



Development of new functional foods derived from hive products: combination of innovation, history and environmental sustainability

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State of Art

Honeybees play a crucial role in global ecosystems, not only as pollinators supporting food production and biodiversity, but also as producers of economically and culturally valuable products. Over the past decades, the managed honeybee colonies increased by 85%, while honey production surged by 181%. The most important bee products consumed worldwide is honey, followed by bee pollen.

Bee pollen is a pellet of field-gathered flower pollen packed by worker bees and used as primary source of protein (20-40 g/100g); due to its high moisture content, fresh pollen is unstable during the time. To store it for longer periods and increase the bioavailability of nutrients, honeybees developed a strategy of storage based on natural fermentation to obtain **bee bread**. The **microbial consortium** responsible for bee bread fermentation consists of lactic acid bacteria, that are responsible for acidifying bee bread thereby creating an inhibits environment and yeasts that play a complementary role producing essential growth factors and producing volatile compounds, enhancing the final aroma.

Mead is the most ancient alcoholic beverage (8-18%) obtained by the natural fermentation of honey, with a demonstrated positive effects on metabolism, particularly aiding digestion, offering physiological benefits, and reducing the risk of chronic diseases beyond basic nutritional functions.

The aim of this research would be developing a line of functional foods derived from honeybee products, with the dual objective of promoting public health and raising consumer awareness about the wild honeybee's world.

Lines of research

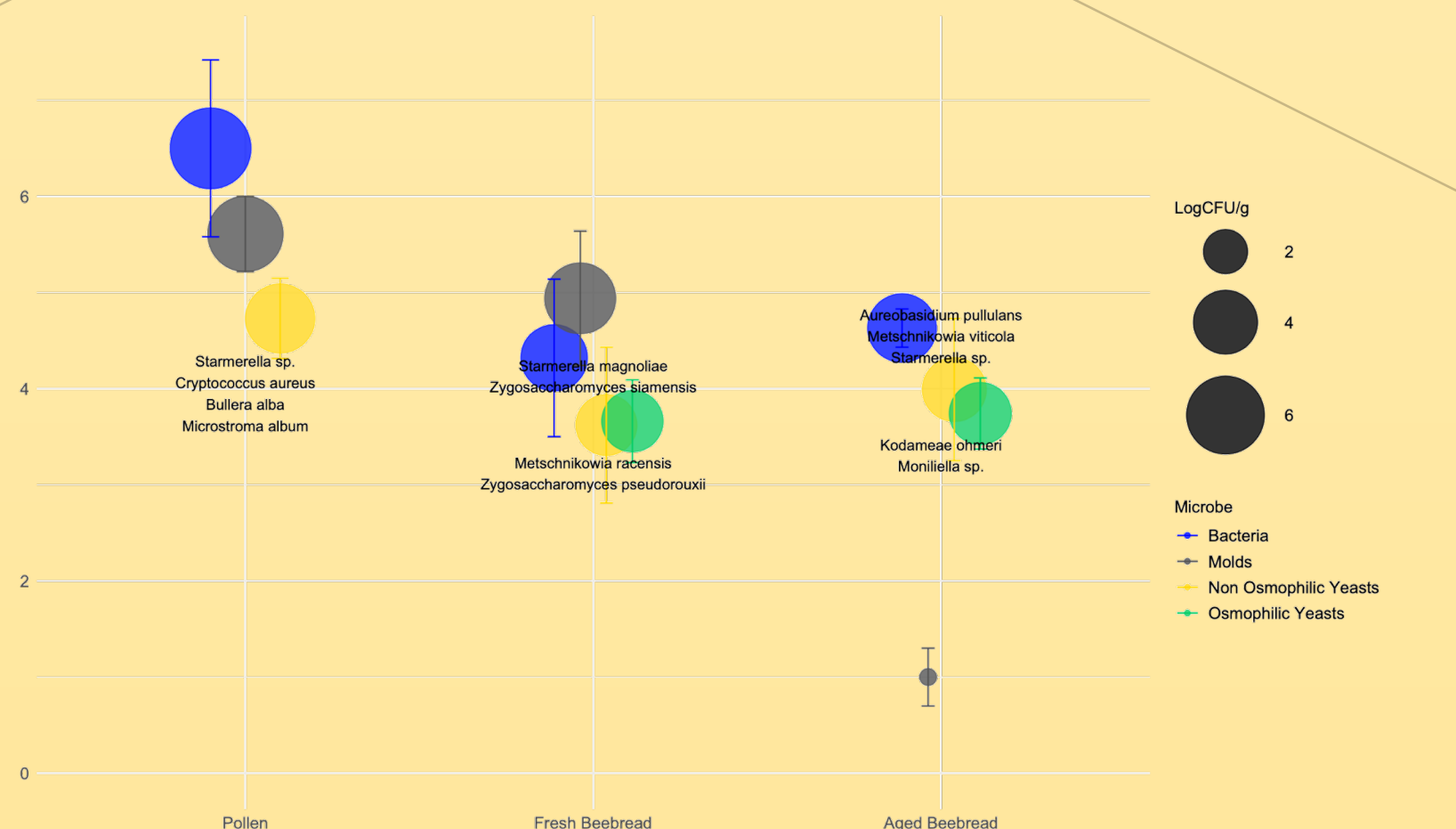
Probiotic pollen

Methods

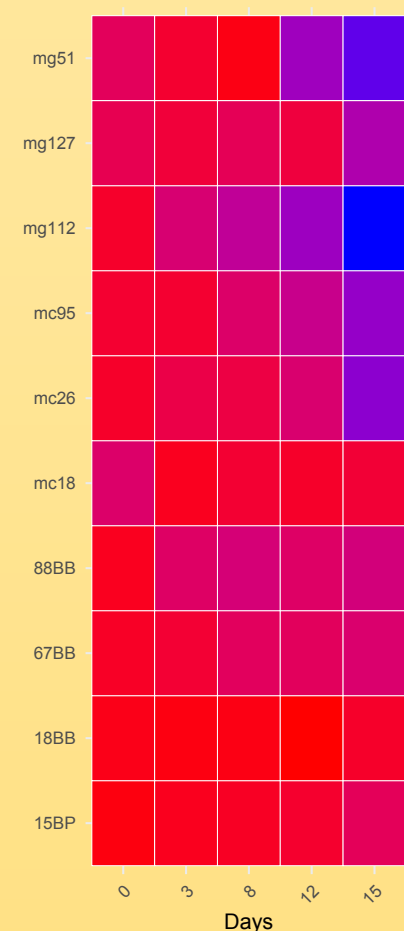
- Yeasts isolation
- Probiotic and functional trials
- Production of probiotic pollen

Results

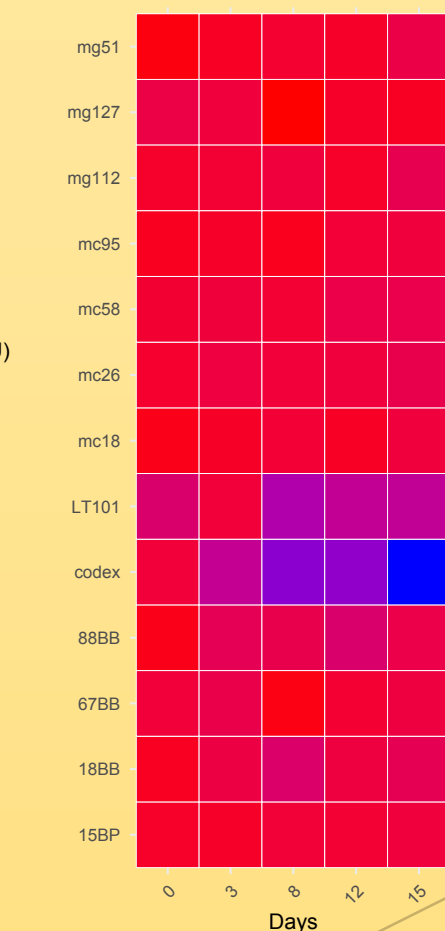
- Ascomycetes showed a total of six strains belonging to *Starmerella* spp., recovered in both pollen and bee bread; two cultures of *Zygosaccharomyces* spp. were isolated only in fresh bee bread, and two cultures of *Metschnikowia* spp. and one strain of *Kodamea ohmeri* in bee bread were identified. Yeast-like *Aureobasidium pullulans* were isolated only in aged bee bread. The results clearly showed less yeast variability in pollen compared with the matrix bee bread;
- Six strains belonging to the *Starmerella*, *Kodamea*, and *Aureobasidium* genera showed higher antioxidant power compared to Codex. *Starmerella* spp., *S. magnoliae*, and *M. viticola*, as well as showing excellent inhibitory ability against pathogens and mold spoilage, display the greatest probiotic traits;
- Freshly inoculated “apistic” yeasts show greater long-term viability compared to *L. thermotolerans* and the control strain (Codex®), confirming their evolutionary adaptation to the substrate.



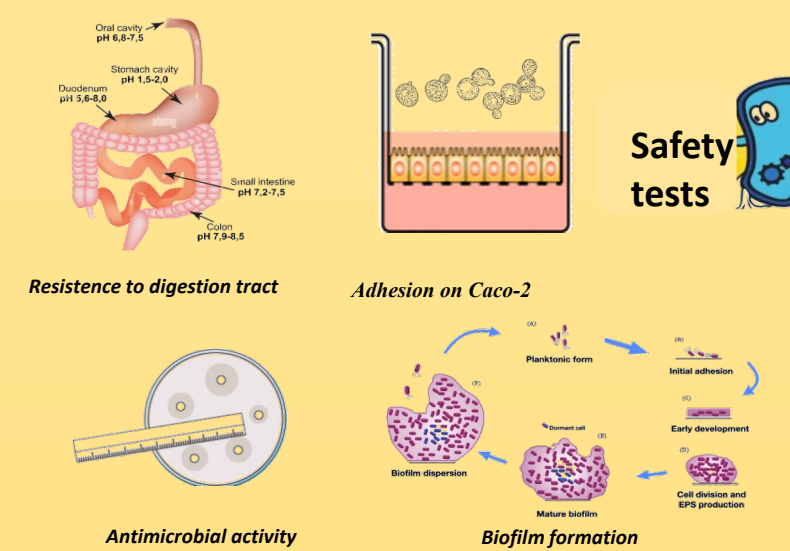
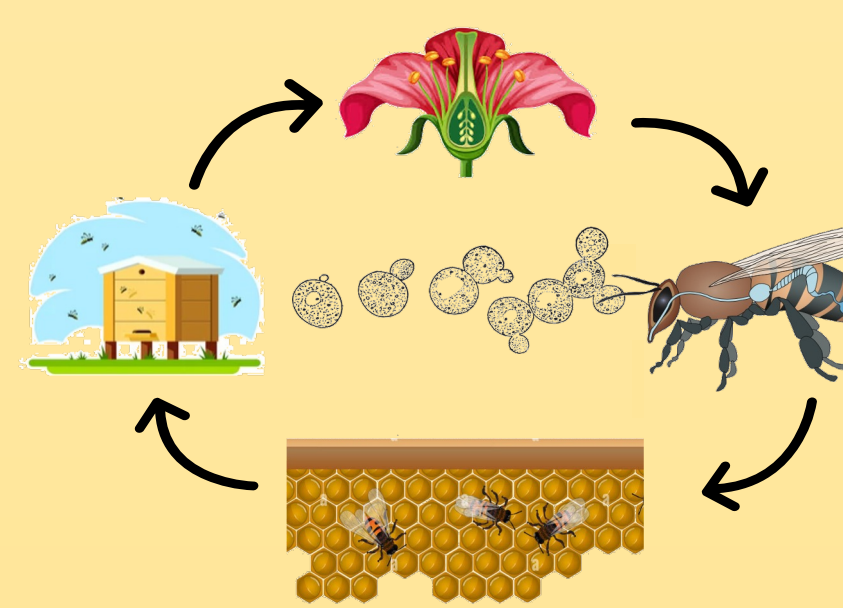
Lyophilized Strains



Fresh Strains



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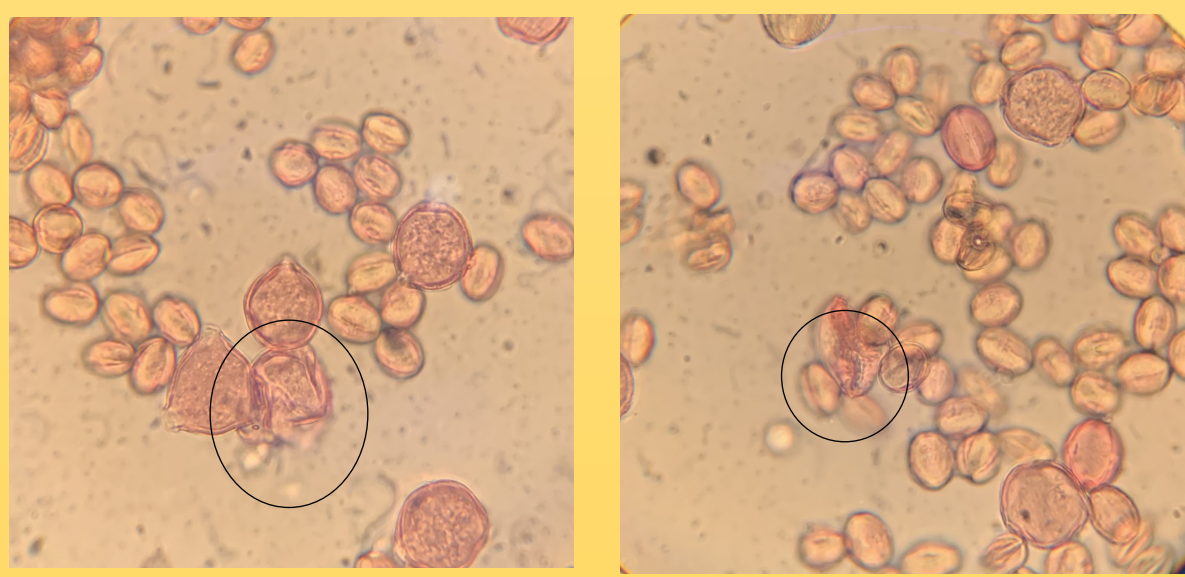
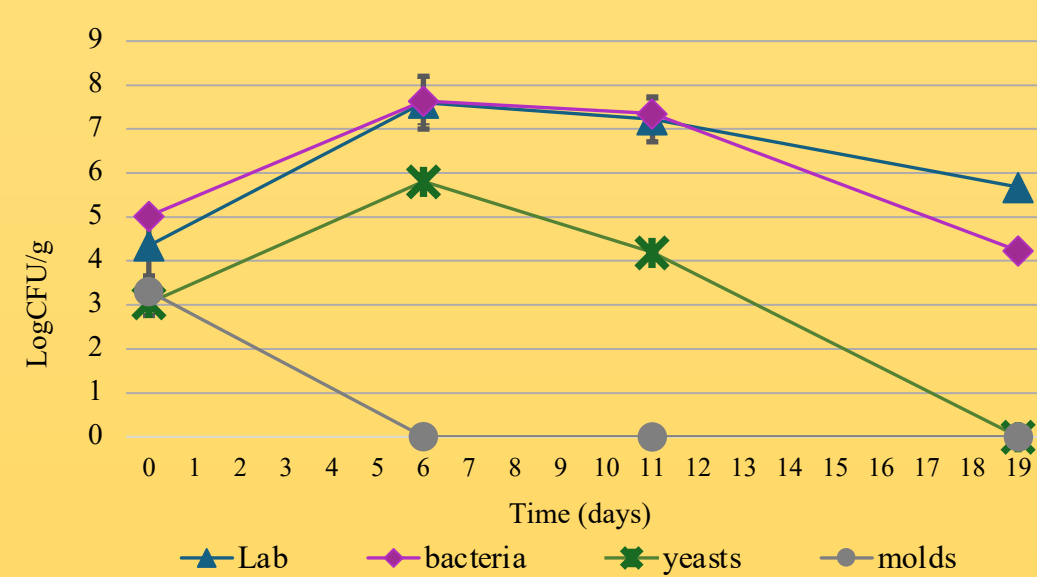
Bee bread

pH

4,93

4,15

3,65



Broken pollen grains as a result of fermentation

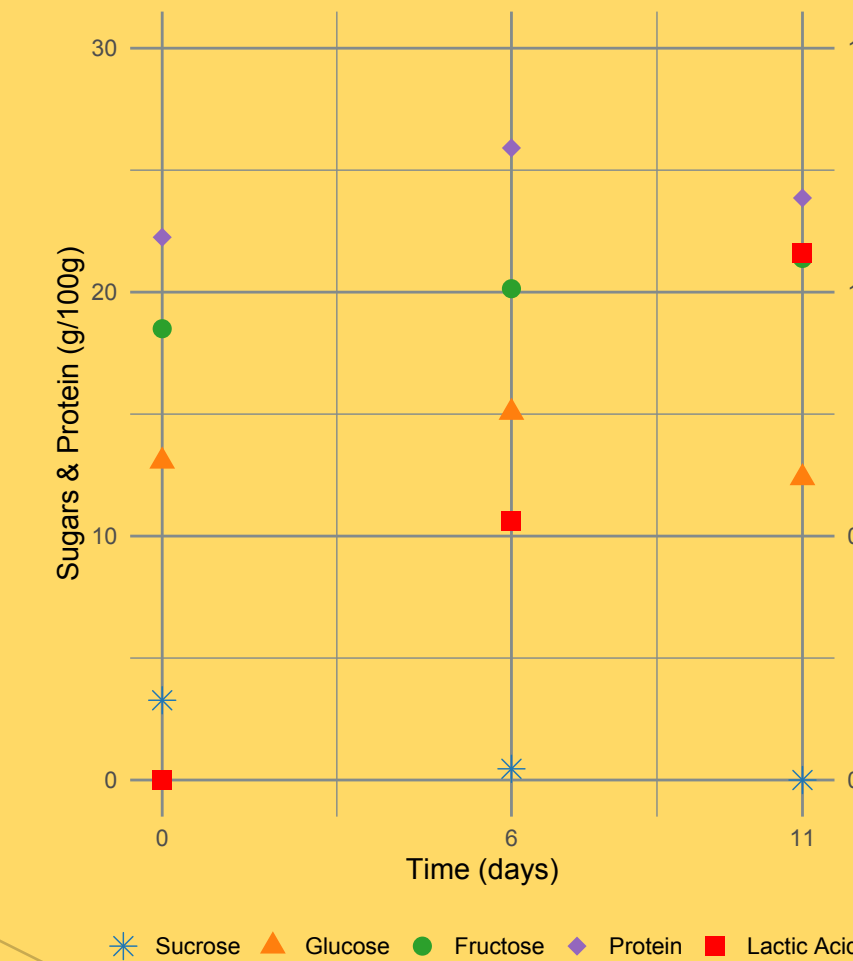
Methods

- 50g of commercial fresh bee pollen, 25% of honey, 25% of water;
- Studying natural and controlled fermentations through viable cell counts;
- Monitoring key analytical parameters in each trials.

preliminary results

- Spontaneous fermentation most closely mimics the natural process in the beehive, although pollen granule breakdown is limited;
- Spontaneous fermentation yields significantly better organoleptic results than fermentations using only lactic acid bacteria
- L. casei* Shirota is unable to grow on the provided substrate, unlike *L. rhamnosus*, which remains active and viable up to the 11th day of fermentation.

Data only from spontaneous fermentation



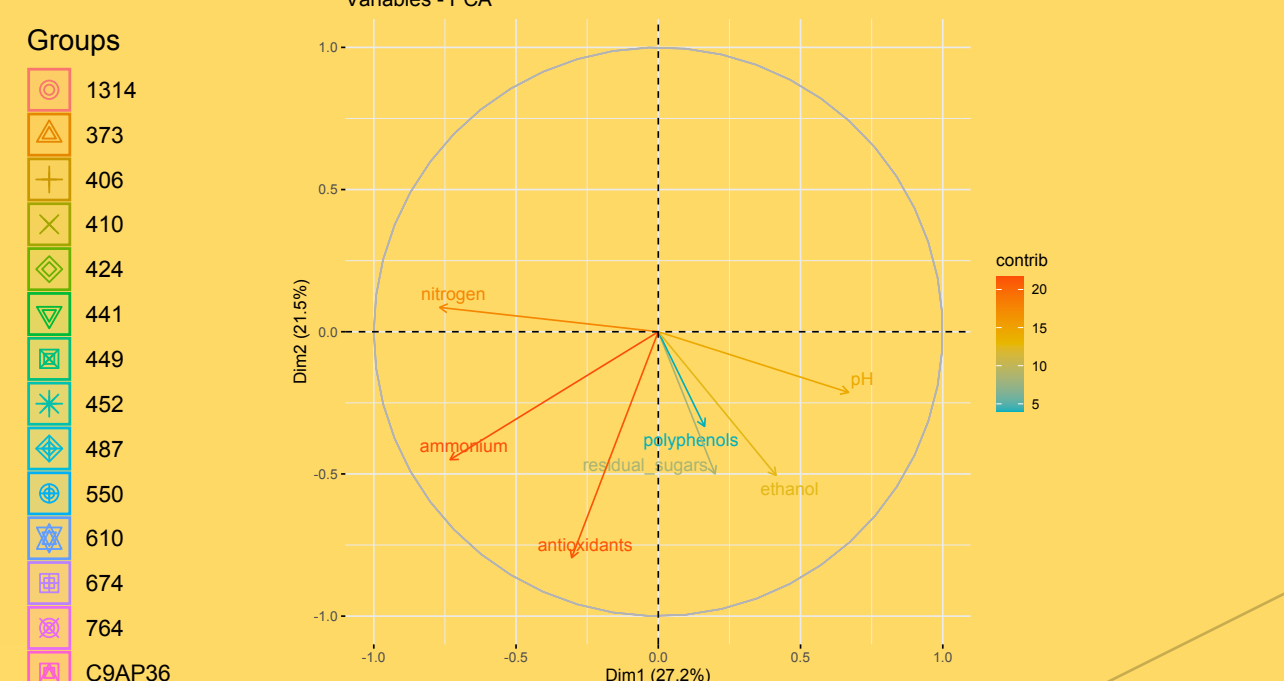
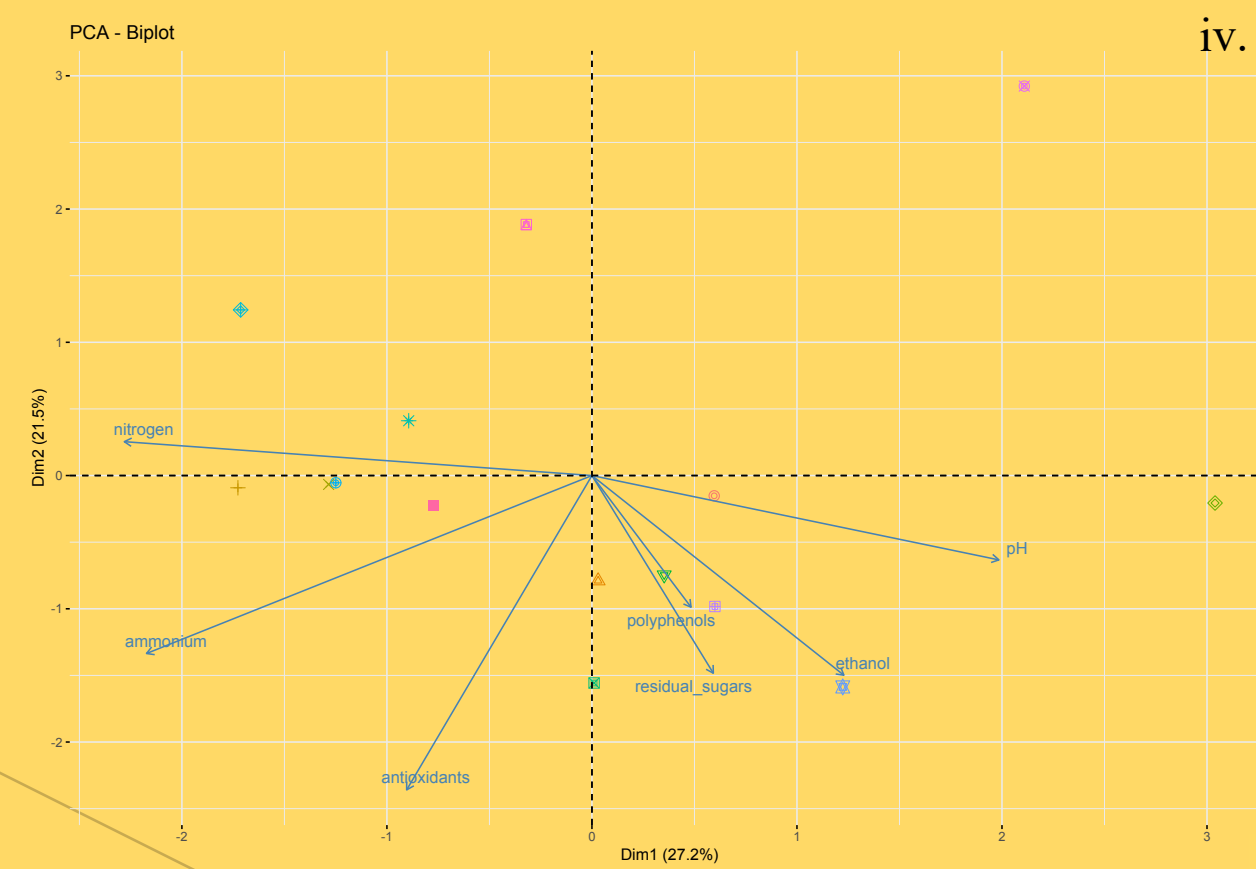
Mead

Methods

- Honey wort (23° Brix)
- YNA adjustment up to 250 mg/L
- Pastorization (108°C x 8 min)
- Inoculation of 26 strains of Saccharomyces and 35 of non Saccharomyces
- Evaluation of fermentation activity and analytical parameters over time

preliminary results of Saccharomyces strains

- Strains such as 410, 424, 441, and 449 show high levels of antioxidants and polyphenols, making them promising for nutraceutical applications;
- 1314, 406, MAF112, and C9AP36 are more active in nitrogen and ammonium uptake, but show low production of secondary metabolites, indicating a neutral or supportive role in mixed cultures;
- 674, 610, and 373 show moderate fermentation, with production of ethanol and presence of residual sugars, indicating incomplete sugar;
- Strain 424, resulting as outlayer is the top candidate for biofunctional mead or beverage applications.



bibliography

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