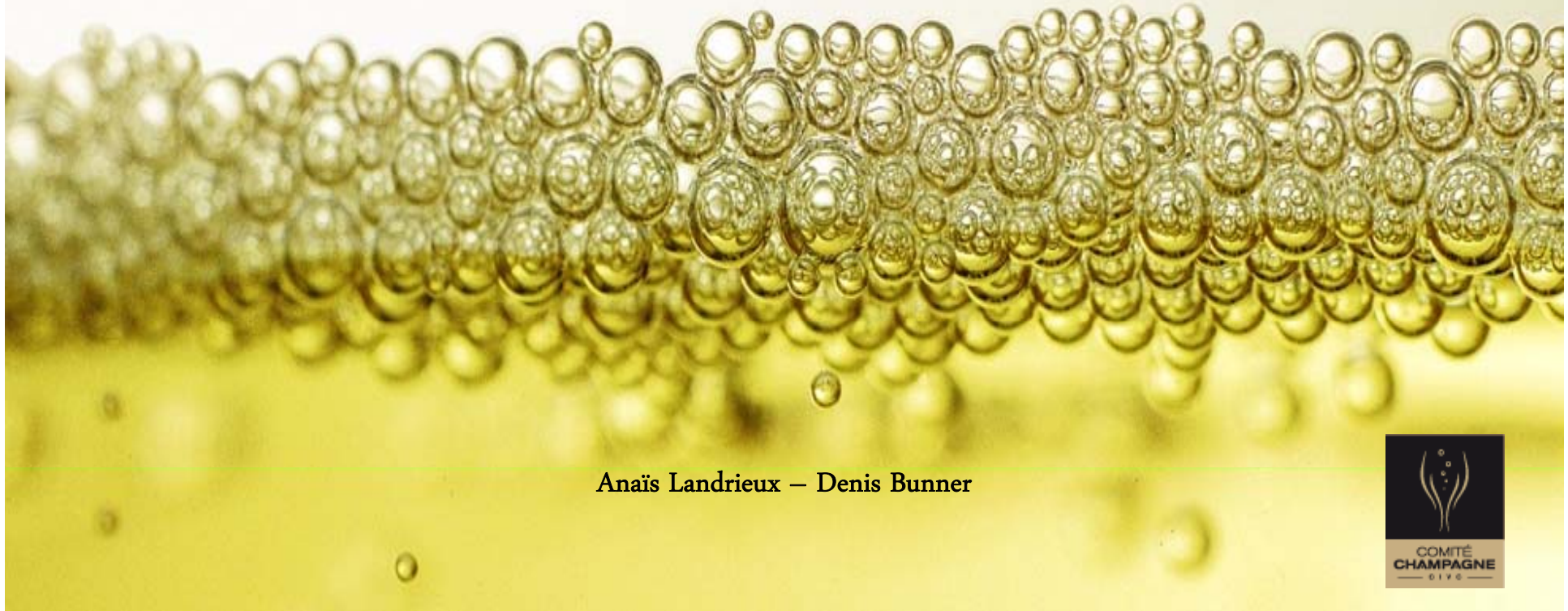




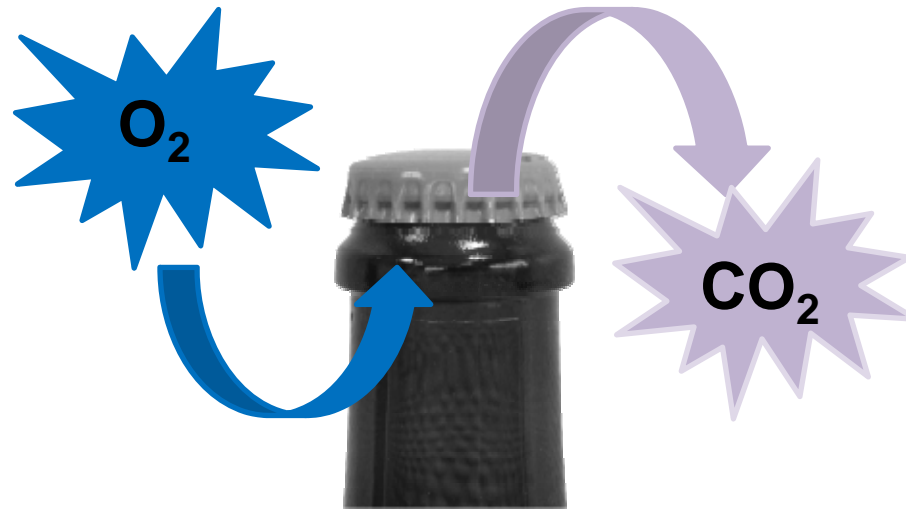
Optical oxygen measurements applied to Champagne bottles



Anaïs Landrieux – Denis Bunner



Oxygen entries in Champagne bottles



Equilibrium partial pressures



Changes in measurement methods

- **1988** : awareness of the importance of gas exchange during wine aging
- **1994** : capsules permeability measurements by MOCON method (LNE)
- **1997** : Orbisphere adapting to oxygen measurement in Champagne bottles
- **2005** : non invasive oxygen measurement (chemiluminescence)



Development of the method

- Water measurements
- Deoxygenation : $[O_2] < 100$ ppb

1. Nitrogen bubbling during 15 min
water deoxygenation



2. CO₂ ice
headspace inerting





Development of the method

- **Pressure rise:**
 - hydrochloric acid/ sodium bicarbonate / test tube
 - $\text{NaHCO}_3 + \text{HCl} \longrightarrow \text{NaCl} + \text{H}_2\text{O} + \text{CO}_2$
 - limit microbial contamination





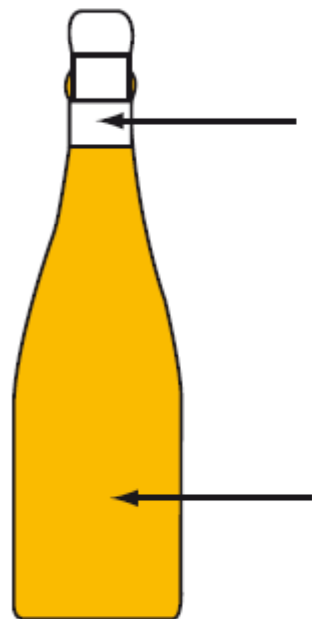
Measurement conditions



- **White glass bottle**
- **Controle of the measurement temperature**
- **Stirring for 15 minutes : equilibrium between liquid and gas phase**



Determination of the total quantity of oxygen in bottles



Headspace

= 41% of total oxygen

Solution

= 59% of total oxygen



Total oxygen

=

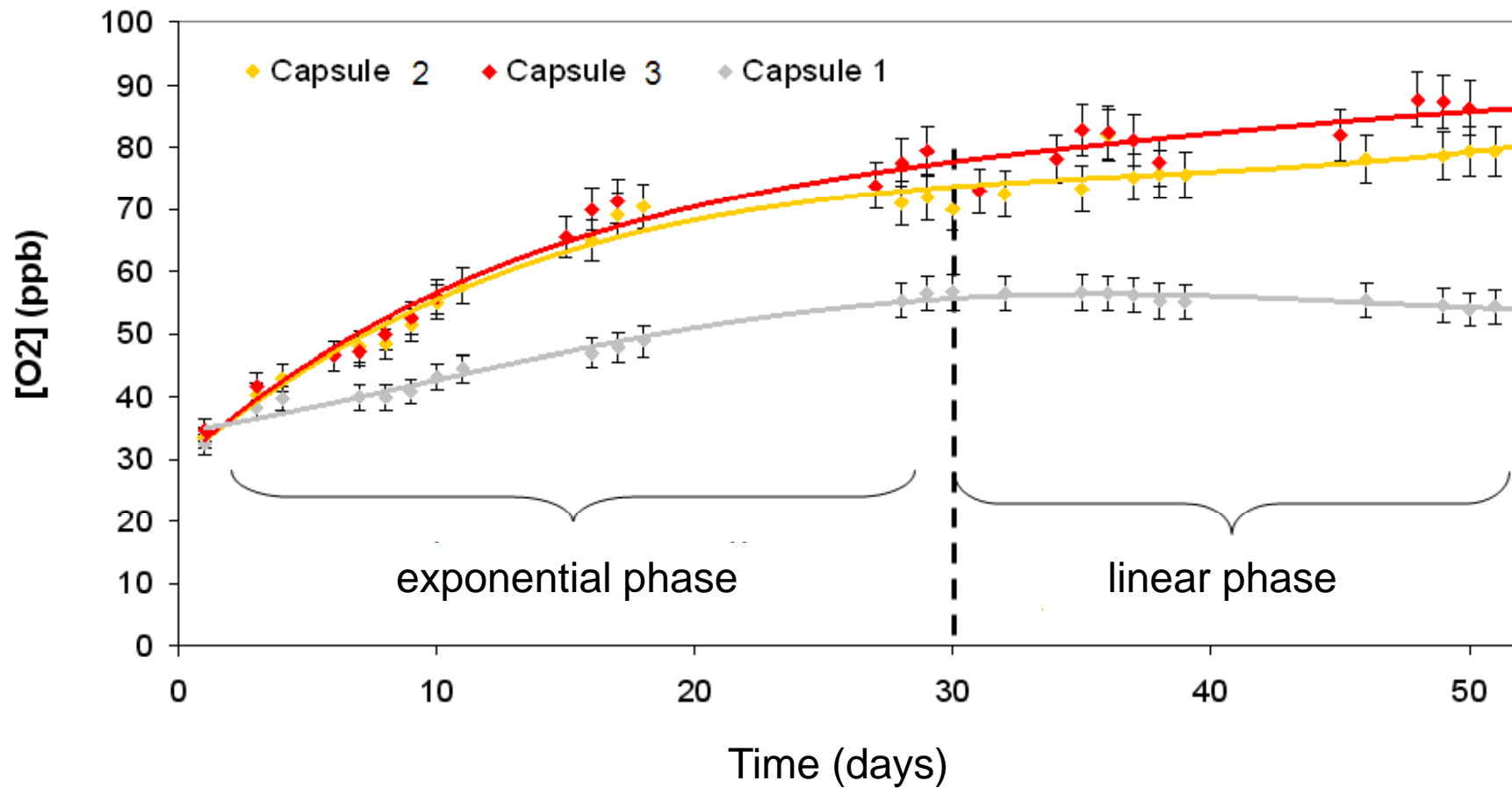
O₂ in solution x (100/59)

=

O₂ in solution x 1,7



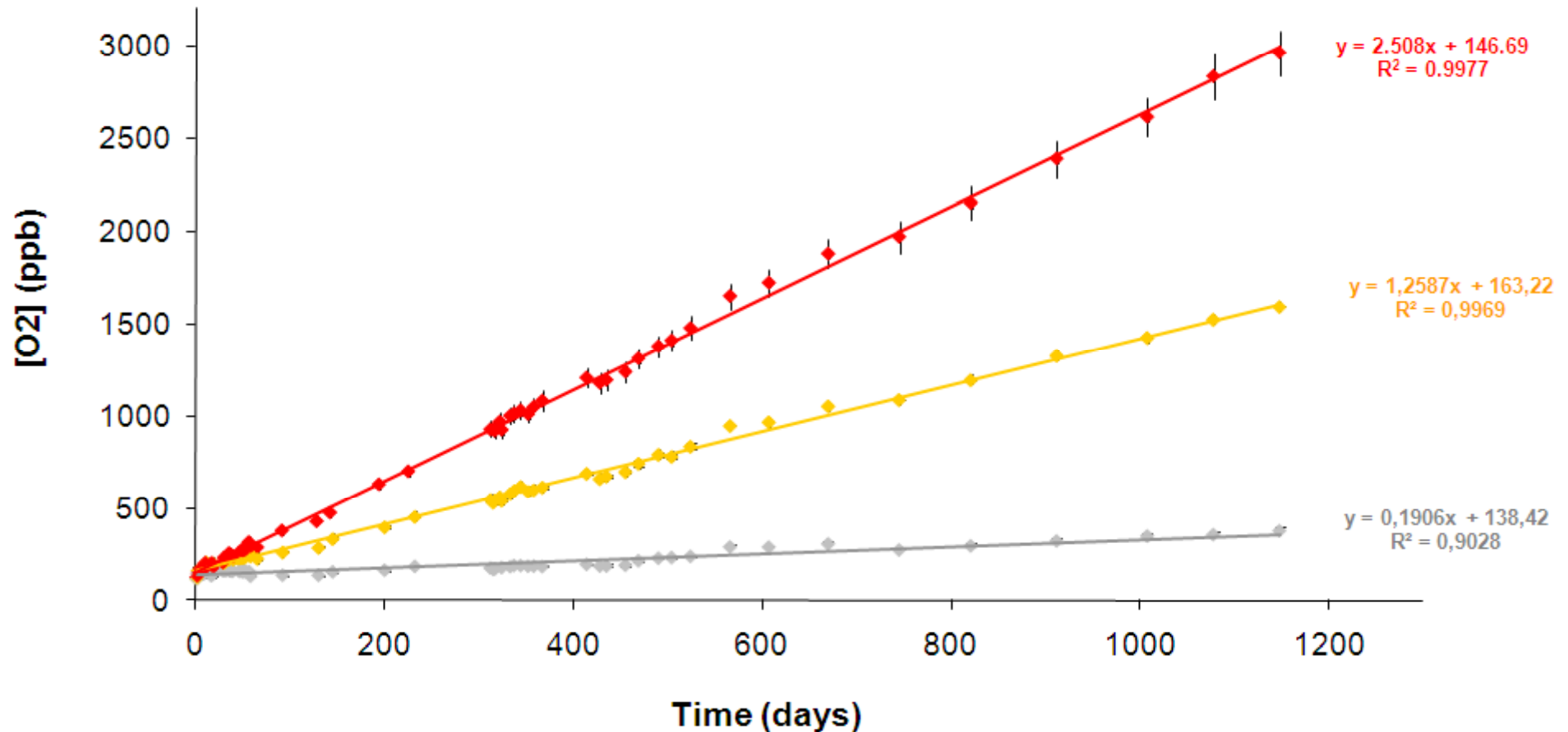
Average oxygen entries through capsules for the first 50 days





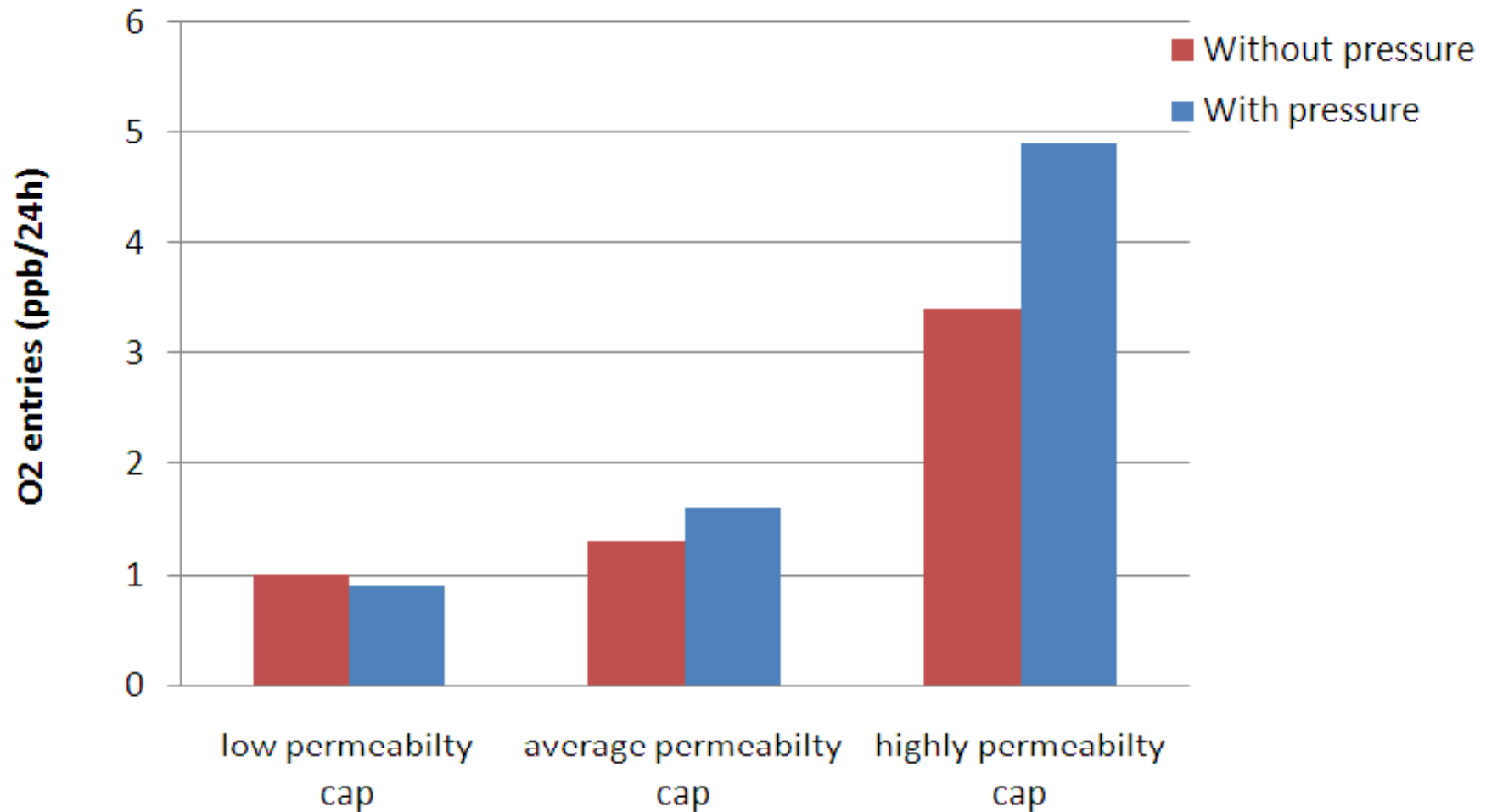
Average oxygen entries through capsules for 3 years

◆ Capsule 1 ◆ Capsule 2 ◆ Capsule 3





Effect of pressure on oxygen entries



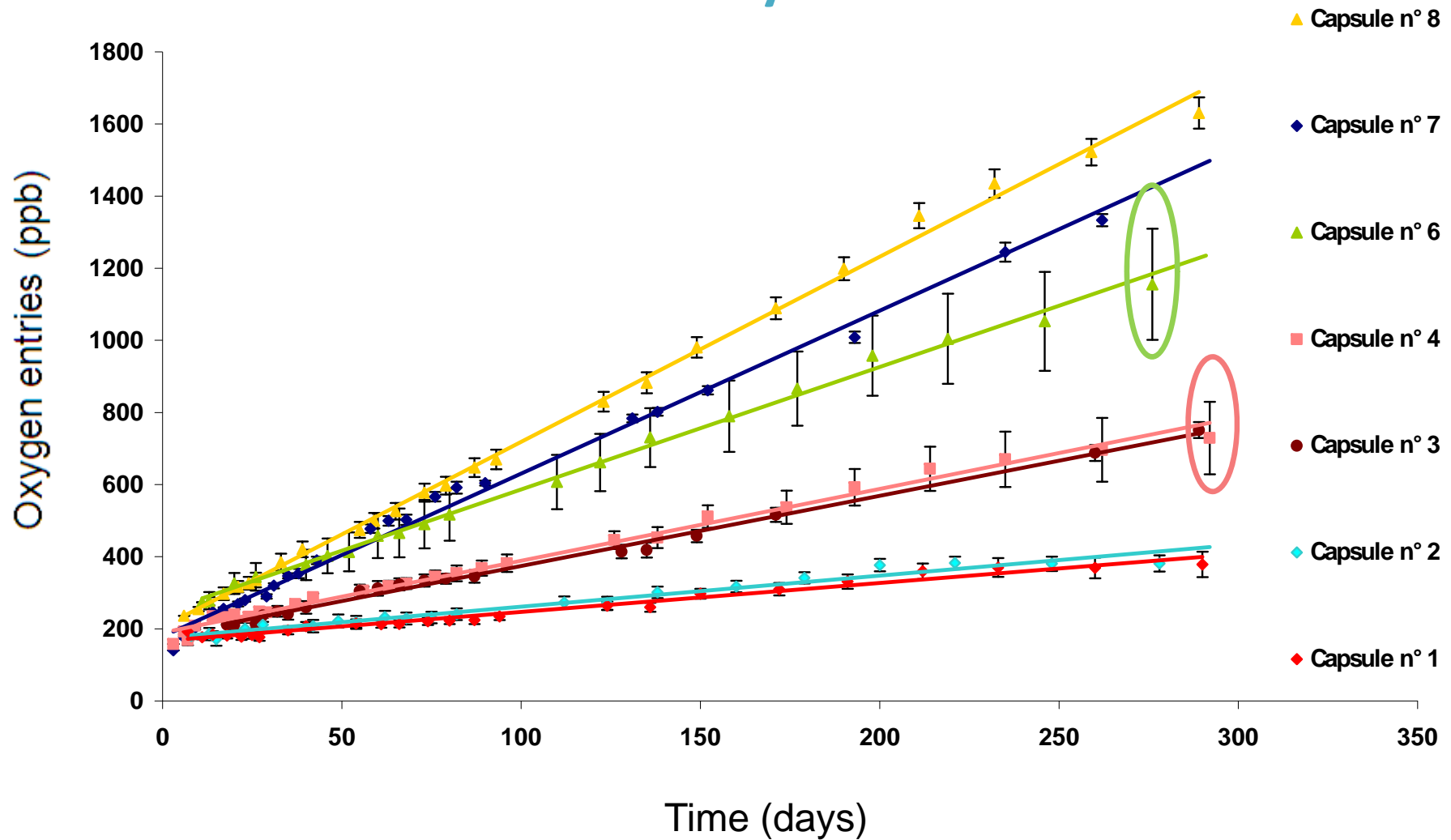


Comparison : LNE method / Chemiluminescence method

Number of capsule	LNE method	Chemiluminescence method
	CO ₂ loss (cm ³ / 24h)	O ₂ entries (mg/L/an)
Capsule n° 8	0,69	1,79
Capsule n° 7	0,59	1,76
Capsule n° 6	0,57	1,21
Capsule n° 4	0,25	0,74
Capsule n° 3	0,25	0,66
Capsule n° 2	0,11	0,24
Capsule n° 1	0,10	0,30

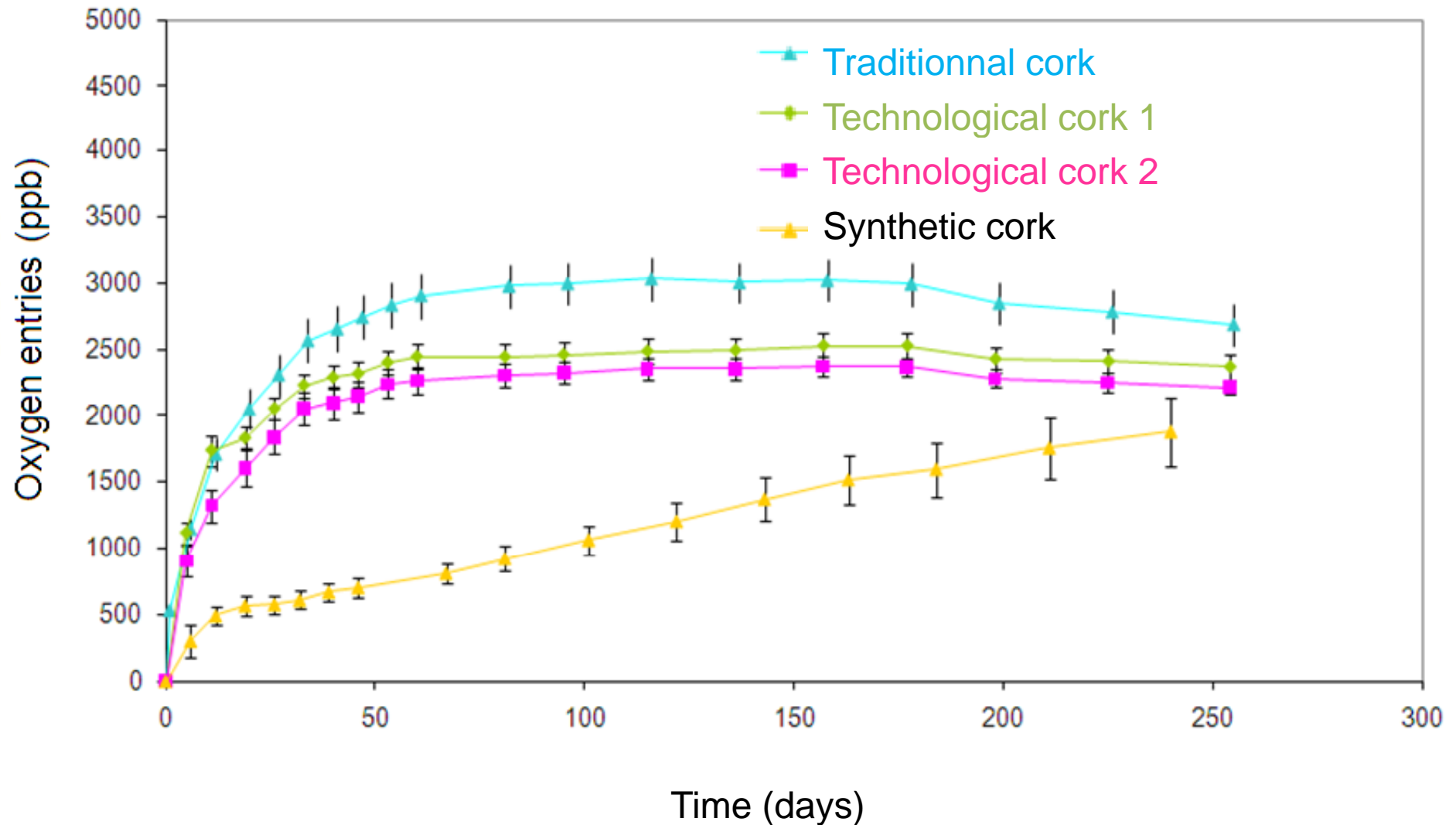


Average oxygen entries through capsules for 1 year





Average oxygen entries through corks





Prospects

- **Understand the corks oxygen consumption**
- **Migration study of molecules from corks to the wine**
- **Classified Champagnes capsules by their oxygen permeability**