

Oxygen ingress through different closures into wine bottles

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By Paulo LOPES



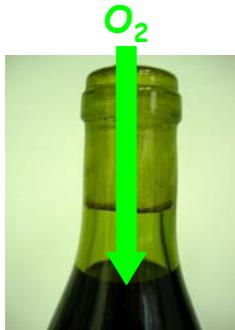
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Background

"O₂ is the greatest enemy of wine," but also, "O₂ makes wine, which ages under its influence" (Pasteur, 1873)



J. Ribéreau-Gayon (1933)

Natural cork stoppers permeability

First three weeks: 0.10 to 0.38 mL of O₂

Four months: 0 to 0.07 mL of O₂



"Oxygen is not the agent of bottle maturation"



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Background

Oxygenation

Strong \Rightarrow detrimental to wine quality Boulton et al. (2005)

Slow and continuous \Rightarrow beneficial for wine development

Too little O_2

Too much O_2

Screw caps

Corks Stoppers

Synthetic closures

Reduced aromas

Struck flint, rubber

SLOs

Skouroumounis et al. (2005)

Brown colour

High-oxidized flavors

> Acetaldehyde



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Background

Oxygen ingress measurement

- Wine chemistry/sensory changes
- Dissolved oxygen measurement (polarographic probe, GC, etc.)
- Time lag method (pressure decay measurement)
- Coulometric sensor (Mocon, Wicke-Kallenbach)

Problems

- Destructive toward the closures \Rightarrow many replicates
- Measurement in dry packages (Mocon, Wicke-Kallenbach)
- Do not allow oxygen ingress measurement over long periods



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Aims

- Develop a non destructive method to determine oxygen ingress into wine bottles

a) Impact of different sealing systems

- o Natural and technical corks
- o Synthetic closures
- o Screw cap closures

b) Impact of bottle orientation during storage

- o Horizontal versus vertical



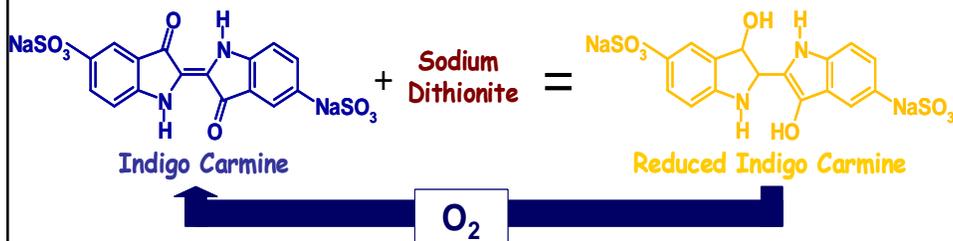
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Colorimetric method (Jean Ribéreau-Gayon)

- Oxidation-reduction properties of indigo carmine



1) Calibration

2) Bottling and sealing commercial bottles

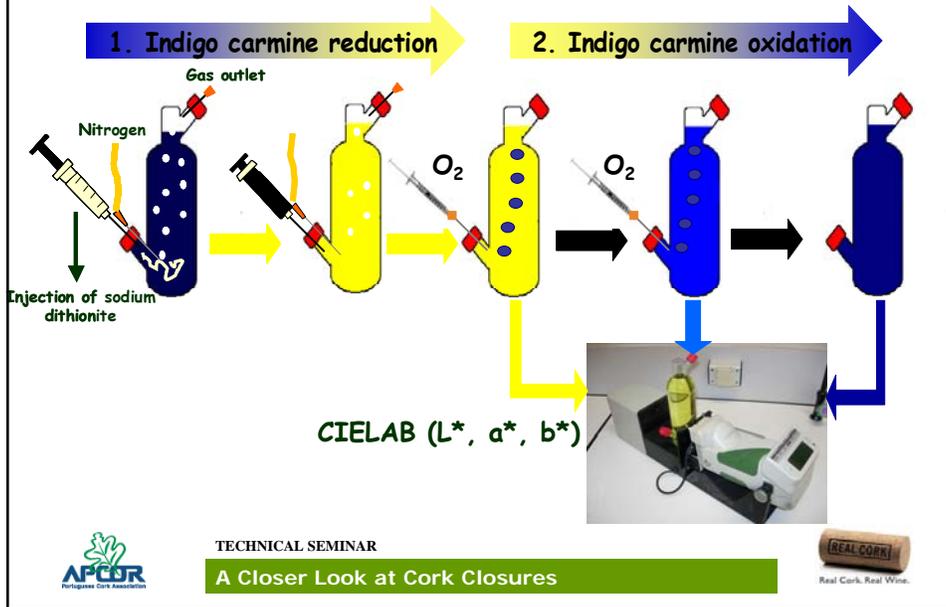


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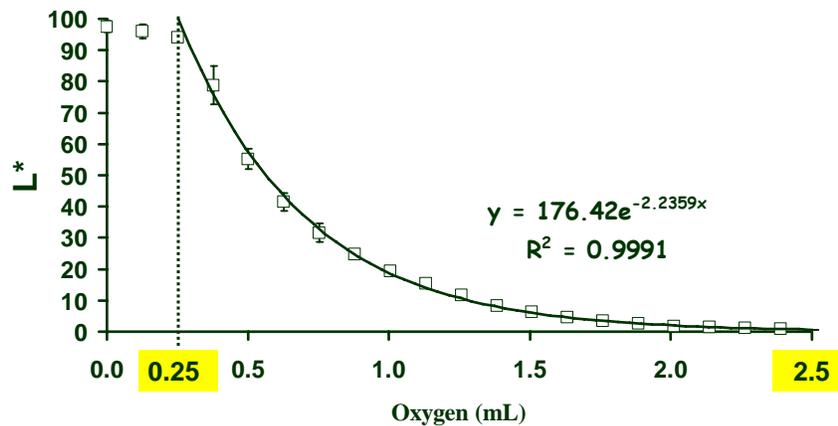
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Calibration procedure



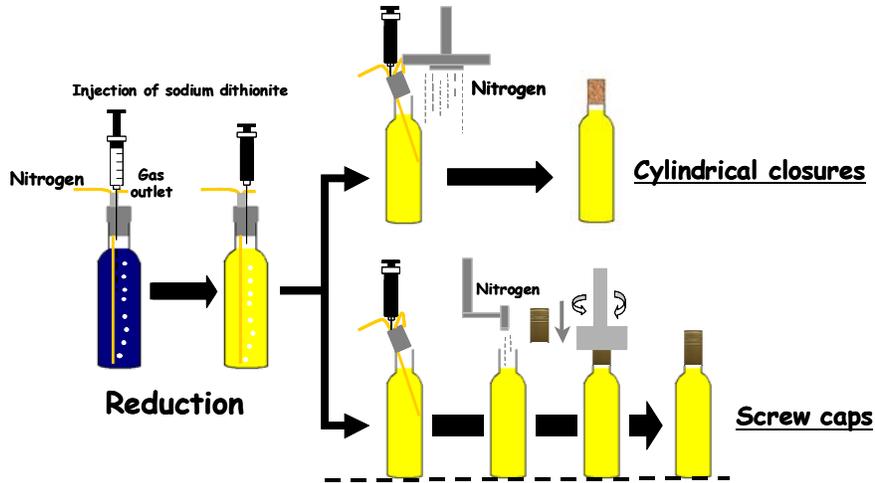
Calibration curve



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Bottling and sealing procedures



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Sealing systems

- All in glass bottles (control)
- Natural corks (44 x 24 mm)
 - 'Fi
 - Fi
- Technical corks
 - Neutrocork
 - Twin Top
- Synthetic closures
 - Nomacorc
 - Supremecorq
- Screw caps
 - Stelvin saran
 - Auscap
 - CSA
 - Cospak



Vertical storage
(20 months)

Horizontal storage
(5 months)

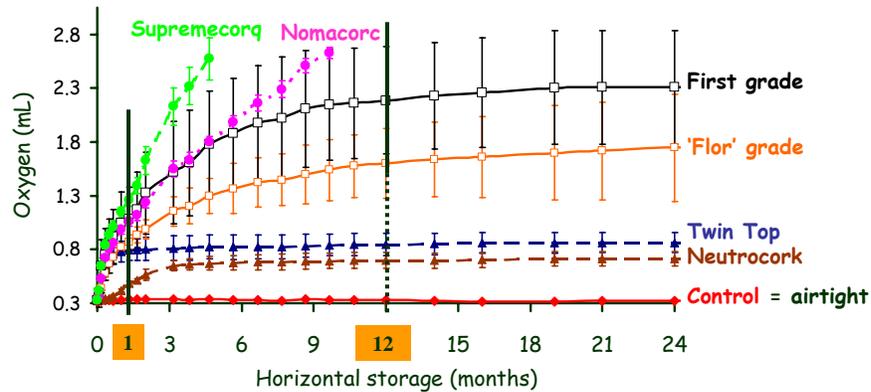


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Oxygen ingress through closures (Horizontal)



- Synthetic and 'technical' corks \Rightarrow O_2 ingress in 2 steps
- Natural corks \Rightarrow O_2 ingress in 3 steps

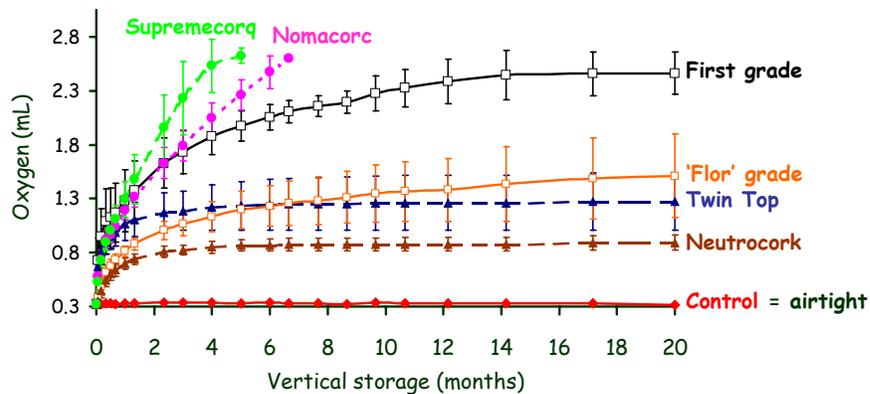


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Oxygen ingress through closures (Vertical)



➤ Similar oxygen ingress patterns (horizontal vs vertical)

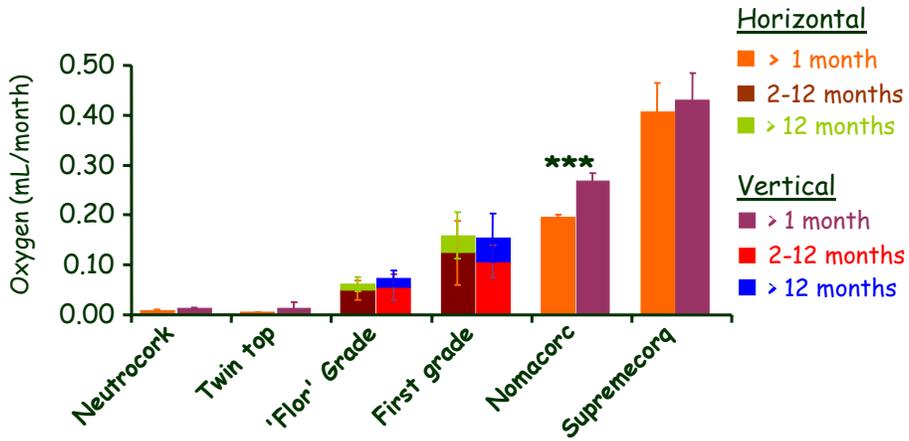


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Oxygen ingress rates through closures



➤ Storage position had little impact on oxygen ingress

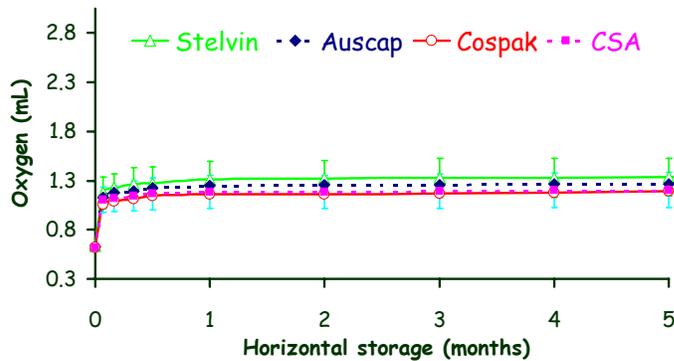


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Oxygen ingress through screw caps



➤ Lower permeability (no statistical differences)



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Full ranges of oxygen ingress rates (μL per day) through closures

	Our study			MOCON
	First period ^a	Horizontal ^b	Vertical ^b	Godden et al. (2005)
Screw caps	< 250	0.3 - 0.7	-	0.2 - 0.8
Technical corks	15 - 40	0.1 - 0.6	0.1 - 0.9	0.6 - 0.13
Natural corks	25 - 45	1.7 - 6.1 ^c 0.1 - 2.3 ^d	0.5 - 4.4 ^c 0.1 - 2.7 ^d	0.1 - 122.7
Nomacorc	30 - 40	6	8 - 9	~10
Supremecorq	35 - 45	11 - 15	11 - 12	

^a Data from vertical and horizontal storage. 2 days (screw caps) and 1 month (cylindrical closures)

^b After 1 month, ^c Between 2 and 12 months of storage, ^d After 12 months of storage

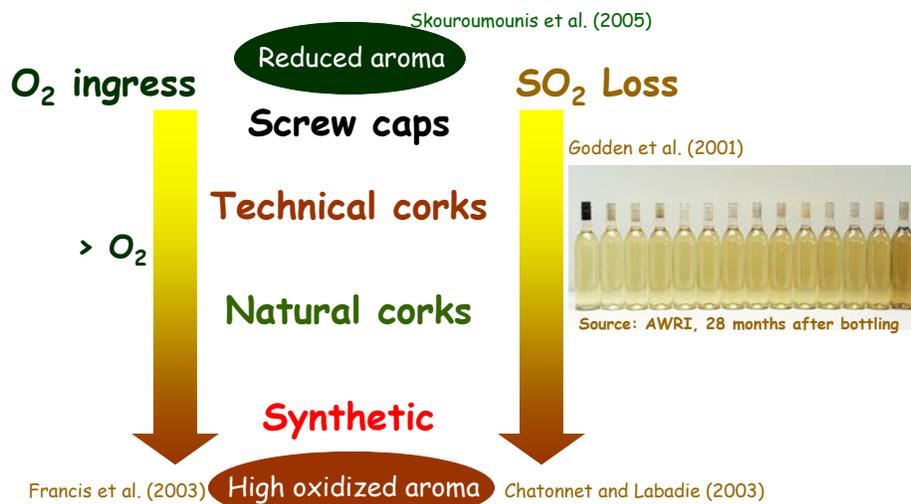


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Other studies



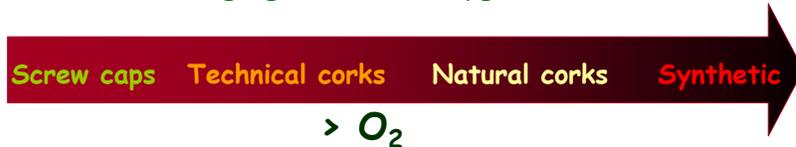
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Conclusions

- ✓ Clearly influenced by the nature of sealing system
 - All in glass bottles (control) = airtight
 - Wine bottle aging \Rightarrow micro-oxygenation



- ✓ Storage position had little impact on O_2 ingress (over 20 months, under controlled conditions)



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Further research

- Mechanisms and main routes of O_2 ingress through different closures into wine bottles

O_2 within closures ??

Atmospheric O_2 ??

Closure glass interface ?

Through closure core ?

- Impact of "micro-oxygenation" induced by different sealing systems on the wine development



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Nondestructive Colorimetric Method To Determine the Oxygen Diffusion Rate through Closures Used in Winemaking

PAULO LOPES, CÉDRIC SAUCIER,* AND YVES GLORIES

Faculté d'Oenologie de Bordeaux, Université Victor Segalen Bordeaux 2 UMR 1219 INRA,
351 Cours de la Libération, 33405 Talence Cedex, France

Oxygen is one of the most important factors determining the aging potential of bottled wine, and oxygen diffusion into bottled wine is extremely dependent on the sealing effectiveness of the closure. A nondestructive colorimetric method was developed to measure oxygen diffusion from 1 to 9.8 mg/L during the postbottling period. This method was used to study oxygen diffusion through different closures available on the market. After 365 days of horizontal storage, only the control bottle was impermeable to atmospheric oxygen; all other closures exhibited variable rates of oxygen diffusion, which were much greater in the first month than in the following months. It was shown that the rate of diffusion was clearly influenced by the type of closure material used.

KEYWORDS: Indigo carmine; sodium dithionite; oxygen diffusion; closures; bottles



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Real Cork. Real Wine.