

# The apple fruit microbiome: influence of orchard management, variety and storage time

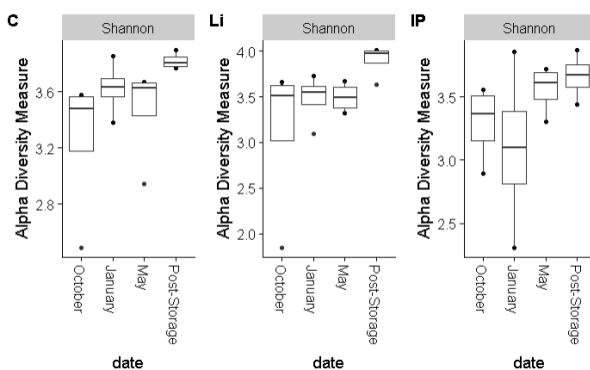
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## INTRODUCTION

Microbial spoilage in commercial apple storage facilities can lead to Food Loss of up to 30% during the storage period. Here we aimed to characterize the microbiome and the abundance of pathogens on the apple skin and to elucidate the influence of the apple variety, orchard management practices and the dynamics of the microbial composition during the entire storage period. The results allow for description of infection levels of different pathogens at harvest and the prediction of post-storage symptom development. Additionally, information about the community composition allows for identification of the main factors driving the composition of the microbiome, the change in diversity during the storage period and the identification of beneficial microorganisms that may eventually be applied as biocontrol agents. The results can be applied in the development and improvement of infection models, inform breeders on how the host genotype interacts with the microbial community and inform researchers on how microbial communities assemble over time.

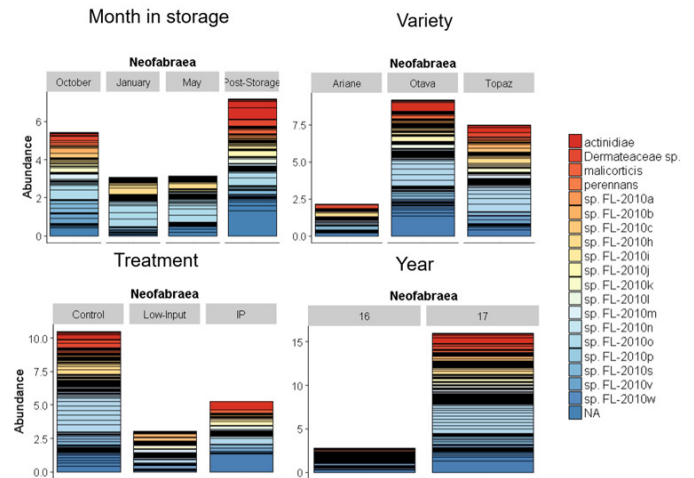
## RESULTS

For two consecutive storage seasons a microbiome dominated by fungi, especially from the two genera *Aureobasidium* and *Cladosporium* was measured. The diversity of the microbiome, measured as Shannon Diversity index was shown to increase during the storage period (Figure 1) reflecting growth of microorganisms in a niche entirely different than on the tree (low temperature, high humidity, no light).



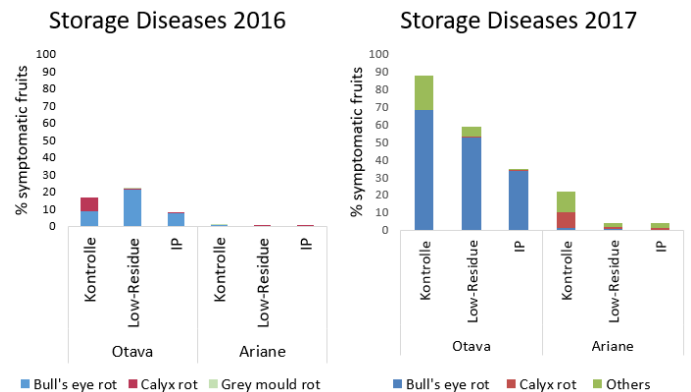
**Figure 1.** Change in Alpha Diversity on apple skins for three different orchard management plans during the storage period.

In addition to information on the microbiome as a whole, the current study also allows for screening the prevalence of diseases causing pathogens such as *Neofabraea* spp. (Figure2)



**Figure2.** Abundance of *Neofabraea* spp. the most prevalent microbial disease on stored apples in Switzerland as a function of storage time, variety, orchard management and year.

Ideally, the prevalence of DNA from various pathogens could serve as an indicator for later disease. Here, it was shown that for different years, the abundance of *Neofabraea* spp. DNA correlates well with the prevalence of Bull's eye rot disease after the storage period (Figure3).



**Figure3.** Fruits scored with microbial damages for two consecutive storage seasons reflecting the increased abundance of *Neofabraea* spp. in the year 2017.

## CONCLUSIONS

- The diversity of the microbiome was shown to increase during the storage period.
- The variety and orchard management practices showed a significant effect on the abundance of various storage pathogens.
- The presence of DNA from pathogens can be used as an indicator for disease development during storage.