The Australian Wine Research Institute

Getting stuck into sub-optimal fermentations

Paul Chambers and Paul Henschke

Fermentation and winemaking

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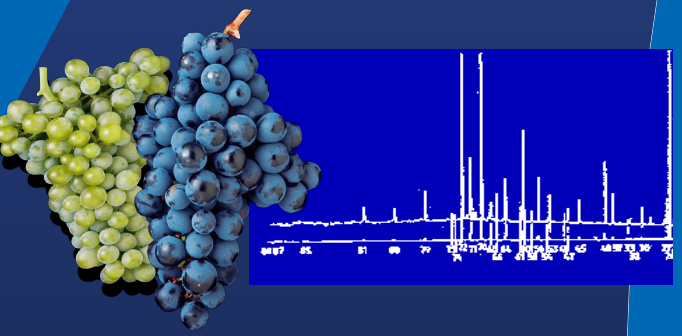

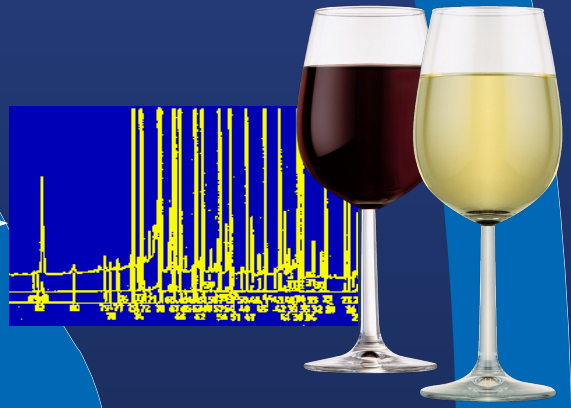

YEAST

The roles of yeast in fermentation

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FERMENTATION

Nutrients

Sugar N O_2 S P Vitamins/ Minerals

Flavour compounds and precursors

Ethanol + CO_2

Esters Alcohols Carbonyls Acids

H_2S Thiols

'Fermentation bouquet'

Varietal character

What the winemaker has control over

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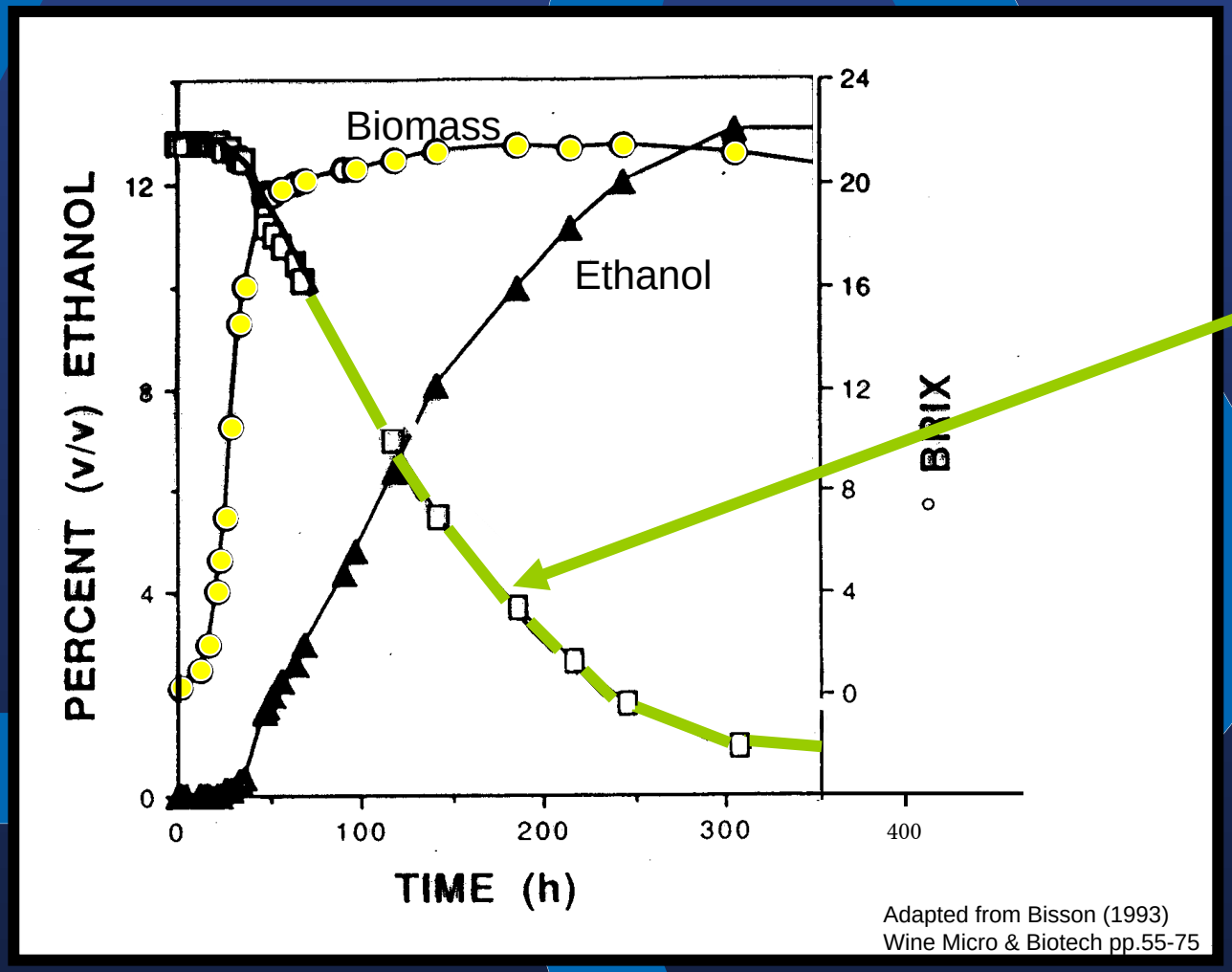
Equipment

Additives
nutrients

Fermentation
rate
temperature

Optimal fermentation profile



Adapted from Bisson (1993)
Wine Micro & Biotech pp.55-75

Fermentation kinetics

OPTIMAL

Fermentation is stressful for yeast

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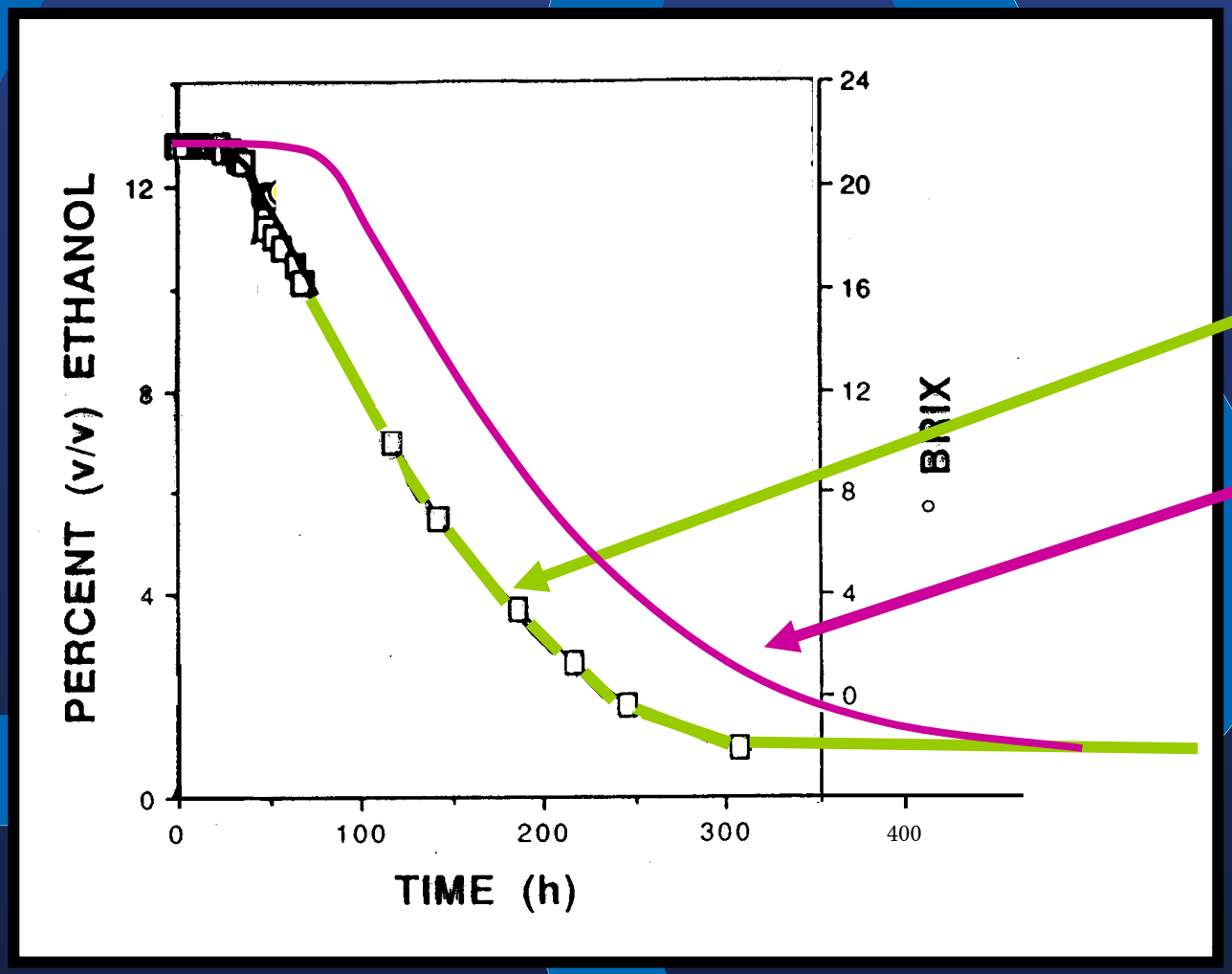
Factor	Grape juice	Wine
Sugar (g/L)	180 – 260	0 – 4
Alcohol (% v/v)	0	10 – 16
Nutrients:		
YAN (mg N/L)	50 – 300	<50
Oxygen (ppm)	0 – 9	0

Yeast must adapt to major stresses;

failure leads to sub-optimal fermentation

Sub-optimal fermentation profile

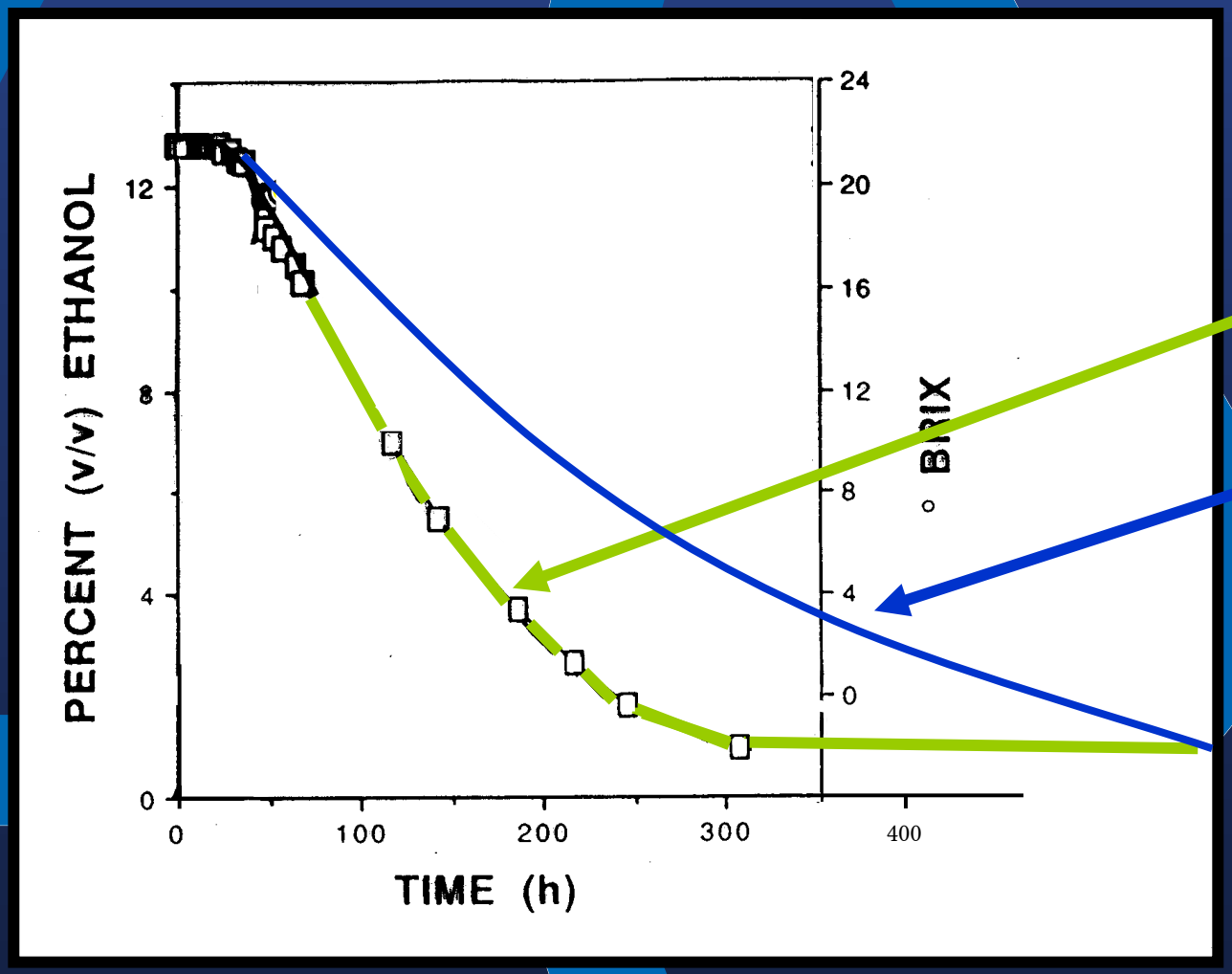


Fermentation kinetics

OPTIMAL

Delayed onset

Sub-optimal fermentation profile

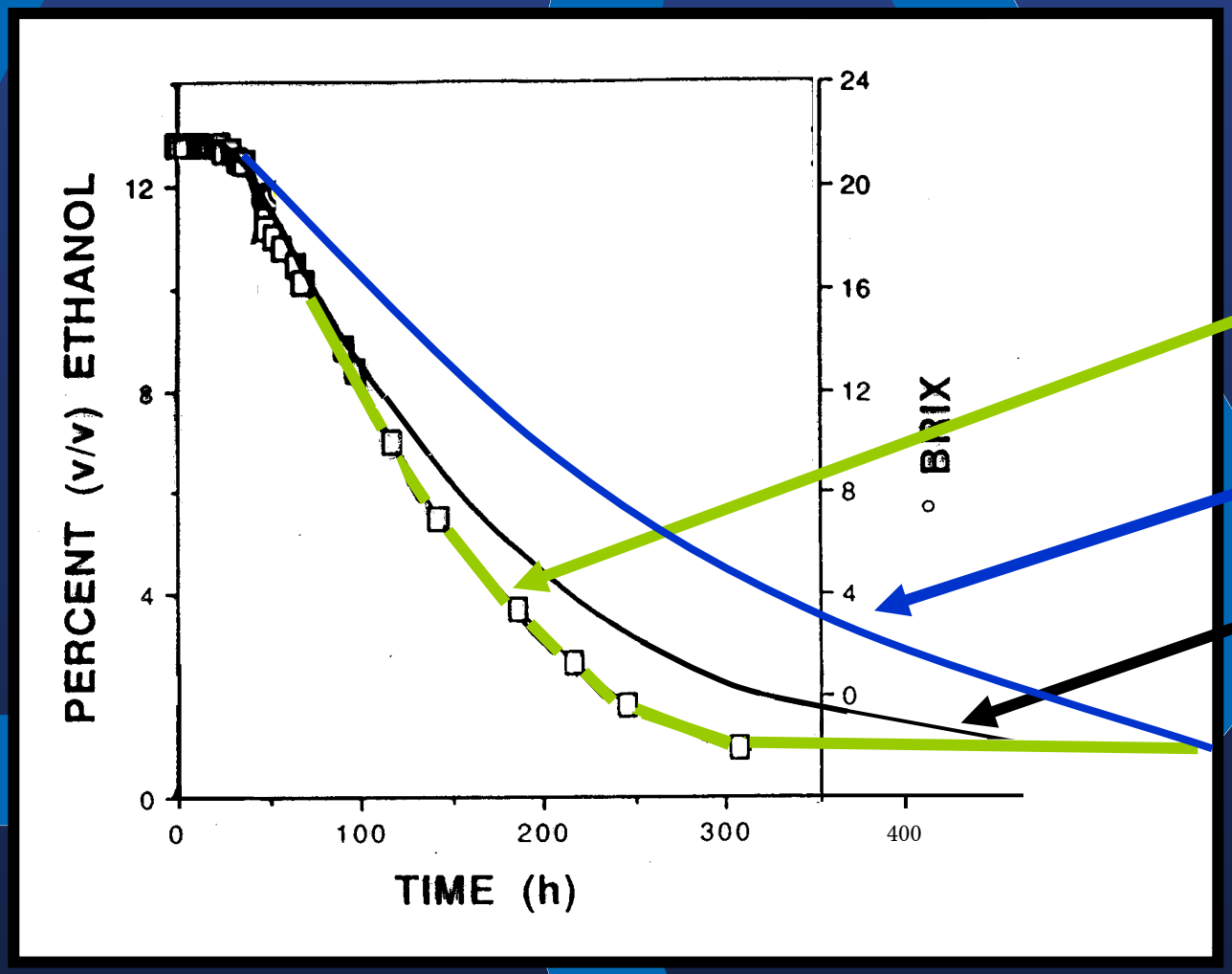


Fermentation kinetics

OPTIMAL

SLOW

Sub-optimal fermentation profiles



Fermentation kinetics

OPTIMAL

SLOW

SLUGGISH

Sub-optimal fermentation profiles

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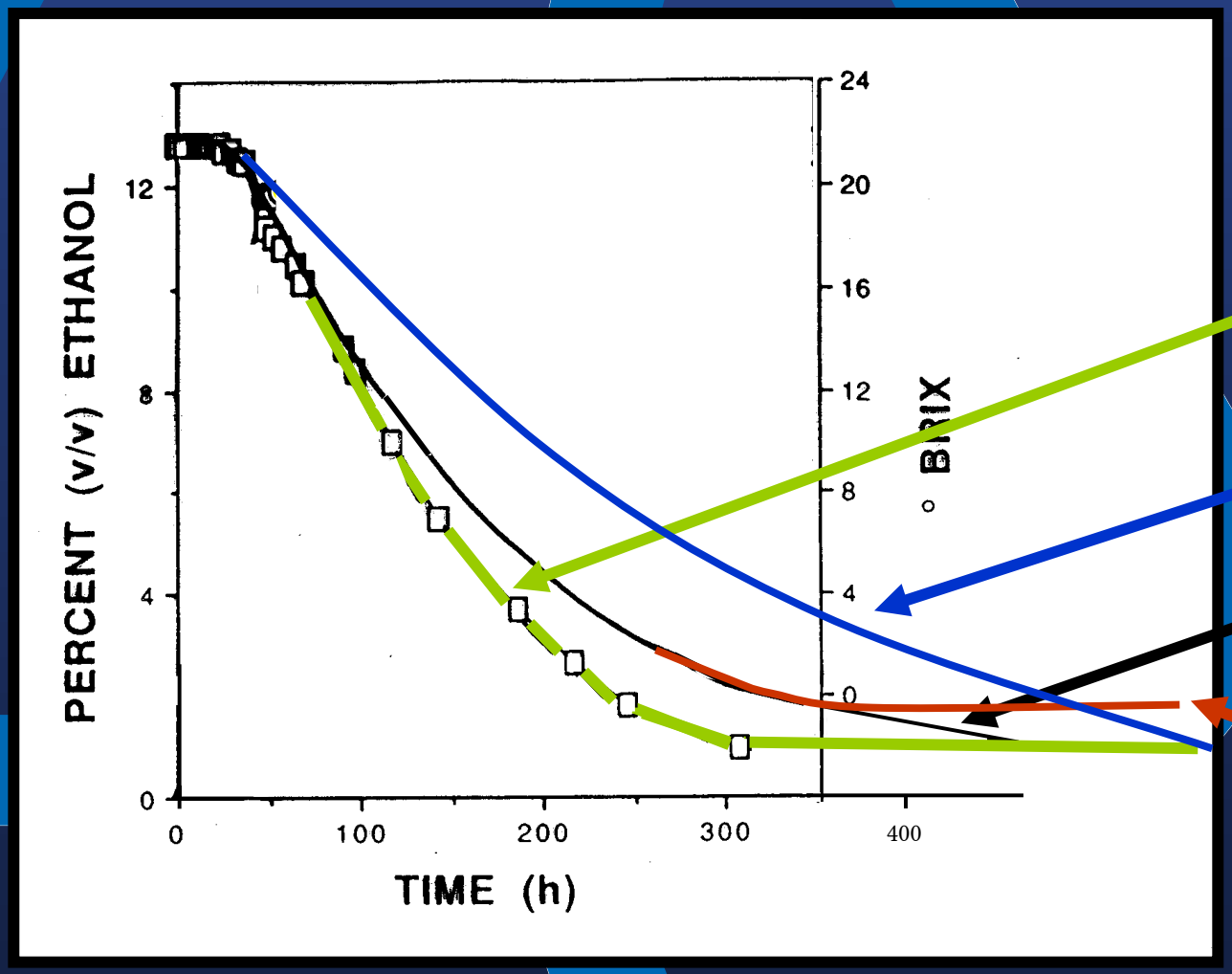

Fermentation kinetics

OPTIMAL

SLOW

SLUGGISH

STUCK

Sub-optimal fermentation:
general observations

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- It's a ***common problem***

- ***Multifactorial***:
  - **yeast**
  - **nutrients in grape juice**
  - **inhibitory factors**
  - **fermentation conditions and management**

Sub-optimal fermentation kinetics:

Some of the Risk Factors

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Yeast-related factors

- choice of yeast
- quality of starter culture
- inoculation regime
- temperature stress

Nutrient deficiencies

- yeast assimilable nitrogen (YAN)
- oxygen
- lipids
- vitamins

Inhibitory factors

- ethanol
- antagonistic micro-organisms
- agrochemical residues

Adapted from Henschke (1997)
ASVO Seminar Procs pp. 30-38,41

Yeast inoculation:
factors that promote yeast dominance

- ***Minimise indigenous yeast populations in must***
  - COOL CONDITIONS during harvest, transport, and must preparation
  - Use SO_2 effectively (>50 mg/L), esp. with damaged fruit
- ***Optimise yeast starter culture population***

Yeast inoculation:
factors that promote yeast dominance

- ***Pre-warm must, 15–18°C, before inoculation***
- ***Condition starter culture by step-wise cooling***
- ***Monitor ferment and GRAPH DATA daily*** (identify potential problems early)

Managing fermentation:

temperature control

- *TEMPERATURE STRESS* can permanently inactivate yeast

- *TEMPERATURE CONTROL* is most powerful tool for controlling fermentation rate

Managing fermentation:
Yeast assimilable nitrogen (YAN)

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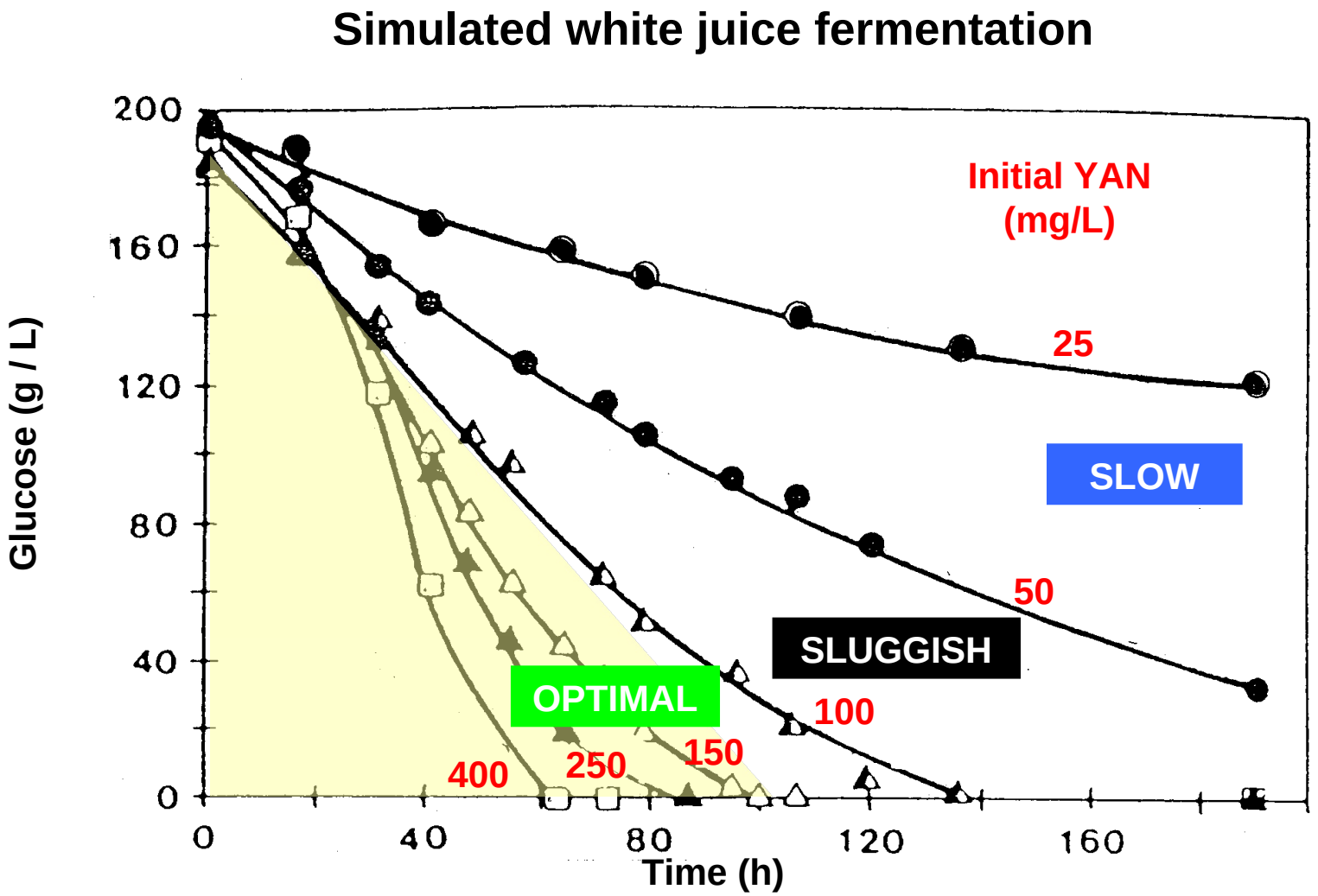
- Sub-optimal YAN leads to sub-optimal ferments

Yeast assimilable nitrogen (YAN)

Fermentation response to YAN



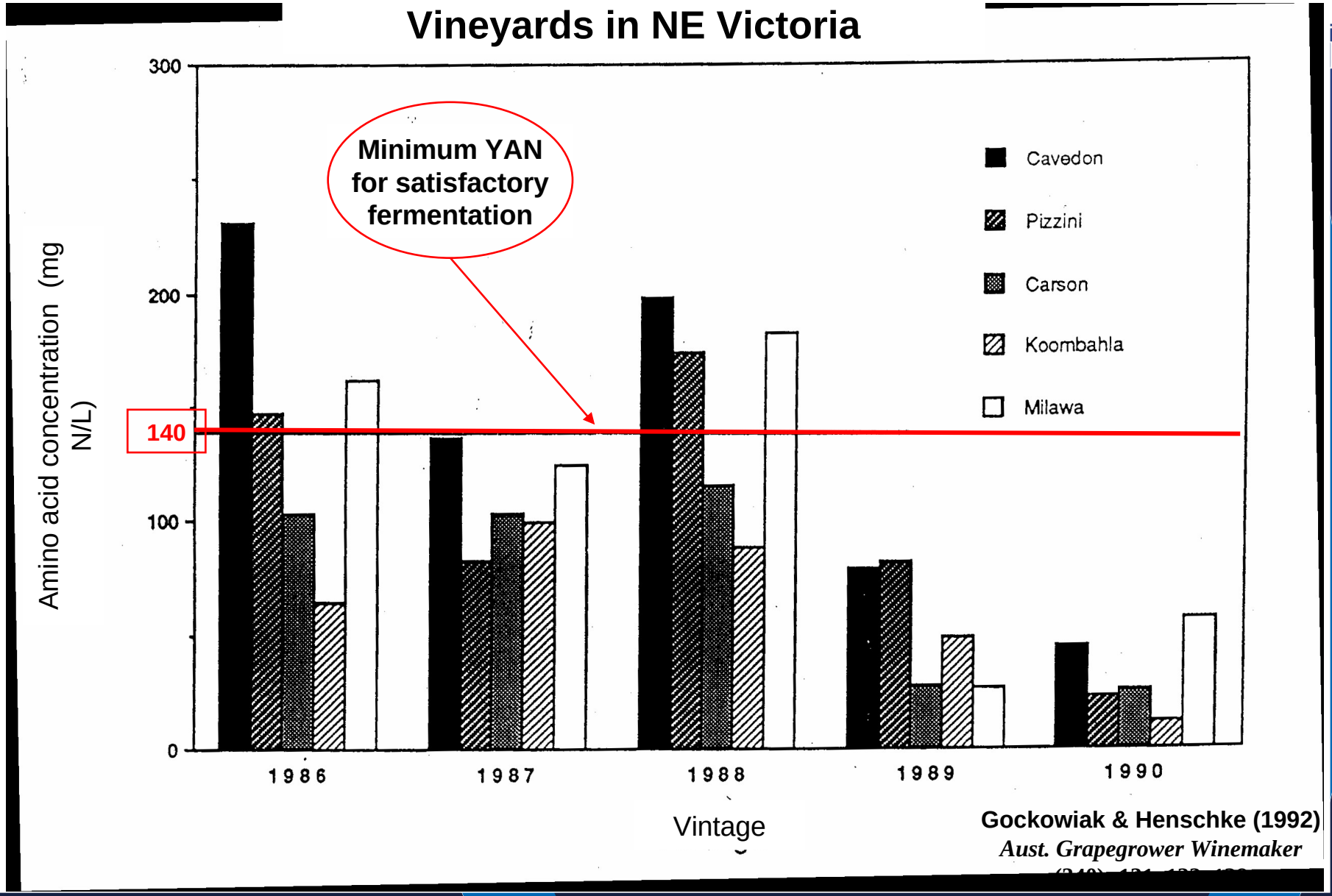
Salmon (1989)
Appl. Envir. Microbiol. 55:953-958

Managing fermentation:
Yeast assimilable nitrogen (YAN)

- Sub-optimal YAN leads to sub-optimal ferments

- YAN levels in must are highly variable

Vineyard and Year effects on juice YAN



Managing fermentation:

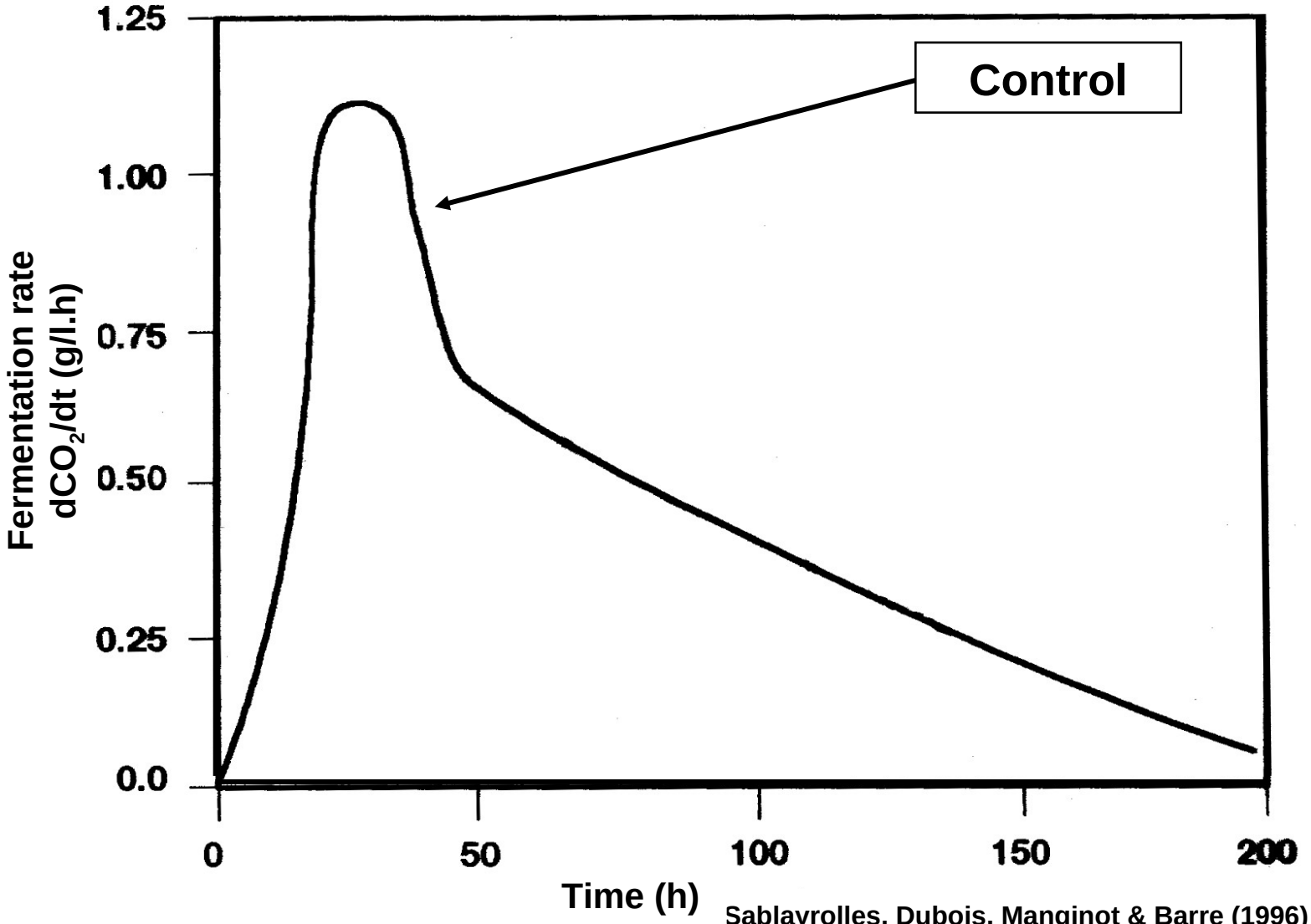
Yeast assimilable nitrogen (YAN)

- Sub-optimal YAN leads to sub-optimal ferments
- YAN levels in must are Highly variable
- YAN levels strongly impact on wine composition and flavour

Essential to measure YAN content of juices/musts in high risk regions

Invigorating fermentation with DAP ✦ O_2

Nutrient strategy for reinvigorating fermentation



Sablayrolles, Dubois, Manginot & Barre (1996)
J. Ferment. Bioeng. 82:377-381

Invigorating fermentation with DAP ✦ O_2

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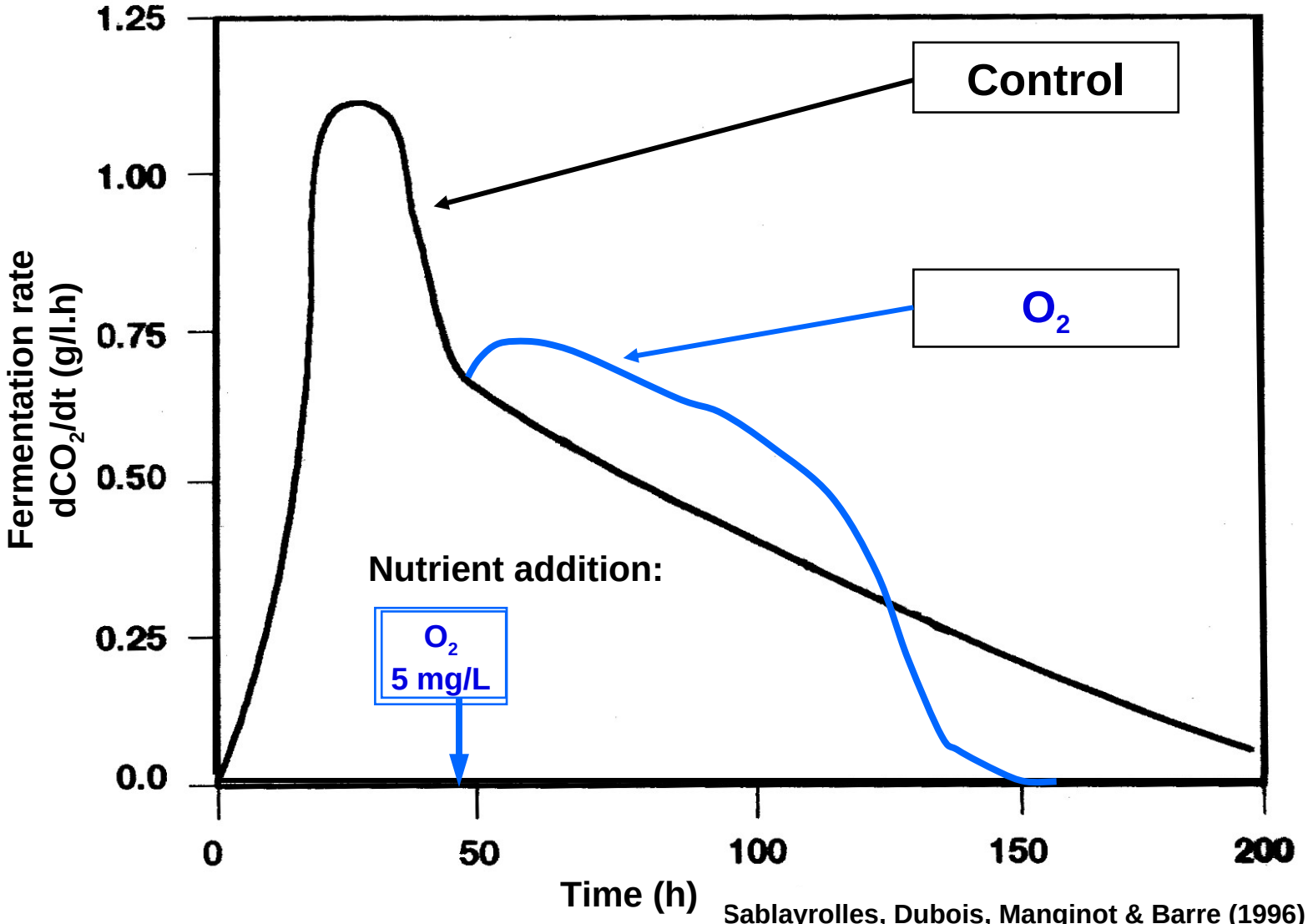

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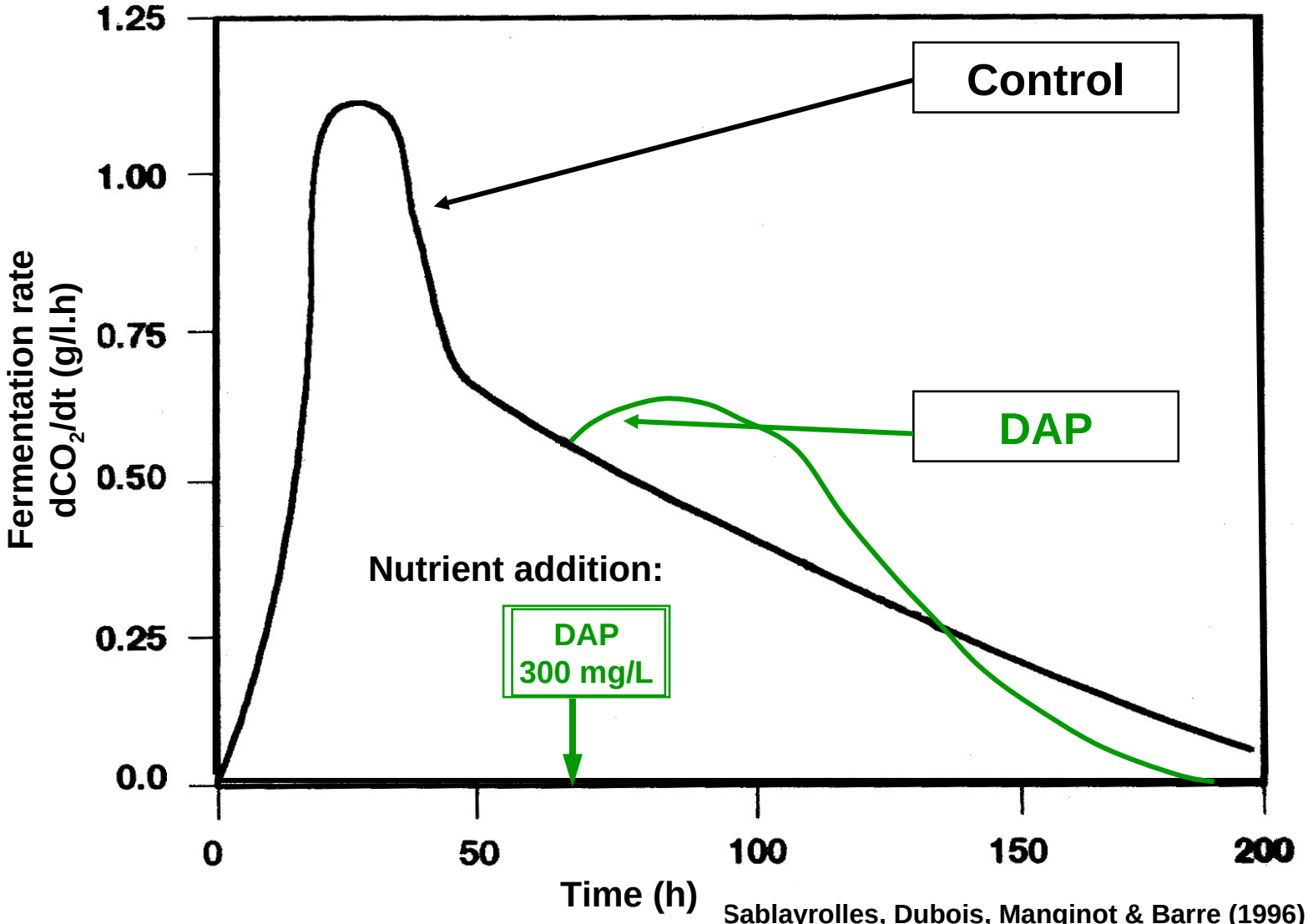

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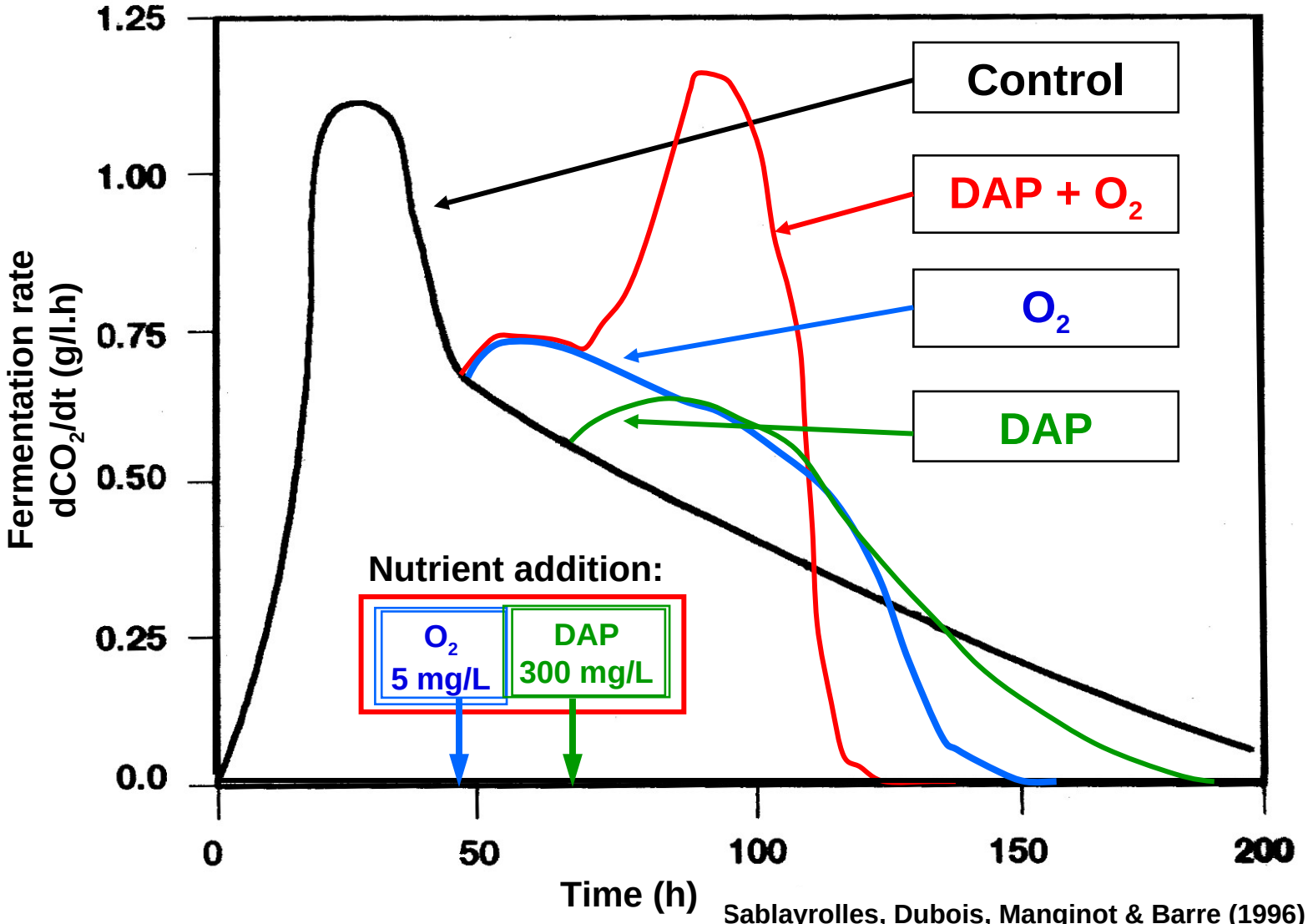

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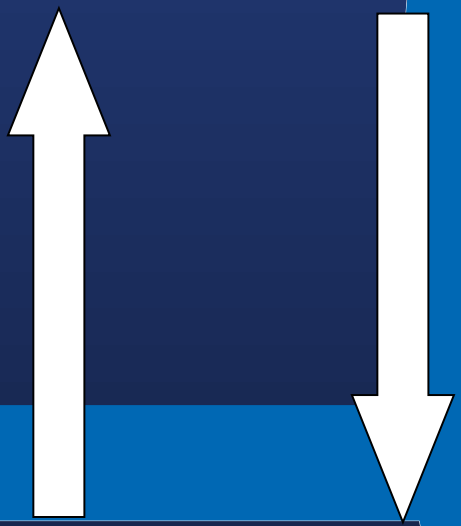
Juice clarification and fermentation

Ferment rate	Wine residual sugar	Clarification treatment
Highest	Lowest	Cold settled
		Bentonite treated and settled
		Enzyme treated and settled
		Centrifugation, 10 min at 1500g
		Coarse filtration
		Centrifugation, 20 min at 10000g
Lowest	Highest	Fine filtration (Sietz EK)



Stuck fermentation: *rescue procedures*

- Use active yeast lees

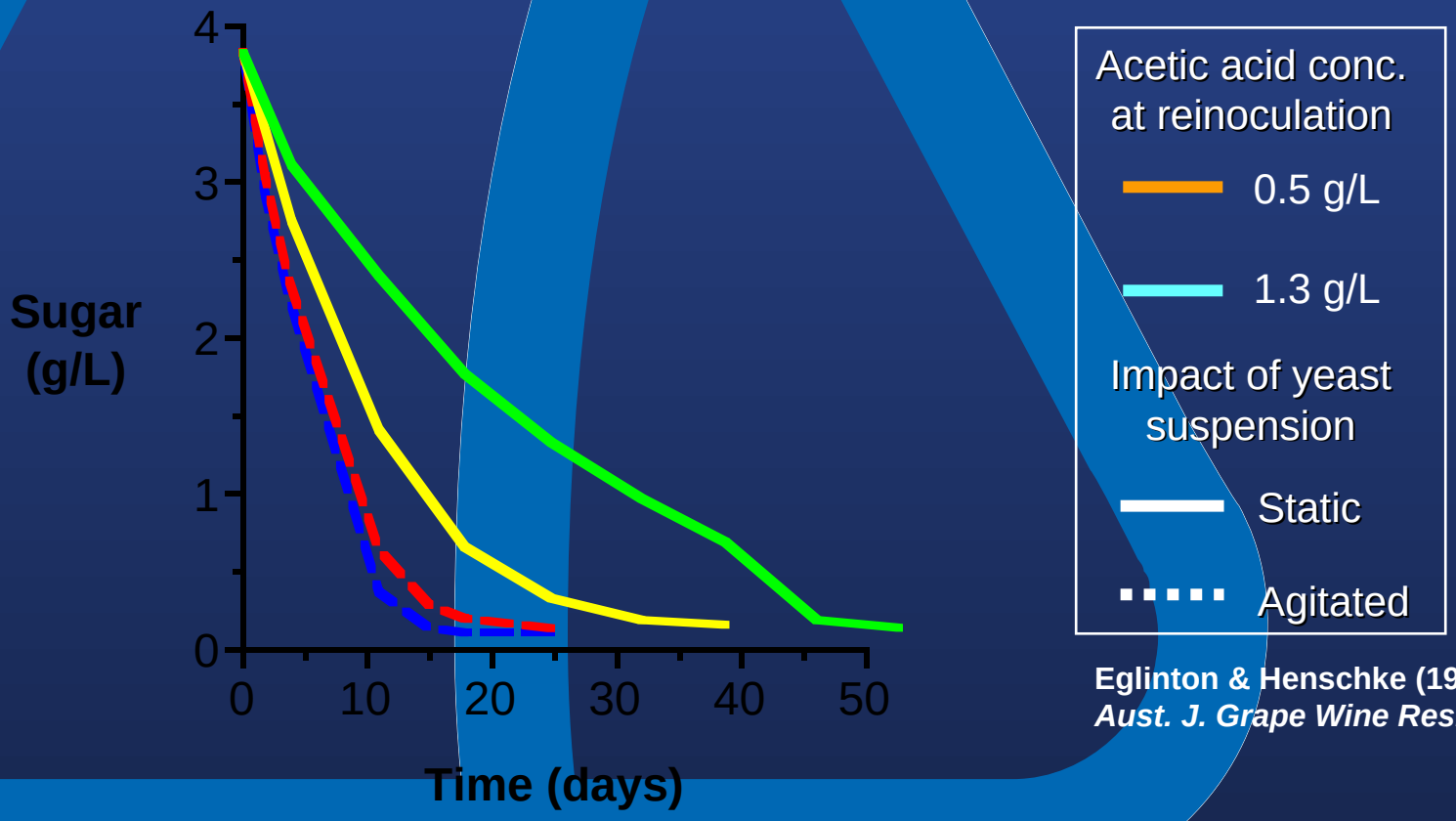
or

- Prepare a ‘rescue yeast’ starter culture in grape juice

or

- Use a ‘stepwise acclimatised’ rescue culture of robust yeast strain

Agitation of ferment is helpful



Eglinton & Henschke (1999)
***Aust. J. Grape Wine Res.* 5:71-78**

Aim to maintain yeast in suspension by physical means until CO_2 production commences, which then keeps yeast suspended

Future developments:

- NIR technology for rapid, continuous monitoring of ferments
- Development of more robust yeast strains

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Australian Government

Grape and Wine Research and Development Corporation