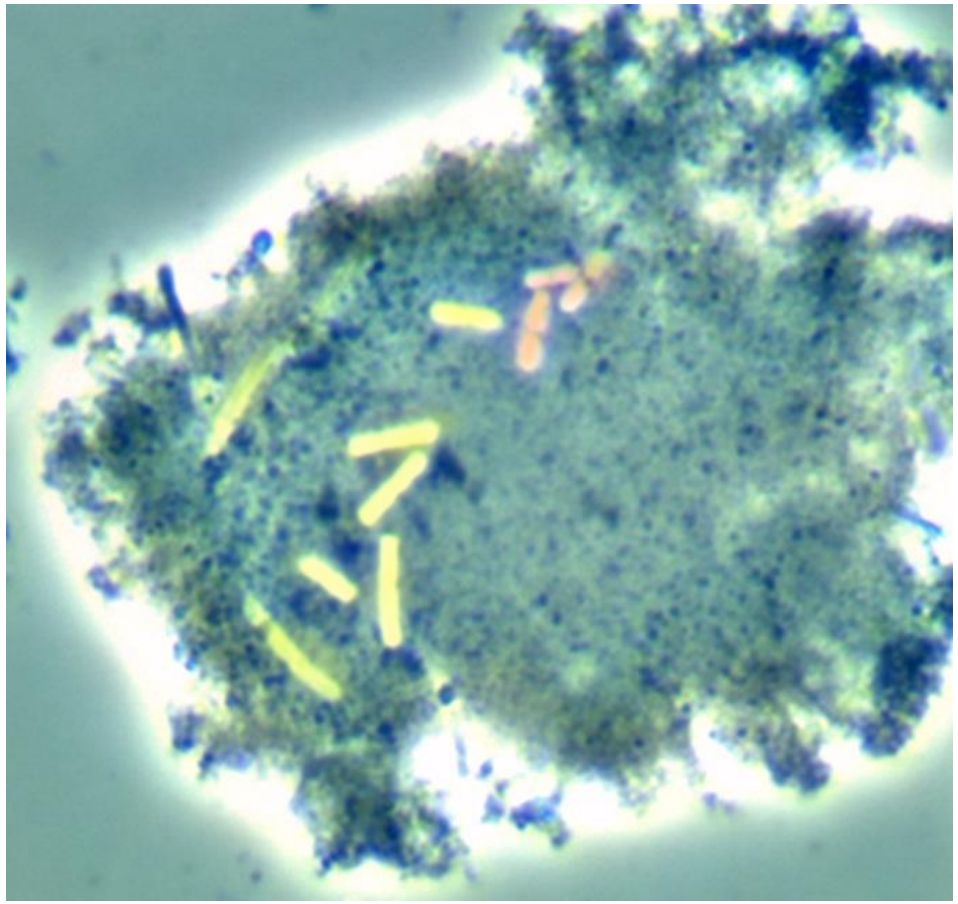
How LAB can cooperate to improve soy juice fermentation?

Stéphanie-Marie Deutsch, Olivier Harlé, Jérôme Niay, Florence Valence, Sandrine Parayre, Julie Aubert, Marie-Bernadette Maillard, Gwenaele Henry, Anne Thierry, Eric Guédon, et al.



How LAB can cooperate to improve soy juice fermentation?

PLANT PROTEIN CONFERENCE 2020

OLIVIER HARLÉ

NIZO Plant Protein Functionality Conference
Online – Live and On-demand • 21–22 October 2020

Soy juice is an interesting alternative to animal milk

$$\frac{\text{Plant-based proteins}}{\text{(Plant + animal) based proteins}} = 50\ \% \rightarrow \text{Health}, \text{Ecology}$$

(Guéguen et al., 2016; Springmann et al., 2018)

Soy juice from [*Glycine max*]

OFF-FLAVORS

OLIGOSACCHARIDES

(Davin and Berot, 1996; Guillon and Champ, 2002)

The lactic fermentation of soy juice

Lactic fermentation

An organic Soy Juice (SJ) :
- Sugars 8 g/L
- Proteins 36 g/L
- Lipids 19 g/L

A yogurt type fermented SJ :
- Lactic acid 4 g/L
- Sugars 4 g/L
- Proteins 36 g/L
- Lipids 19 g/L

Lactic fermentation can improve food quality

→ Lactic fermentation can improve organoleptic and nutritional properties of soy juice

OFF-FLAVORS

OLIGOSACCHARIDES

HEDONIC-FLAVORS

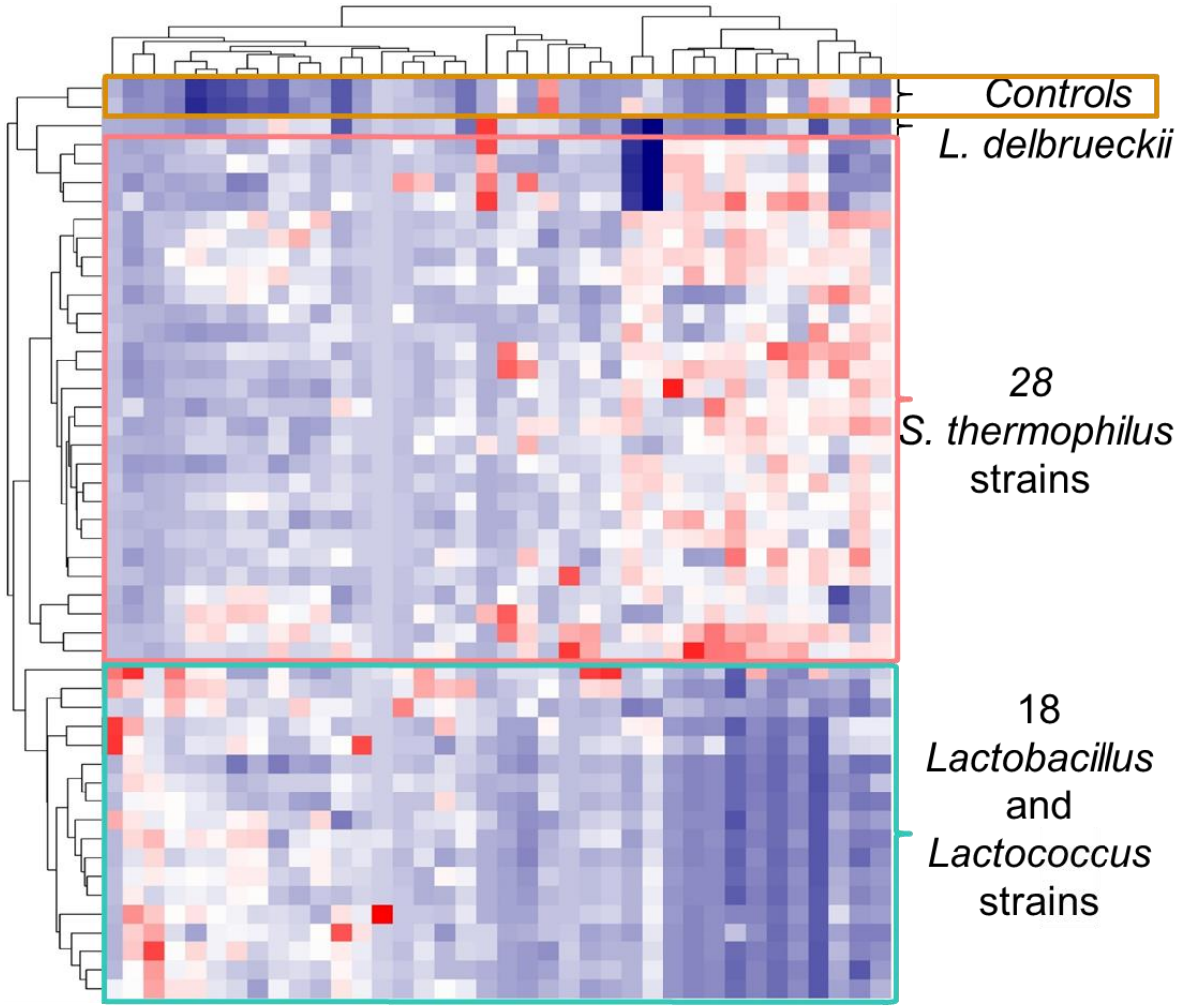
BUT

LAB are diverse

LAB are diverse

In soy juice fermentation, LAB can induce diverse profiles of:

- Sugars
- Organic acids
- Aroma compounds
- Amino Acids
- Vitamins
- Cofactors
- Redox potential modulation (Eh)

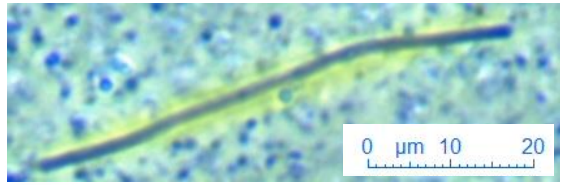


38 aroma compounds identified (Harlé et al, 2020)

LAB good fitness makes good fermentations

Lactiplantibacillus plantarum CIRM-BIA777 (*Lp777*) releases few AAs but is not stressed in SJ fermentation

Lactobacillus delbrueckii CIRM-BIA865 (*Ld865*) releases various AAs and is stressed in SJ fermentation (cell elongation)



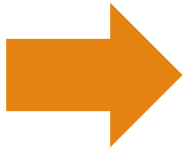
LAB coculture are interesting to ferment soy juice

There can be :

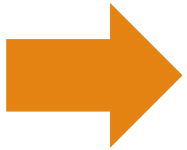
Metabolic complementarities (Sieuwerts et al, 2008)

+

Positive interactions (Sieuwerts et al, 2016)



Improve organoleptic properties



Increase fermentation rate

Lp777 and *Ld865* increased acidification rate in coculture

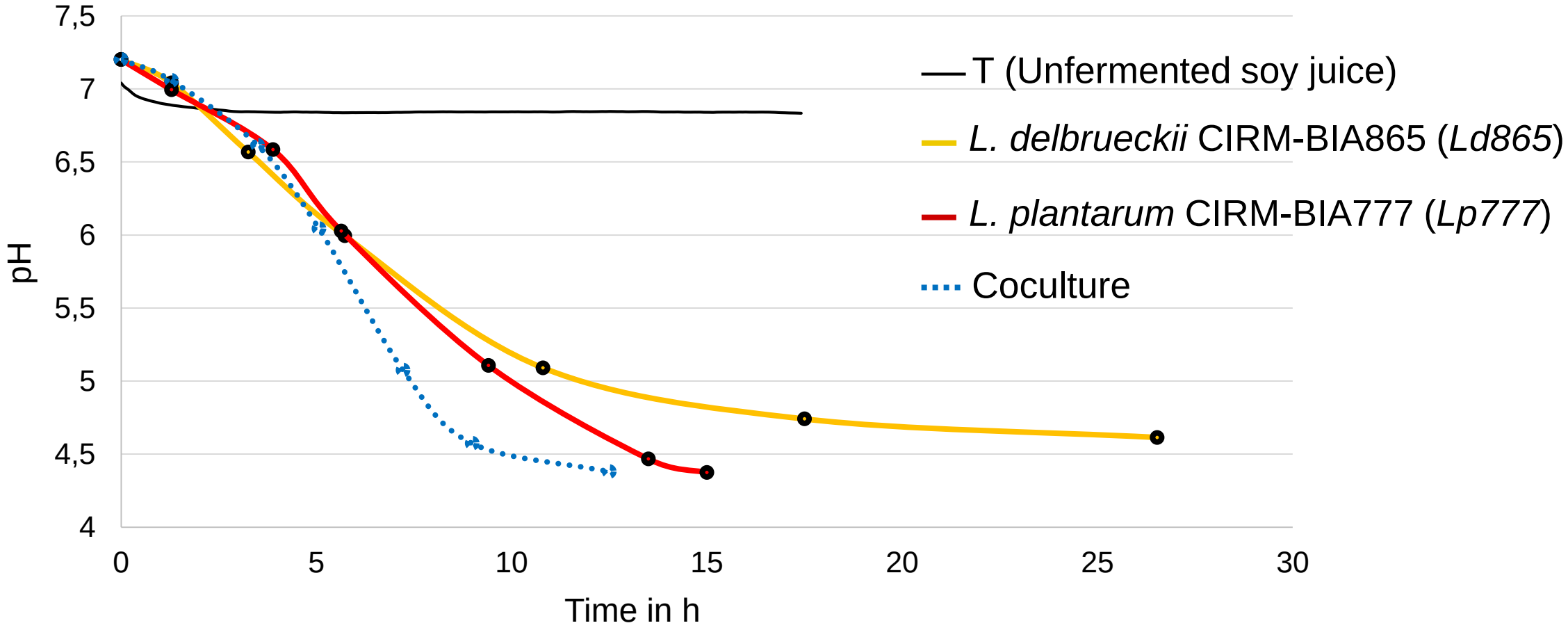
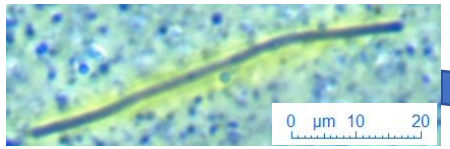


Figure 1. Fermentation kinetics of *Lp777* and *Ld865* in mono- and cocultures in SJ.

Ld865 was less stressed in coculture compared to monoculture

Ld865 in SJ monoculture

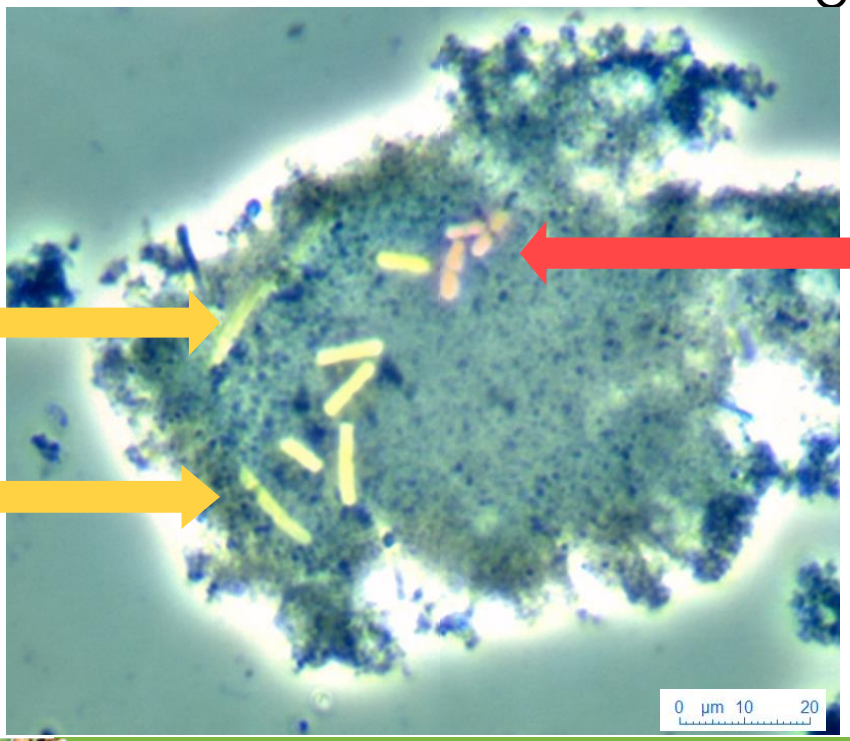


SJ Coculture

Lp777 in SJ monoculture

Lactobacillus delbrueckii CIRM-BIA*865*

Lactiplantibacillus plantarum CIRM-BIA*777*



Ld865 cell division was stimulated in coculture compared to monoculture

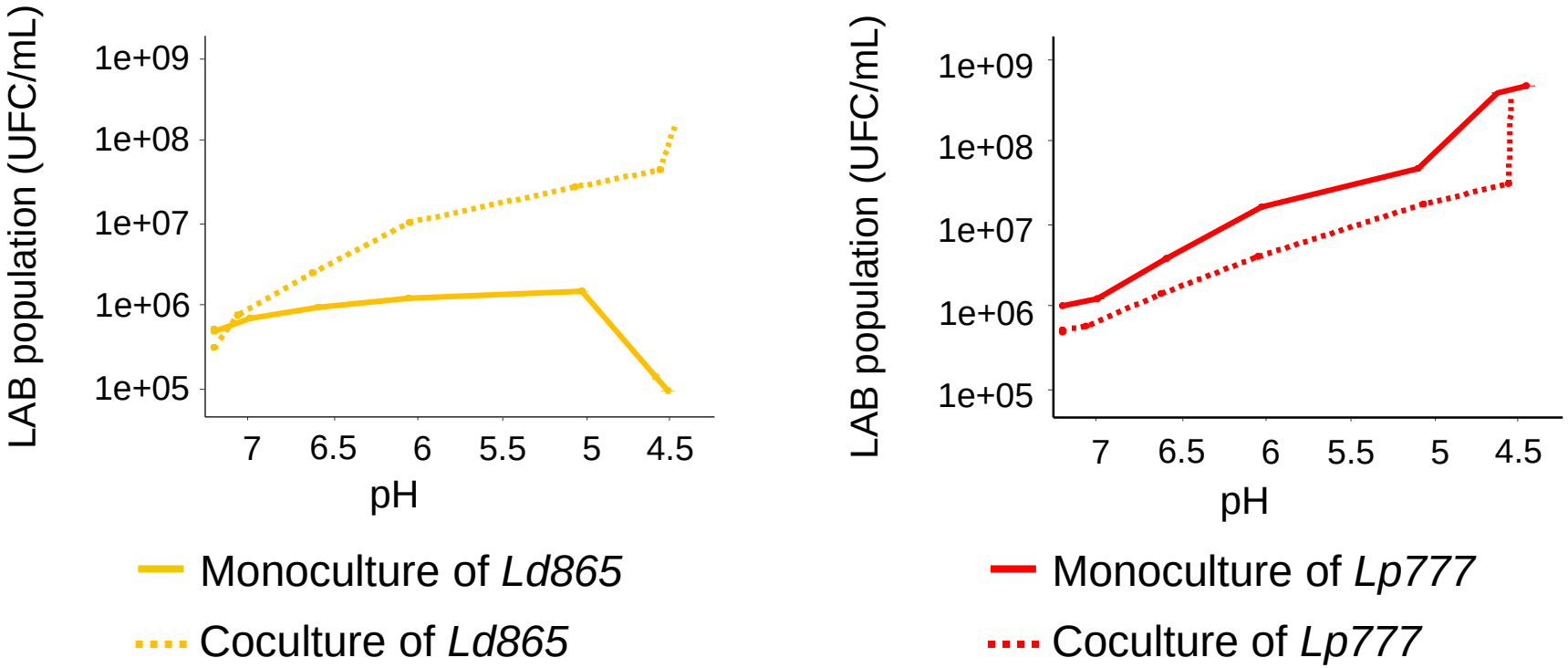
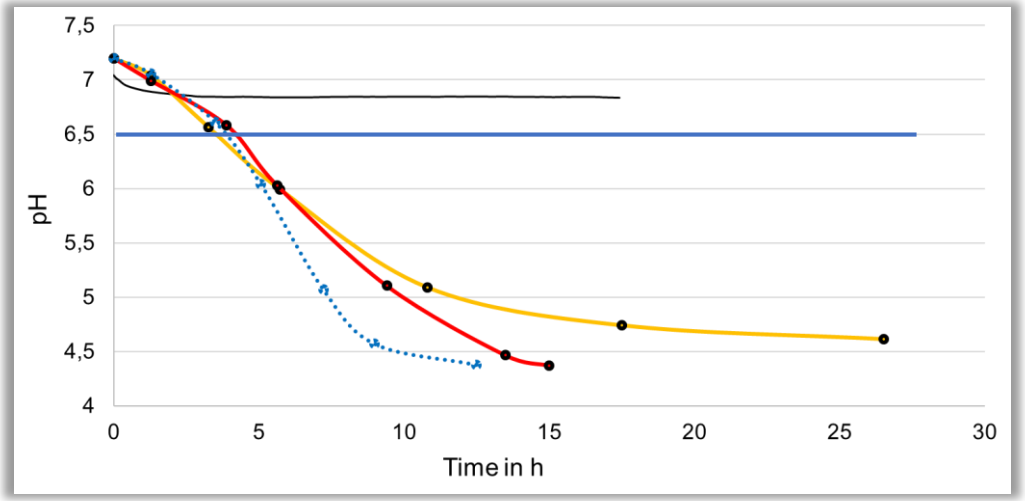
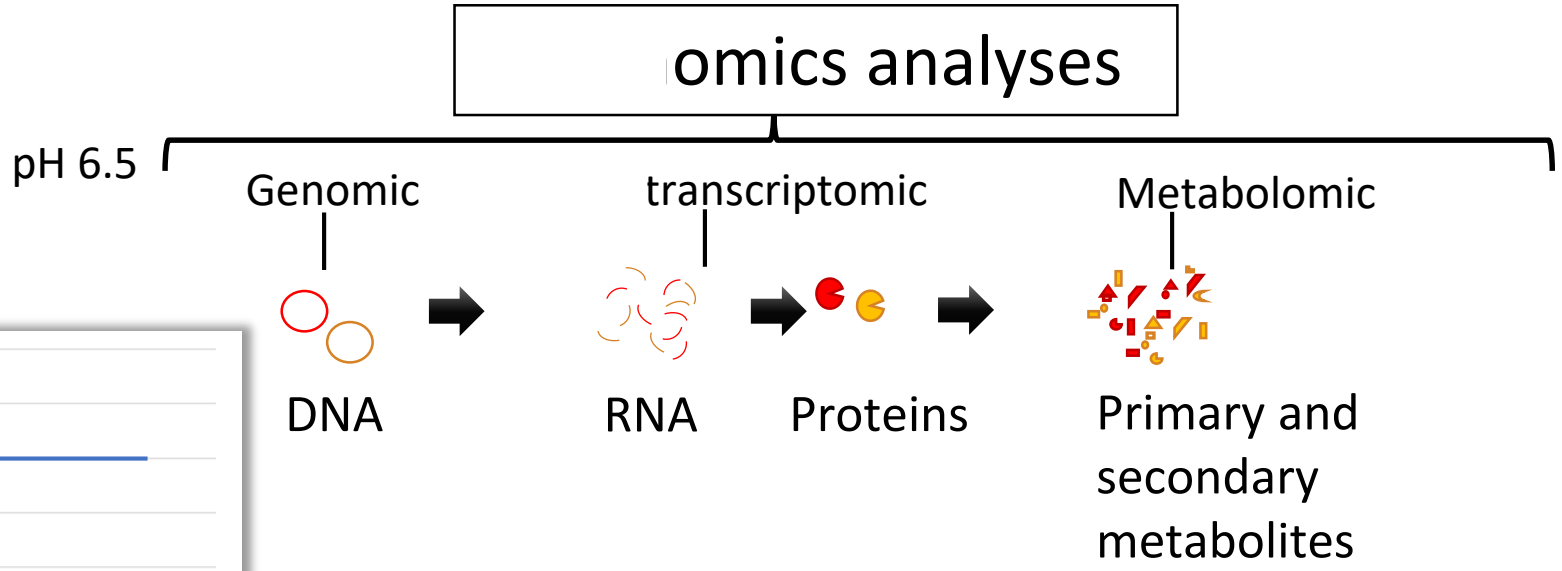


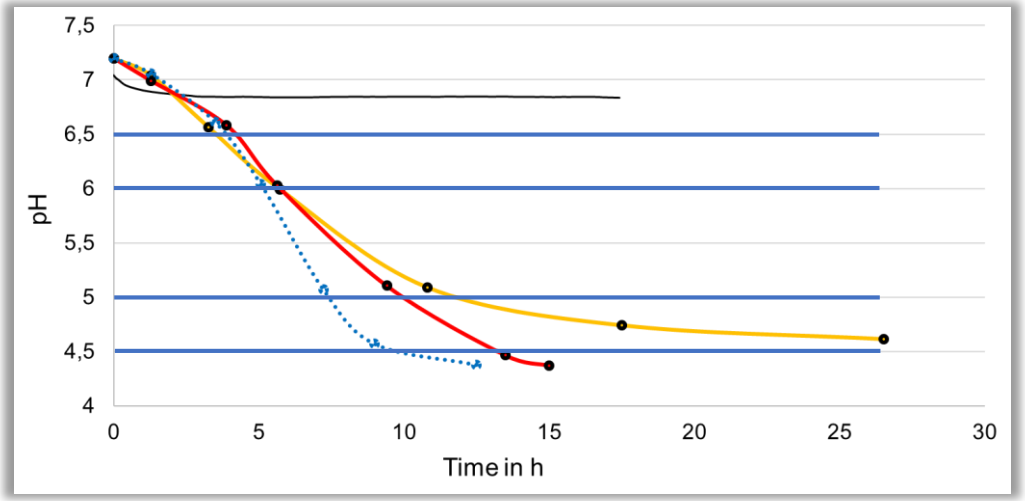
Figure 2. Growth of *Ld865* and *Lp777* performed in monoculture and in coculture in SJ fermentation at 37°C

Molecular bases of *Lp777* and *Ld865* cooperation were investigated





Molecular bases of *Lp777* and *Ld865* cooperation were investigated



(analysis of the kinetic of fermentation)

pH 4.5
pH 5.0
pH 6.0
pH 6.5

Metaomics analyses

Genomic

Dual transcriptomic

Metabolomic

Interactions

Interactions

Process

Product

Interactions

DNA

RNA

Proteins

Primary and secondary metabolites

In coculture, fermentation rate increased compared to monoculture

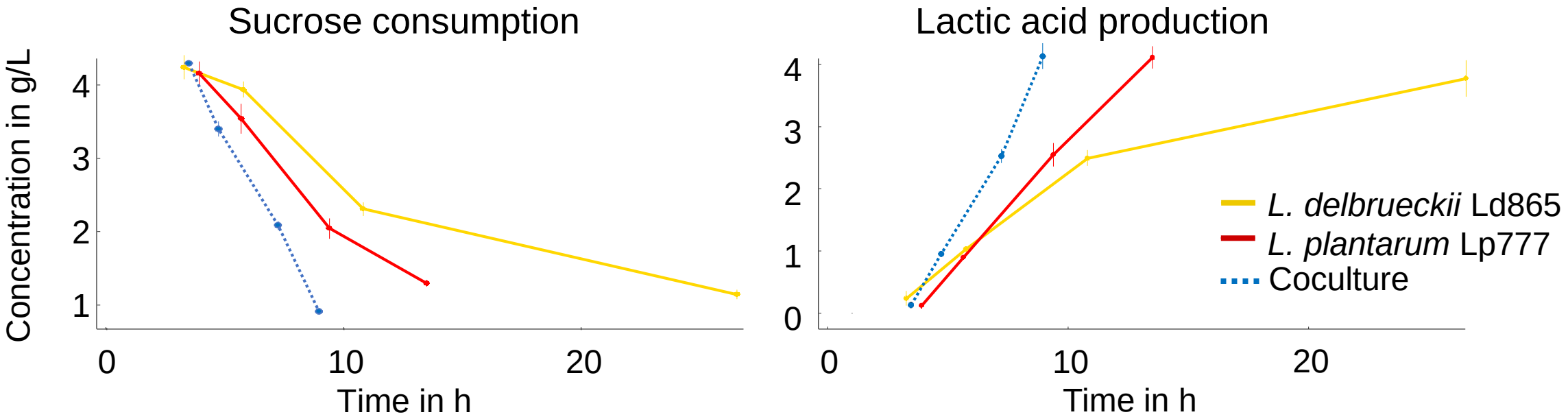
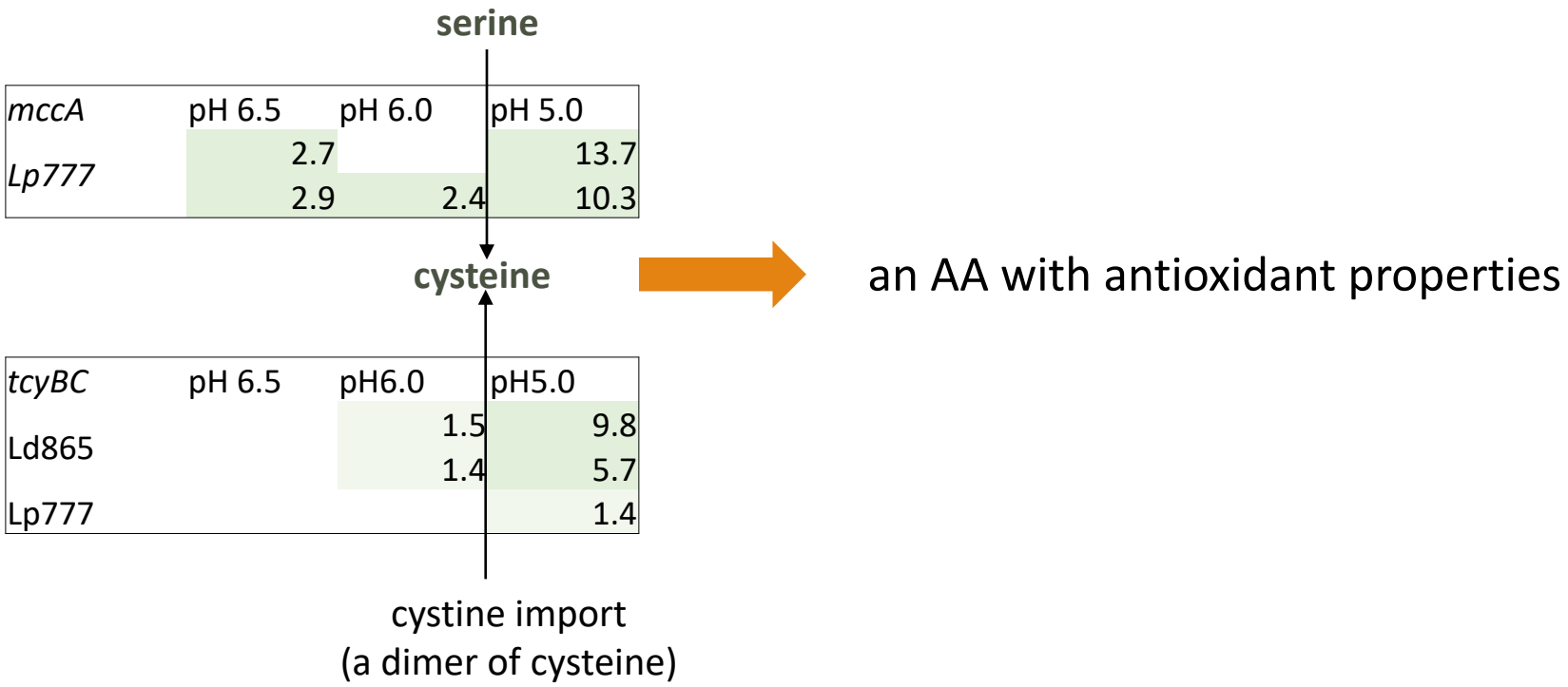
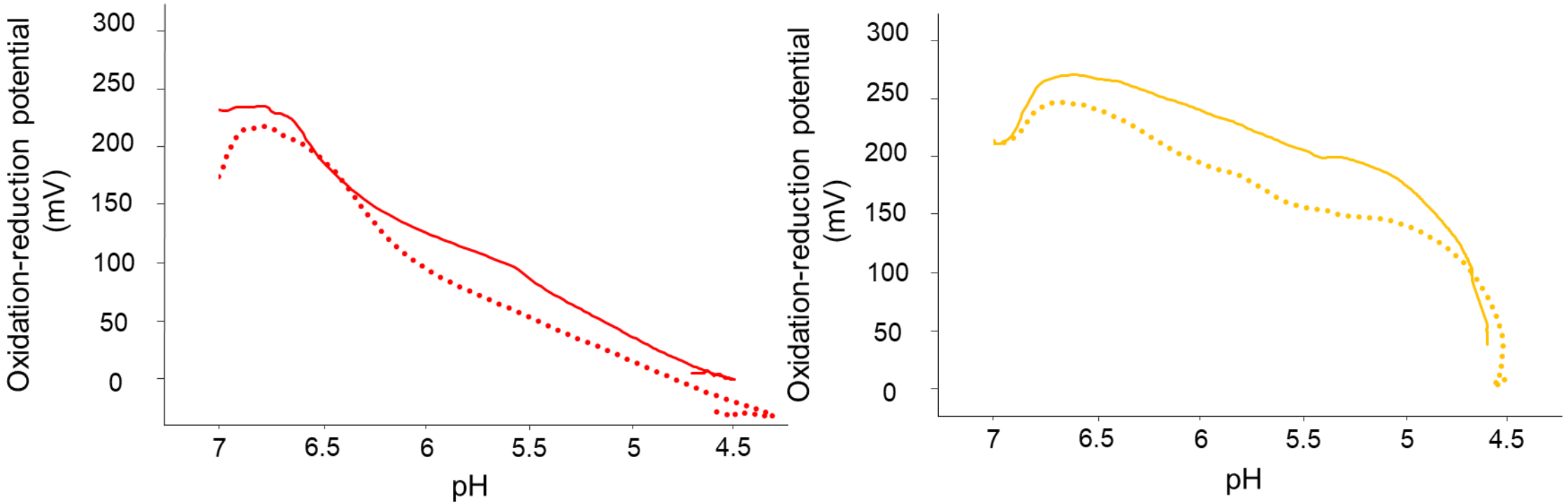


Figure 3. Sucrose consumption and lactic acid production of *Lp777* and *Ld865* in mono- and coculture in soy juice fermentation at 37°C.

In coculture, cysteine synthesis & transport were upregulated



Cystine addition in SJ decreased oxidation-reduction potential



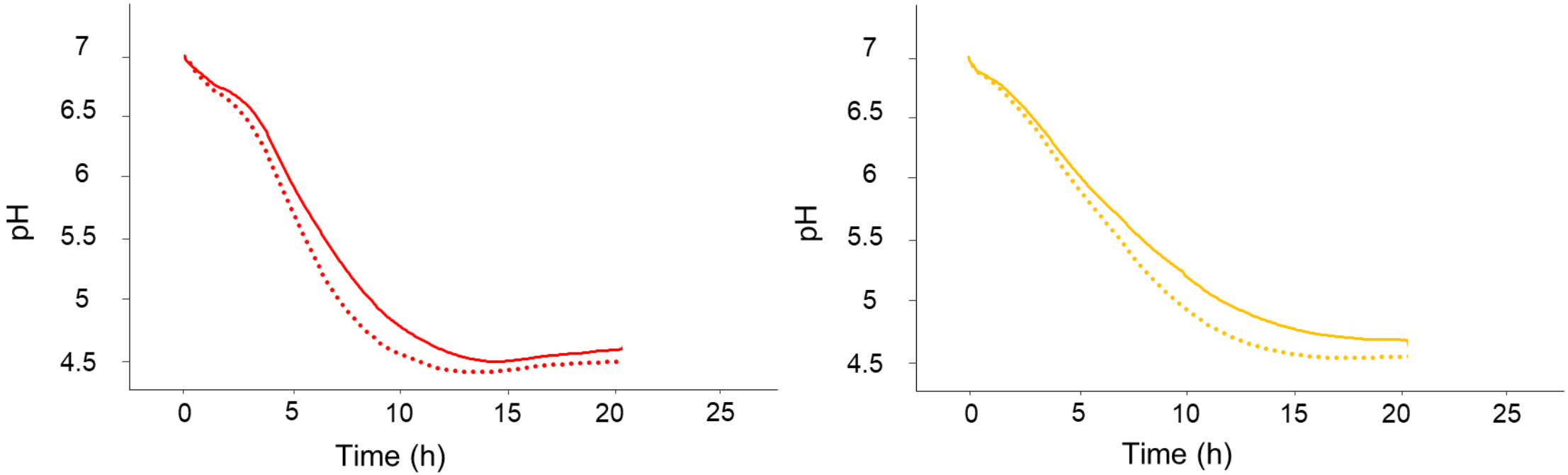
Lp777 monoculture in SJ without addition

monoculture in SJ with 100mg/L of cystine

Ld865 monoculture in SJ without addition

Figure 4. Oxidation reduction potential kinetics of soy juice at 37°C by *Lp777* or *Ld865* monocultures with or without addition of 100 mg/L of cystine.

Cystine addition in SJ increased acidification rate



Lp777 monoculture in SJ without addition

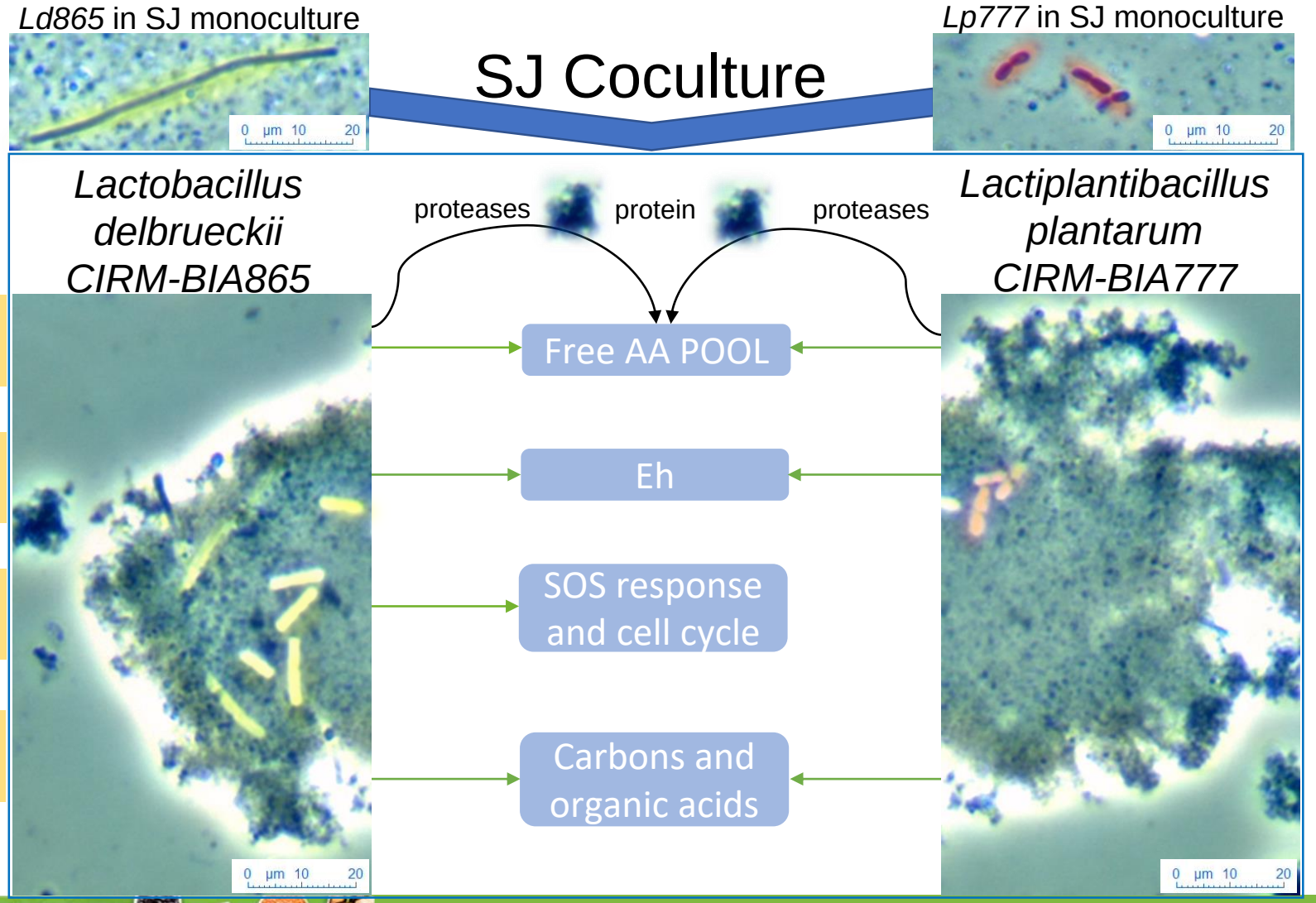
monoculture in SJ with 100mg/L of cystine

Ld865 monoculture in SJ without addition

Figure 5. Acidification kinetics of soy juice at 37°C by *Lp777* or *Ld865* monocultures with or without addition of 100 mg/L of cystine.

Conclusion: Molecular bases present various metabolic complementarities

- Amino acids Cross-feeding
- Antioxidant cooperation
- *Ld865* growth and cell division is stimulated
- Higher fermentation rate



Conclusion

Genomics + Dual transcriptomics + Metabolomics

Different points of views

Better comprehension

Better control of the process

Thanks for listening

And many thanks to…

Hélène FALENTIN

Stéphanie-Marie DEUTSCH

Anne THIERRY

Éric GUÉDON

Jérôme NIAY

Gwenaëlle HENRY

Sandrine PARAYRE

Marie-Bernadette MAILLARD

Florence VALENCE-BERTEL

Triballat-Noyal R&D UF TEAM

Bibliography

Davin, A., Berot, S., 1996. Technologie de préparation de produits enrichis en protéines végétales destinés aux consommateurs. Protéines Végétales 389–390.

Guéguen, J., Walrand, S., Bourgeois, O., 2016. Les protéines végétales : contexte et potentiels en alimentation humaine. Cahiers de Nutrition et de Diététique 51, 177–185. https://doi.org/10.1016/j.cnd.2016.02.001

Guillon, F., Champ, M.M.-J., 2002. Carbohydrate fractions of legumes: uses in human nutrition and potential for health. Br J Nutr 88, 293–306. https://doi.org/10.1079/BJN2002720

Harlé, O., Falentin, H., Niay, J., Valence, F., Courselaud, C., Chuat, V., Maillard, M.-B., Guédon, É., Deutsch, S.-M., Thierry, A., 2020. Diversity of the metabolic profiles of a broad range of lactic acid bacteria in soy juice fermentation. Food Microbiology 103410. https://doi.org/10.1016/j.fm.2019.103410

Seefeldt, K., Weimer, B.C., 2000. Diversity of sulfur compound production in lactic acid bacteria. Journal of dairy science 83, 2740–2746.

Sieuwerts, S., 2016. Microbial Interactions in the Yoghurt Consortium: Current Status and Product Implications. SOJMID 4, 01–05. https://doi.org/10.15226/sojmid/4/2/00150

Sieuwerts, S., Bok, F.A.M. de, Hugenholtz, J., Vlieg, J.E.T. van H., 2008. Unraveling Microbial Interactions in Food Fermentations: from Classical to Genomics Approaches. Appl. Environ. Microbiol. 74, 4997–5007. https://doi.org/10.1128/AEM.00113-08

Springmann, M., Clark, M., Mason-D'Croz, D., Wiebe, K., Bodirsky, B.L., Lassaletta, L., Vries, W. de, Vermeulen, S.J., Herrero, M., Carlson, K.M., Jonell, M., Troell, M., DeClerck, F., Gordon, L.J., Zurayk, R., Scarborough, P., Rayner, M., Loken, B., Fanzo, J., Godfray, H.C.J., Tilman, D., Rockström, J., Willett, W., 2018. Options for keeping the food system within environmental limits. Nature 562, 519. https://doi.org/10.1038/s41586-018-0594-0