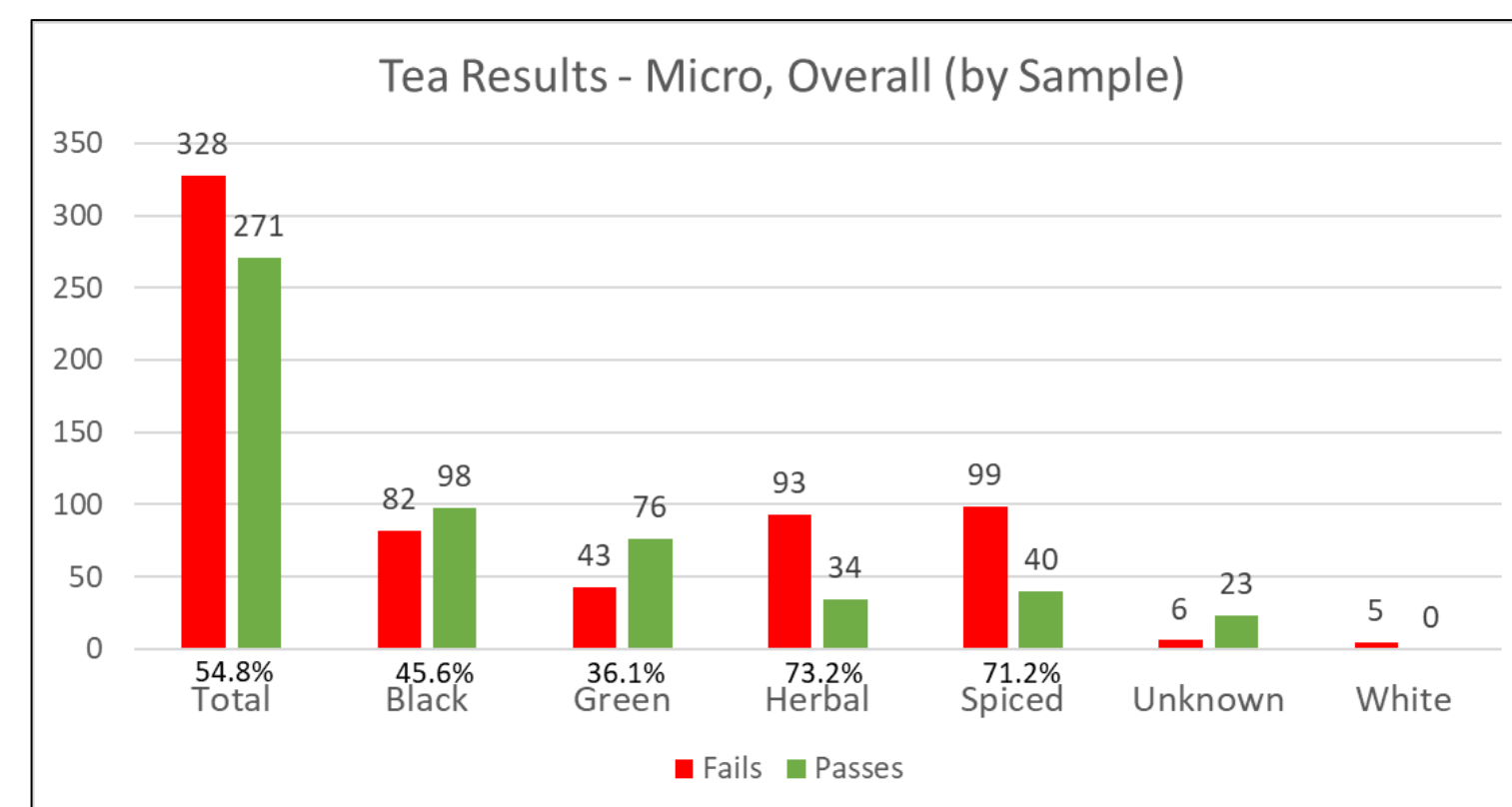
Loose-leaf bagged tea is a commonly requested beverage item that comprises up to 7% of the microbiological samples from the space food systems. As loose-leaf tea blends often contain herbs and spices that frequently have high microbial loads, they have a high failure rate as defined by the microbiological standards outlined in NASA-STD-3001, which are more stringent than the limits set for industry. Between April 2019 and September 2022, 54.8% of loose-leaf teas submitted for microbiological testing have failed, necessitating the evaluation of a variety of brands and lot numbers of each requested tea type to meet crew preference requests, which are typically specific, resulting in excess labor and material costs to provide a single product for spaceflight consumption. Attempts to identify specific brands or ingredients that are less likely to produce a failure have been unsuccessful, as to date, no trends in those measures have been identified. We have, however, noticed a trend in types of teas (spiced and herbal) which are more likely to fail. Of additional concern, hot water available for brewing tea on ISS is dispensed at a lower temperature than the CDC recommended brewing temperature. In a study we previously reported, we found that brewing water temperature may not have a significant impact on the number of aerobic bacteria in chamomile tea, as there were no significant differences in the total microbial load between tea brewed with boiling, ISS-like, or room temperature waters. It did appear that ISS temperature water was similarly effective to boiling water against a pathogenic bacterial species. In this study, we aim to assess whether the total number of aerobic bacteria of other high-fail-rate tea types is similarly unaffected when brewing tea in room temperature or boiling water. Data from this study and the previous study, as well as additional analysis of every tea product that has been tested as part of the normal food system since April 2019, will be used to determine the expected typical microbial load for loose-leaf teas, which we will compare to existing industry limits so that we can recommend a new microbiological limit for loose-leaf teas that accurately reflects the true risk of consuming brewed teas in spaceflight.

## Background



Loose-leaf bagged tea is a common crew request:

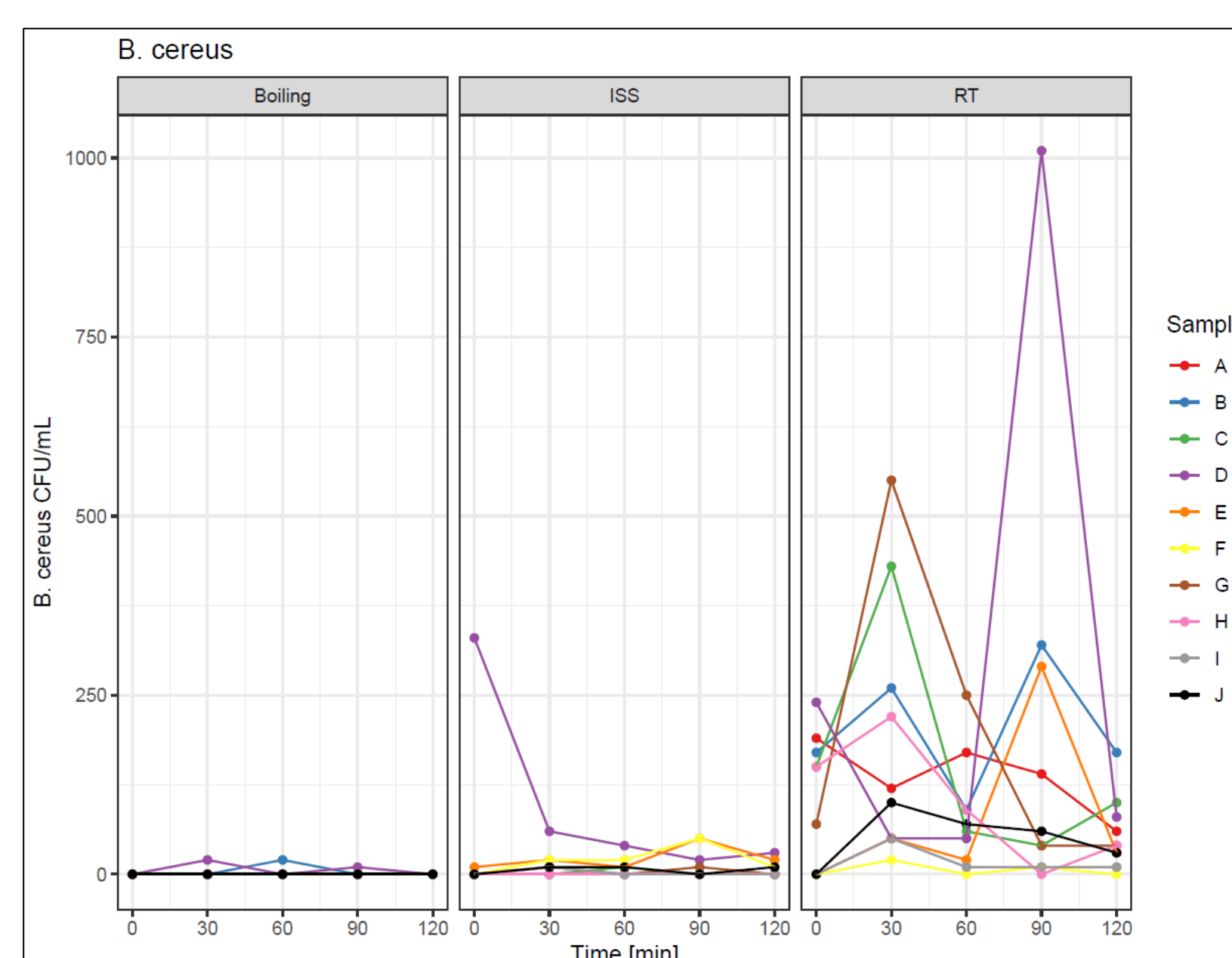
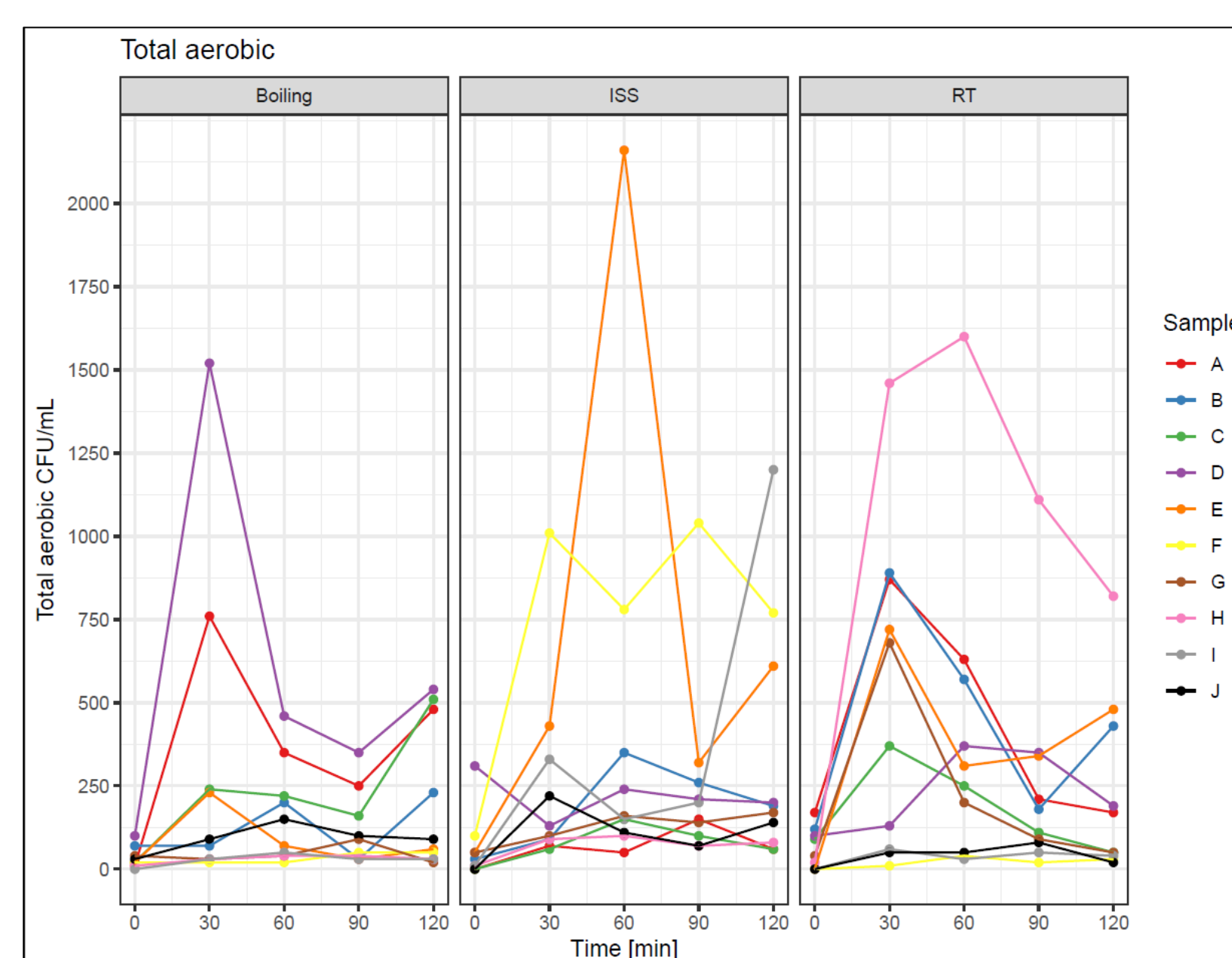
- For some, it is preferred caffeine source
- Comforting
- Can alleviate stomach discomfort



Loose-leaf bagged tea has a high rate of microbiological failure:

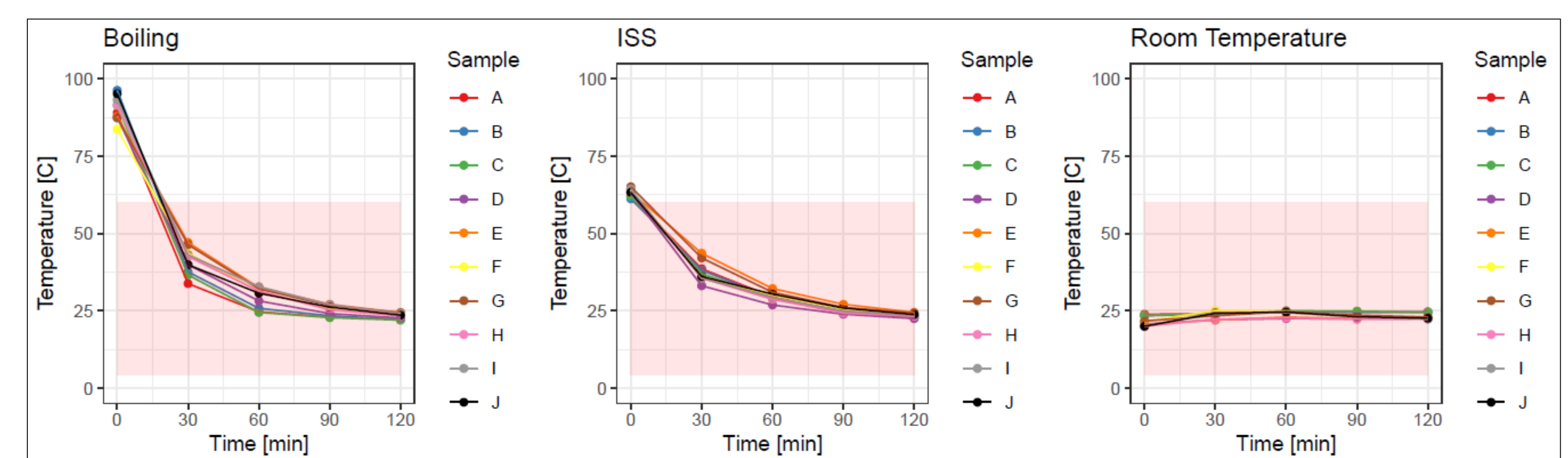
- Often made of herbs and spices with high microbial loads
- Non-homogenous mixtures
- Many teas are dried outdoors, exposed to local fauna
- 54.8% of loose-leaf teas tested in the NASA JSC Microbiology lab have failed to meet NASA standards for microbial cleanliness, which are more stringent than industry
- Boiling-temperature water recommended by CDC for tea brewing

## Previous Data



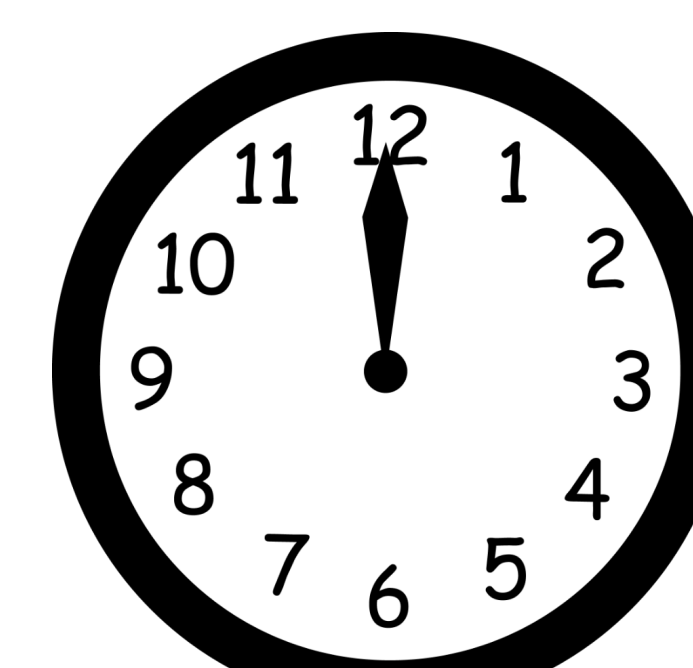
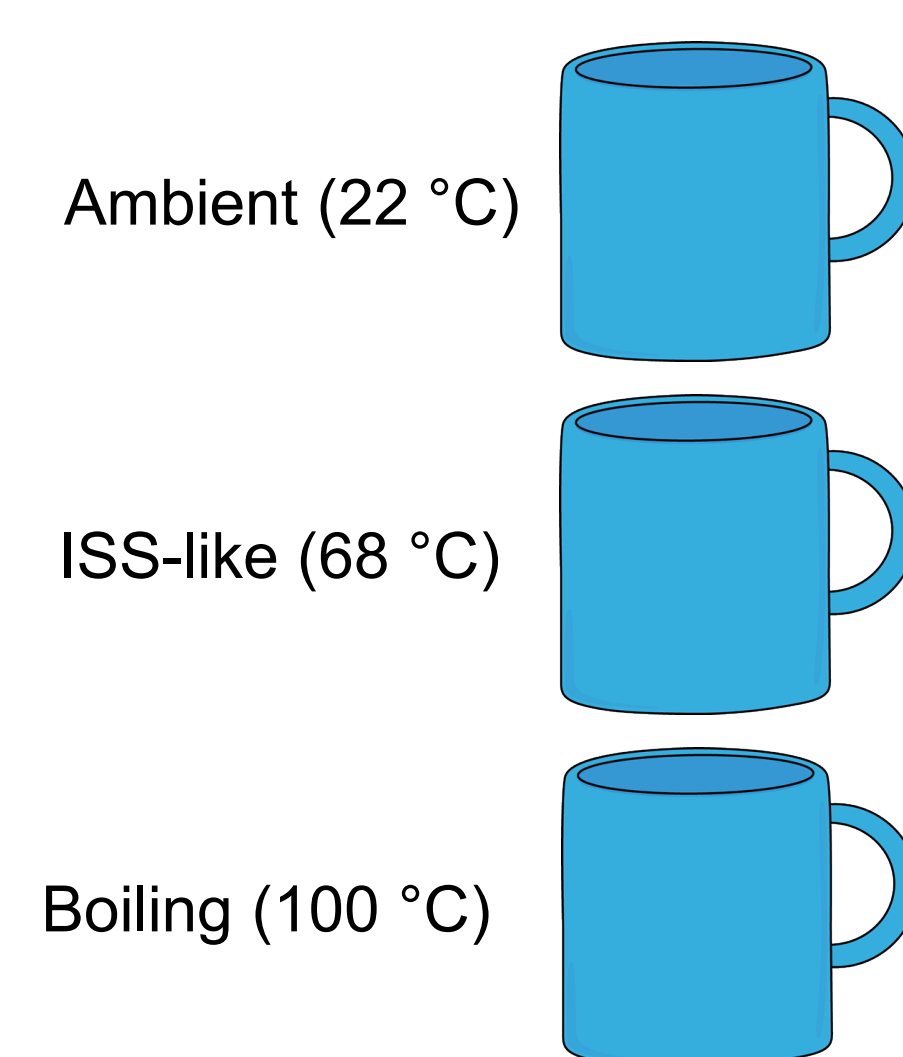
A previous study investigating loose-leaf tea brewed with boiling (100 °C), ISS-like (68 °C) and room-temperature (22 °C) water showed that boiling and ISS-like water had similar effect on total microbial load (top) and a spiked pathogen (bottom) over a 2-hour steeping period at ambient temperature.

The previous study assessed only one type of tea (chamomile herbal).

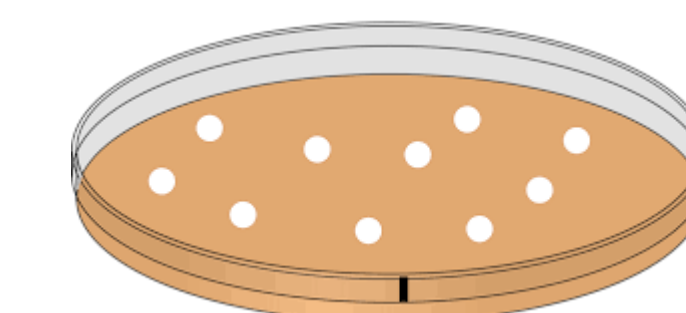


## Current Study-Specific Aims

Assess the total microbial load of commonly requested loose-leaf bagged tea types over a 2-hour drinking period. This study adds testing of spiced black tea (chai) and herbal teas containing dried fruits (lemon ginger), which also have a high rate of failure.



2-hour brew time with sampling every hour



Quantify microbial load using standard aerobic plate counts and data analysis



Combine the new data with analysis of loose-leaf bagged teas performed as part of the standard food system to determine if increasing the bacterial limit for brewed teas would alter our risk posture, with the aim of recommending a new limit for teas if the data supports the change.

Analysis planned include statistical analysis and outlier detection, as well as comparison to existing industry limits

This study is currently ongoing with results expected by end of March 2025. For questions, you may contact the presenting author at [starla.g.thornhill@nasa.gov](mailto:starla.g.thornhill@nasa.gov).