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How LAB can cooperate to improve soy juice fermentation?

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UNIVERSITE ECOLOGIE BRETAGNE GEOSCIENCES LOIRE AGRONOMIE ALIMENTATION

Triballat NOYAL

ANRT ASSOCIATION NATIONALE RECHERCHE TECHNOLOGIE

INRAE la science pour la vie, l'humain, la terre

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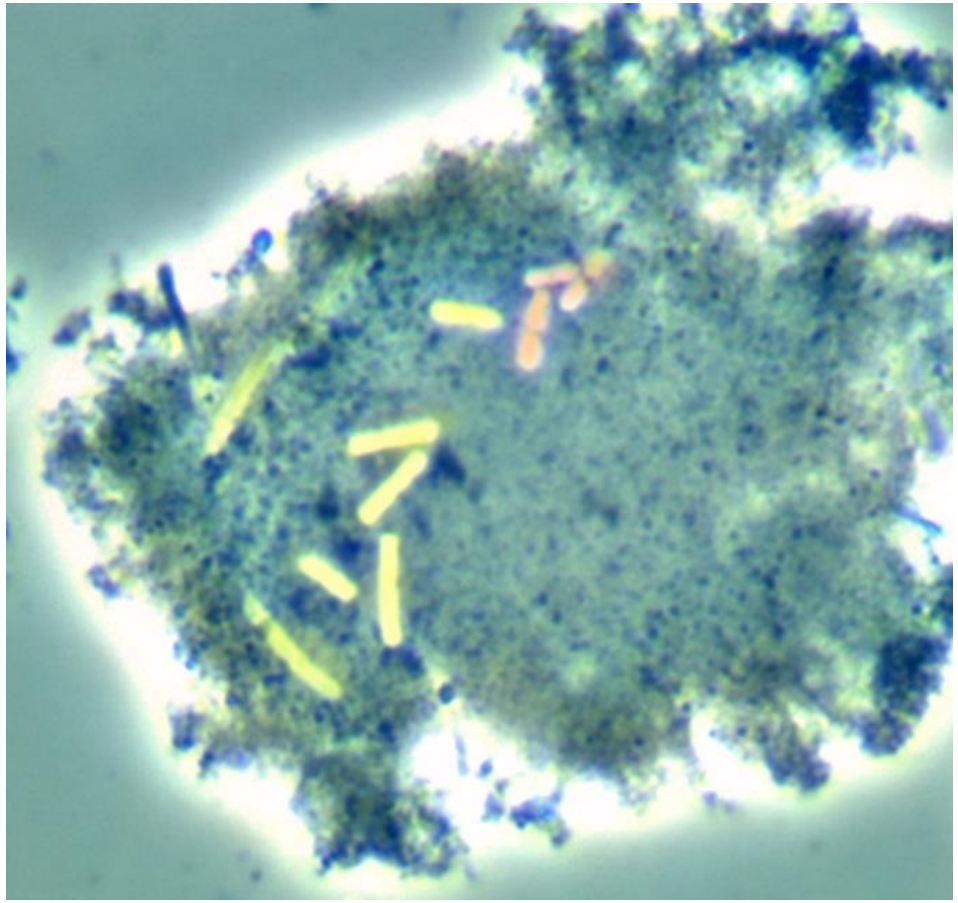


How LAB can cooperate to improve soy juice fermentation?

PLANT PROTEIN CONFERENCE 2020

OLIVIER HARLÉ

Soy juice is an interesting alternative to animal milk

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

→ Health

→ 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

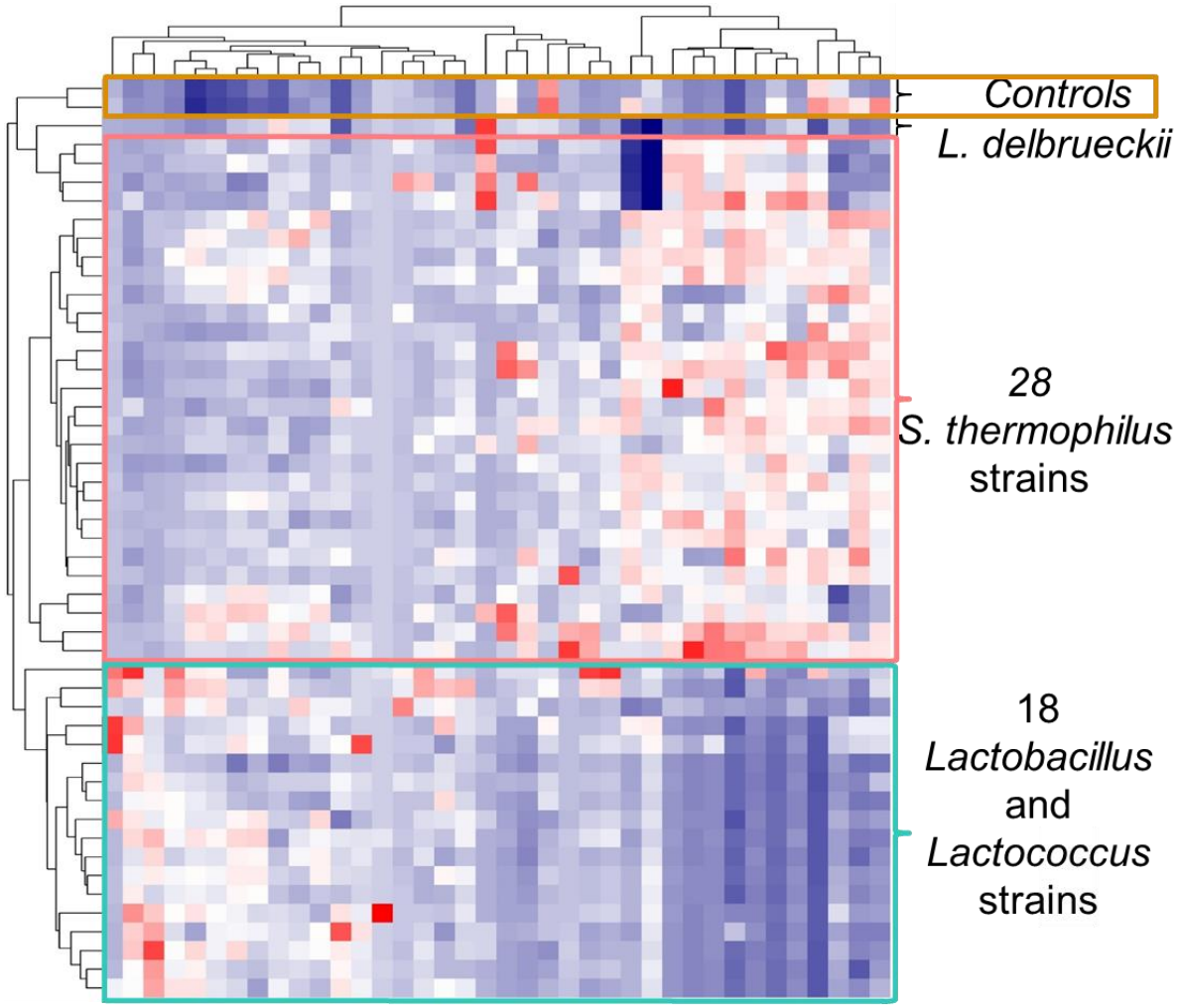
BUT

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)

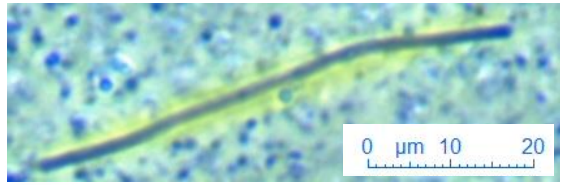


38 aroma compounds identified (Harlé et al, 2020)

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) → Improve organoleptic properties

+

Positive interactions (Sieuwerts et al, 2016) → Increase fermentation rate

Lp777 and *Ld865* increased acidification rate in coculture

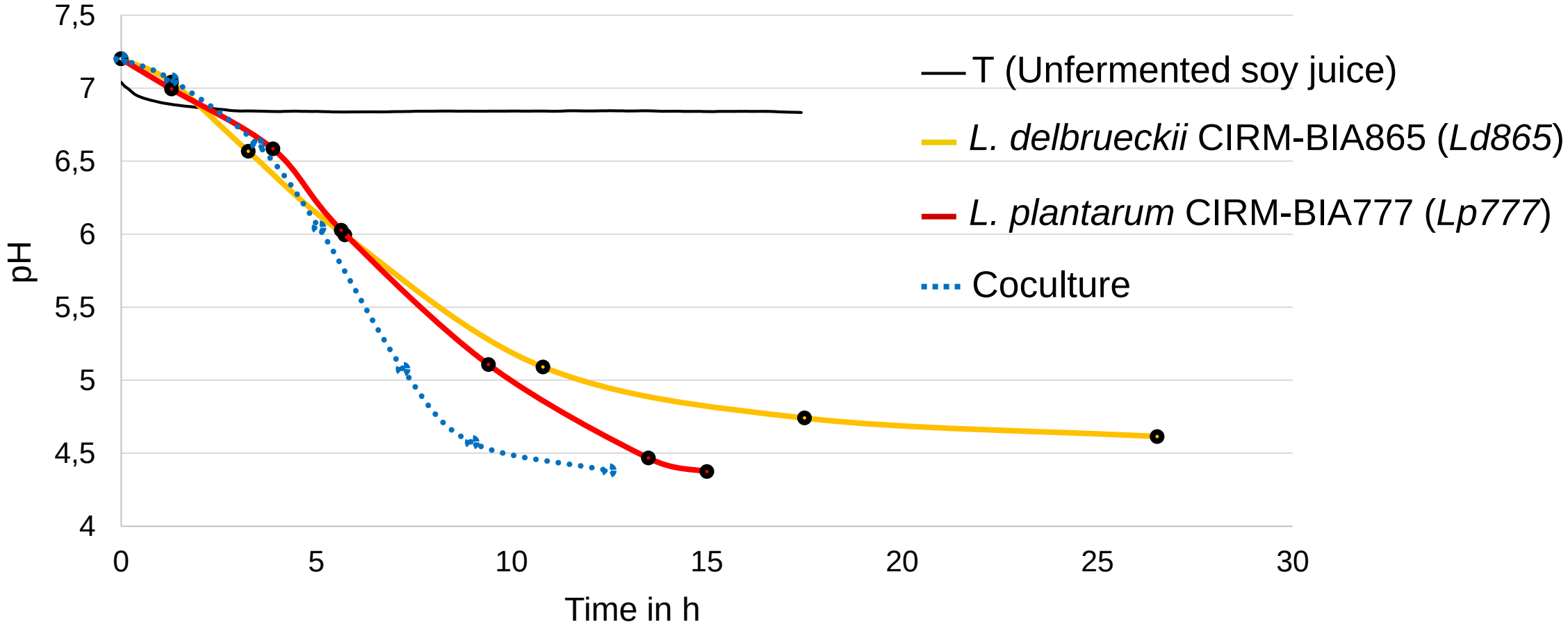
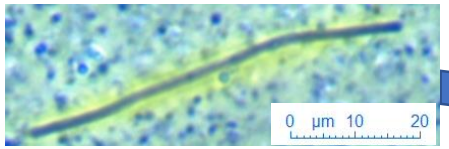


Figure 1. Fermentation kinetics of *Lp777* and *Ld865* in mono- and cocultures in SJ.

Ld865 was less stressed in coculture compared to monoculture

Ld865 in SJ monoculture

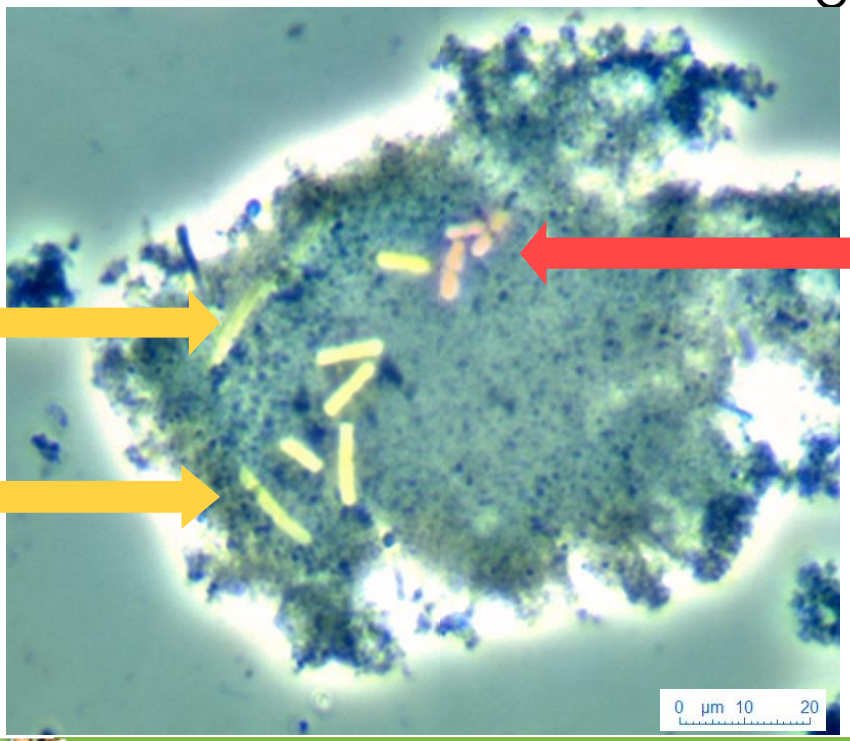


SJ Coculture

Lp777 in SJ monoculture

Lactobacillus delbrueckii CIRM-BIA*865*

Lactiplantibacillus plantarum CIRM-BIA*777*



Ld865 cell division was stimulated in coculture compared to monoculture

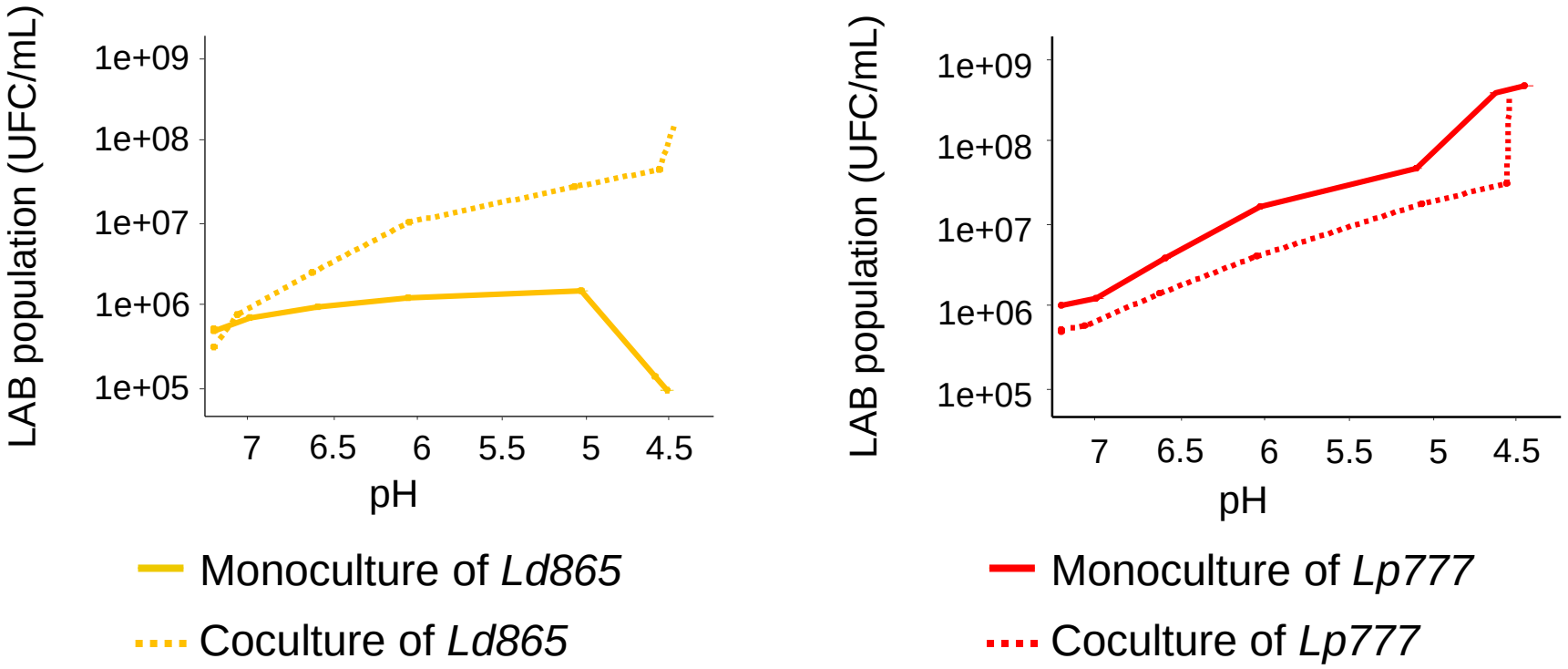
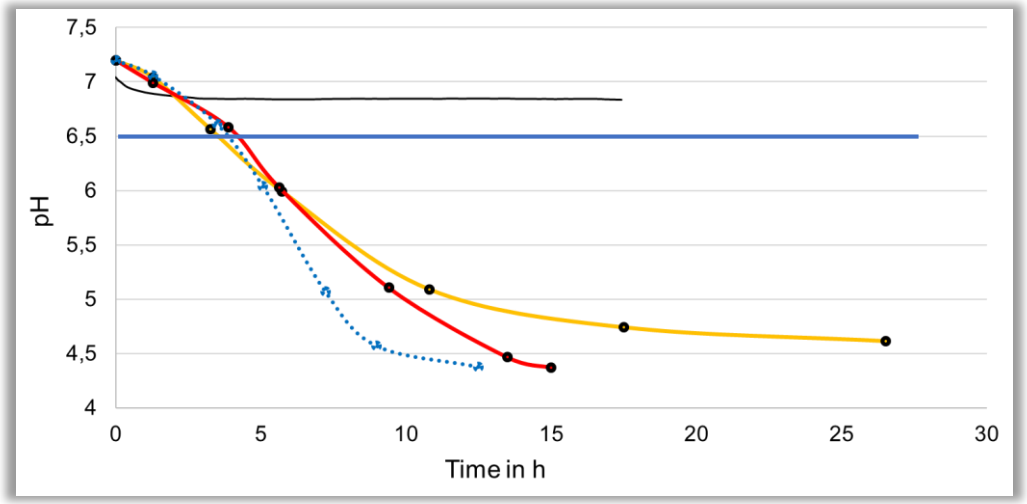
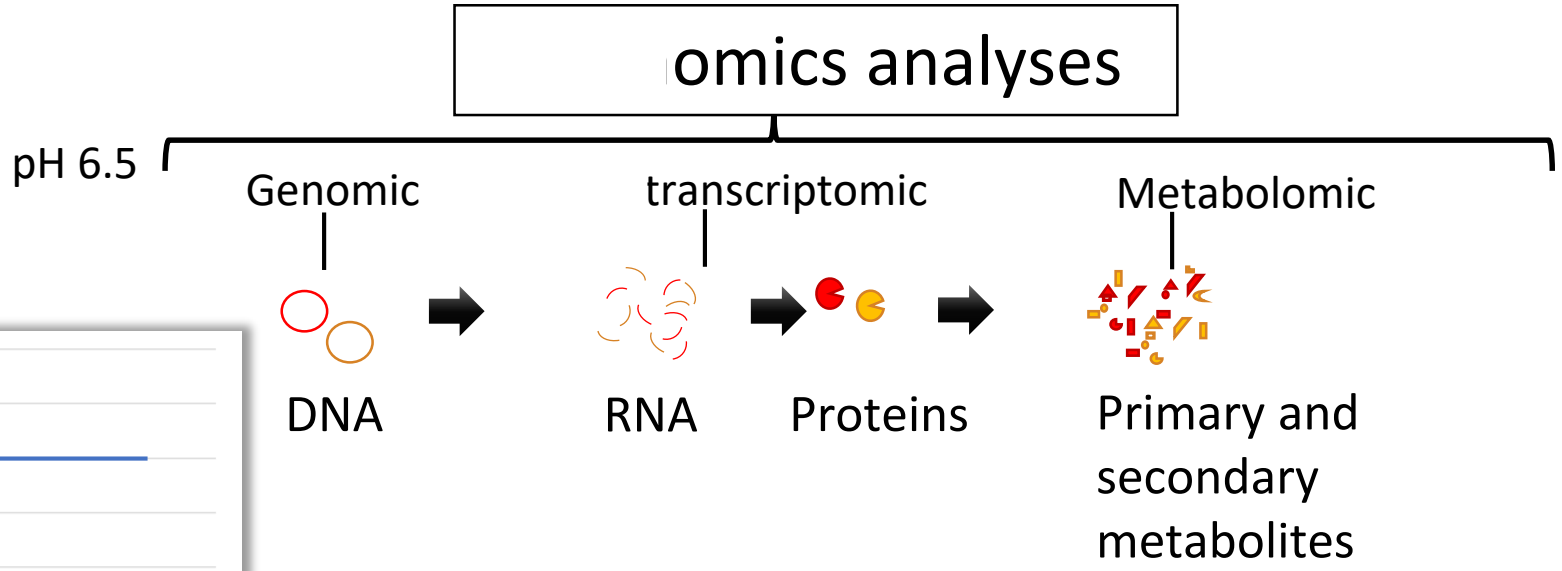


Figure 2. Growth of *Ld865* and *Lp777* performed in monoculture and in coculture in SJ fermentation at 37°C

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





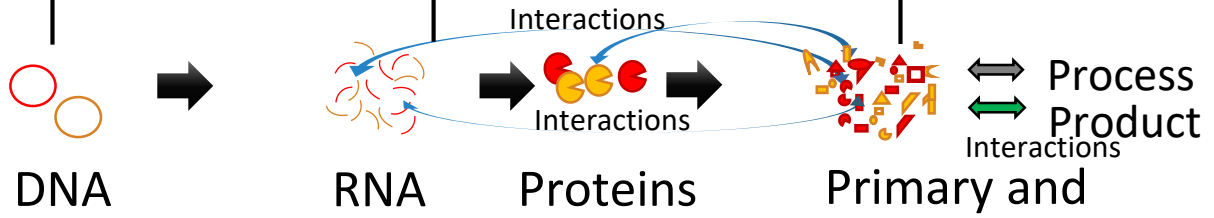
Molecular bases of *Lp777* and *Ld865* cooperation were investigated

(analysis of the kinetic of fermentation)

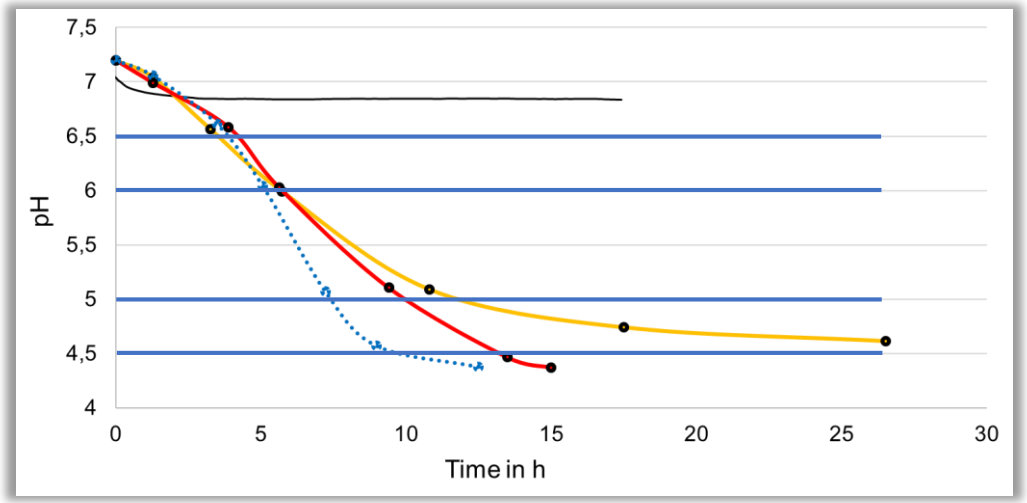
pH 4.5
pH 5.0
pH 6.0
pH 6.5

Metaomics analyses

Genomic | Dual transcriptomic | Metabolomic



DNA → RNA → Proteins → Primary and secondary metabolites



In coculture, fermentation rate increased compared to monoculture

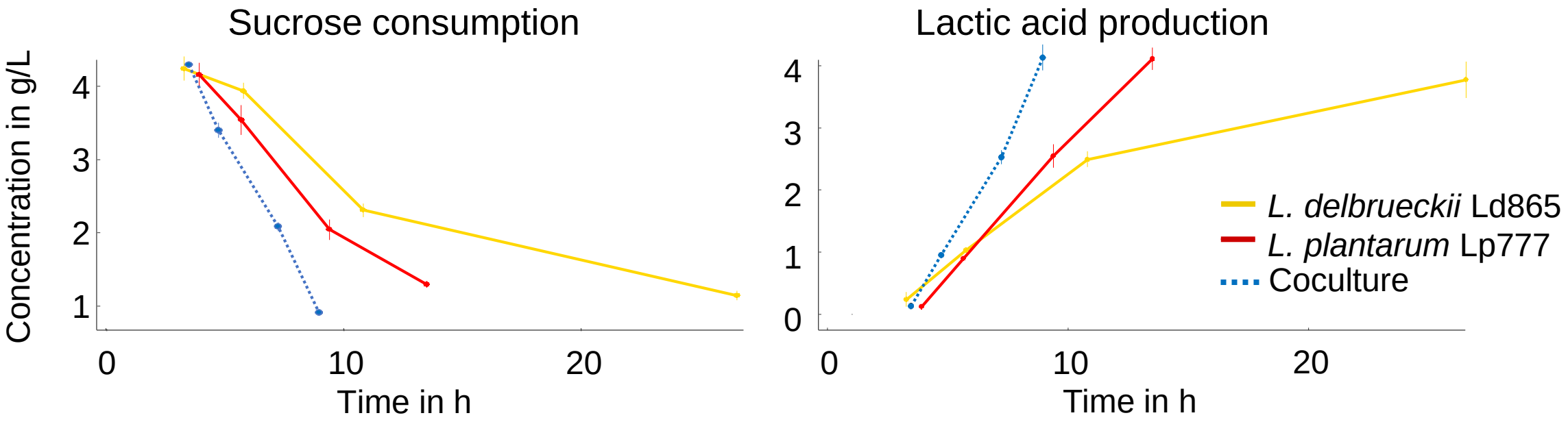


Figure 3. Sucrose consumption and lactic acid production of *Lp777* and *Ld865* in mono- and coculture in soy juice fermentation at 37°C.

In coculture, cysteine synthesis & transport were upregulated

serine

mccA	pH 6.5	pH 6.0	pH 5.0
Lp777	2.7		13.7
	2.9	2.4	10.3

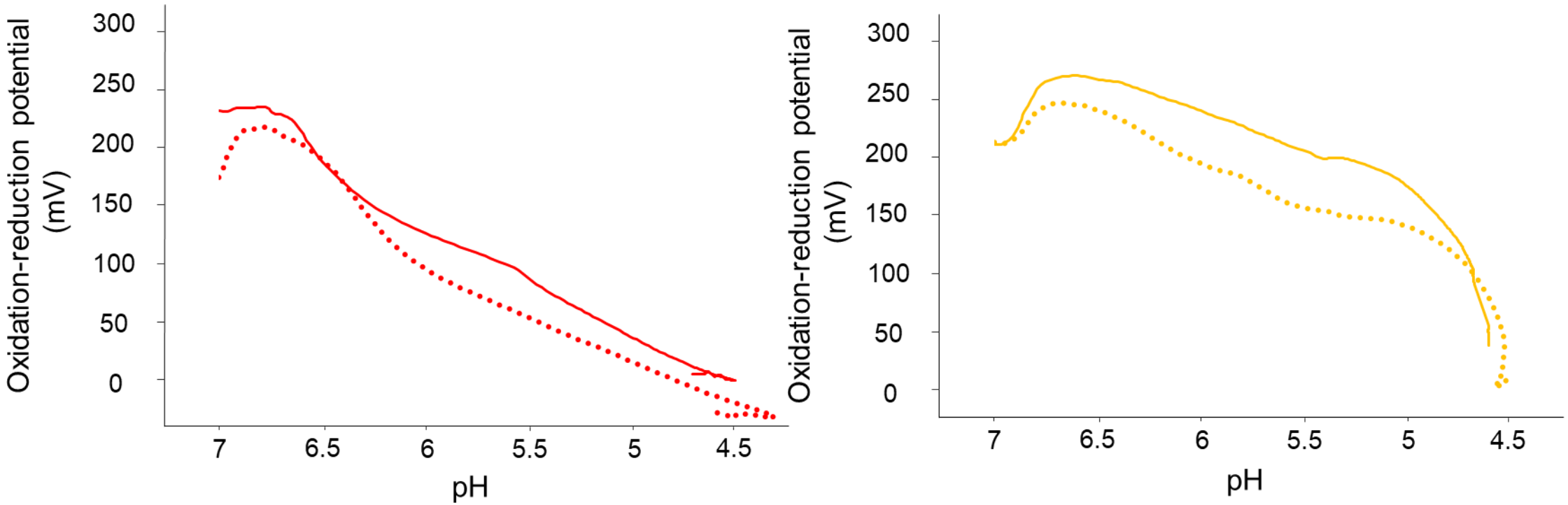
cysteine

tcyBC	pH 6.5	pH6.0	pH5.0
Ld865		1.5	9.8
		1.4	5.7
Lp777			1.4

cystine import
(a dimer of cysteine)

an AA with antioxidant properties

Cystine addition in SJ decreased oxidation-reduction potential



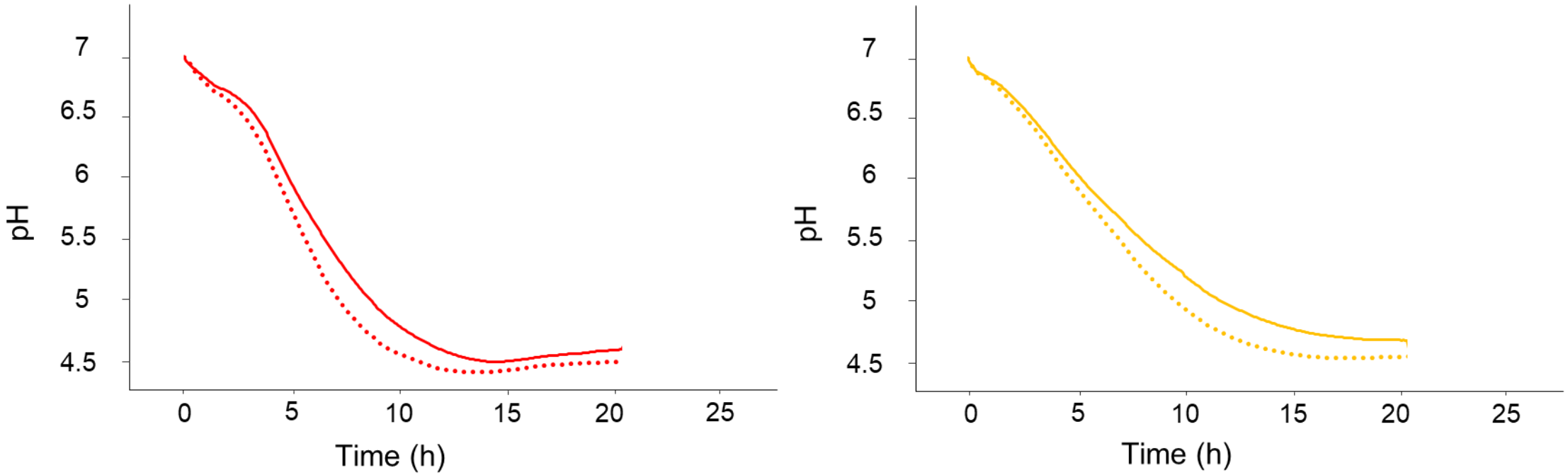
Lp777 monoculture in SJ without addition

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

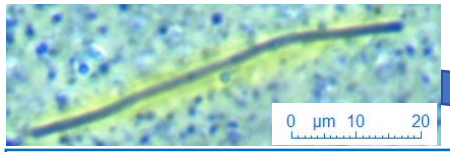
monoculture in SJ with 100mg/L of cystine

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

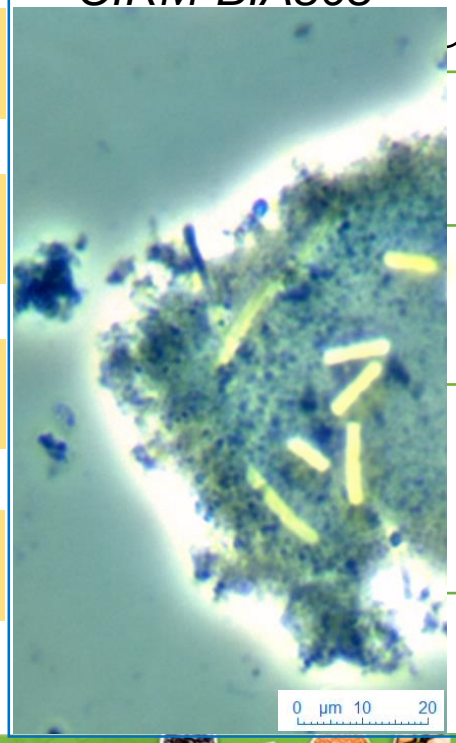
Ld865 in SJ monoculture



SJ Coculture

Lp777 in SJ monoculture

Lactobacillus delbrueckii CIRM-BIA865

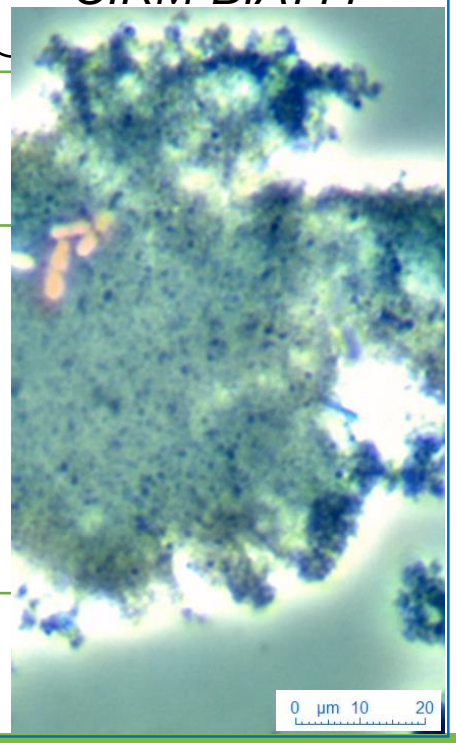


proteases

protein

proteases

Lactiplantibacillus plantarum CIRM-BIA777



Free AA POOL

Eh

SOS response and cell cycle

Carbons and organic acids

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

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