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Application of atmospheric pressure cold plasma to disinfect wine barrels

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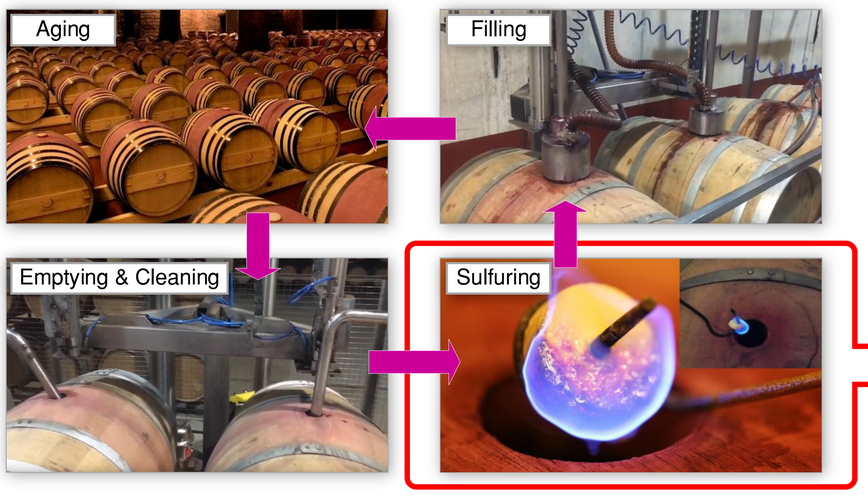

Directive 98/8/EC concerning the placing of biocidal products on the market

In Spain there is a **moratorium** until **2022**

Looking for **Alternatives**

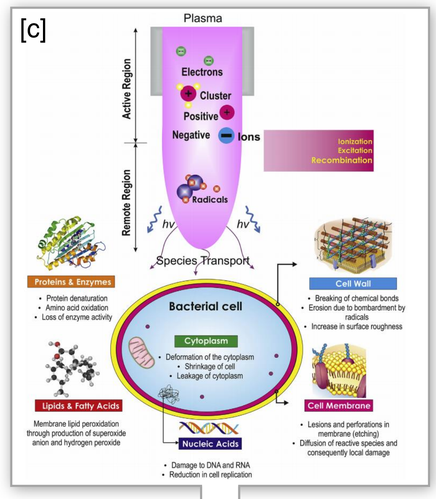

Fig.1. [a] **Microwave** Shock Pulse (MwSP); [b] **Ozone** Treatment; [c] **Atmospheric Plasma**
(Image from N.N. Misra & Cheorun Jo, Applications of cold plasma technology for microbiological safety in meat industry. Trends in Food Science & Technology 64 (2017) 74-86)

Introduction

- The use of **oak wood barrels** in the elaboration and **aging of wines** is a practice that is considered as a very favorable element in the participation and organoleptic evolution of wines.
- A **used barrel** does not have the same potential as that of a new one, but it still has an **excellent use** value for numerous wines and alcoholic products at a lower cost, so its good maintenance is essential for this purpose.
- The **problems** that arise during the aging of the wine are essentially associated with **microbiological or chemical contamination**. Microorganisms take refuge in the natural pores of the wood and can cause negative organoleptic alterations in the wine, such as the synthesis of volatile phenols (stable aroma, leather, etc.), the increase of volatile acidity (aroma vinegar) or the biogenic amines formation.
- **Barrel sulfuring** has been a traditional practice widely used in wineries for barrel sanitization. The traditional way is to burn a sulfur pill inside empty barrels (this combustion produces sulfur dioxide, wich has biocidal effects on wood). However, the appearance of **Directive 98/8/EC** of the **European Commission**, which prohibits the use of sulfur dioxide for the sanitization of barrels, has led to the need for new solutions that allow this task to be viable from an economic and operational point of view, guaranteeing effective sanitization (**Figure 1**).
- In Spain there is a **moratorium until 2022**, this scenario has led to the development of new alternative technologies for the sanitization of barrels (thermal, ozone, ultrasound, etc.). However, none of them have been able to respond adequately to the needs of the wine sector.
- The application of **atmospheric pressure cold plasma** (APCP) could be an interesting solution to these drawbacks.

Methods

- The APCP treatments were applied for **30 min** to the surface of oak wood barrel fragments that had been **artificially contaminated** with 3 spoilage microorganisms; *Brettanomyces bruxellensis*, *Pediococcus pentosaceus* and *Acetobacter aceti*.
- Details of the tests are indicated in **Figure 2**.
- Thermographies were performed every 5 minutes during the treatments. Maximum temperatures are indicated in **Figure 3**.
- The APCP treatments were applied in **triplicate** and after these, the microbial cultivable population of the yeast, lactic acid and acetic acid bacteria were measured by plating in the adequate culture media counting the colony forming units (CFU) per wood gr.
- The surface of the treated samples was observed by SEM (x1000). No structural change was observed with respect to the surface of the untreated sample (**Figure 4**).

Results & Discussion

- **Air** and **Nitrogen** APCP treatments achieved a **total inactivation** of viable *Brettanomyces bruxellensis*, and cut *A. aceti* cultivable population by half. Overall, Air APCP treatment was less efficient and *P. pentosaceus* was reduced 2 logarithmic units after the three treatments, being the most resistant species.
- Taking into consideration those preliminary results, **APCP could be an interesting tool** for reducing microbial wood contamination although further research is still necessary.
- More tests should be carried out to determine the safety of the treatment on wood and wine contained therein. The effectiveness of the treatment will also be tested using **PAW** (Plasma Activated Water).

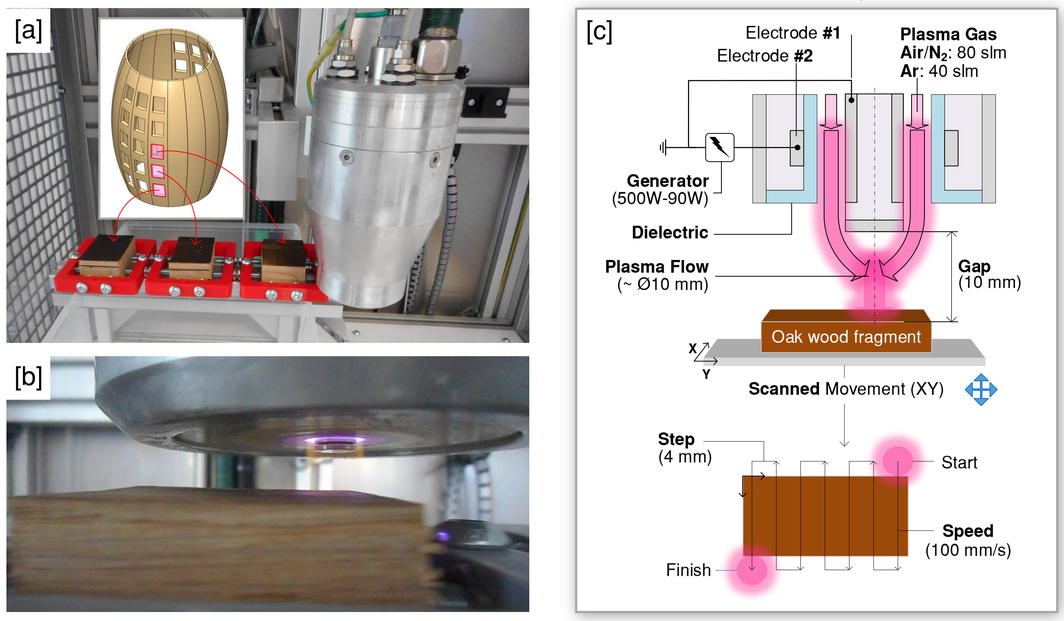

Fig. 2. [a] Plasma treatment process of oak wood barrel portions; [b] Close view of plasma treatment process; [c] Scheme of plasma treatment process

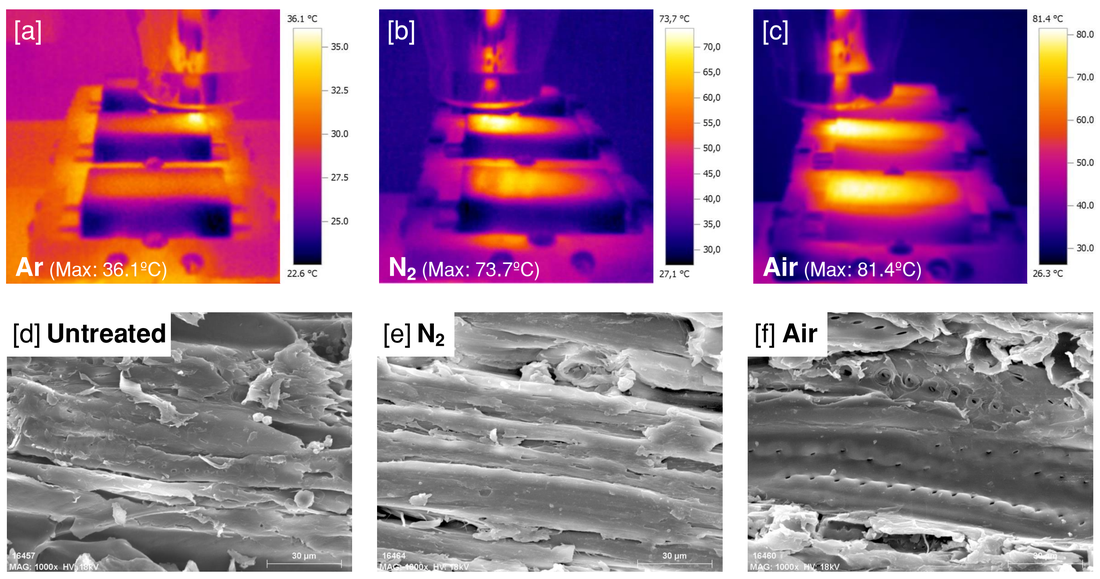

Fig. 3. Thermograpies during plasma treatment using as plasma gas: [a] Argon; [b] Nitrogen; [c] Air and SEM images (x1000) corresponding to wood surface of samples: [d] Untreated; after plasma treatment using as plasma gas: [e] Nitrogen; [f] Air

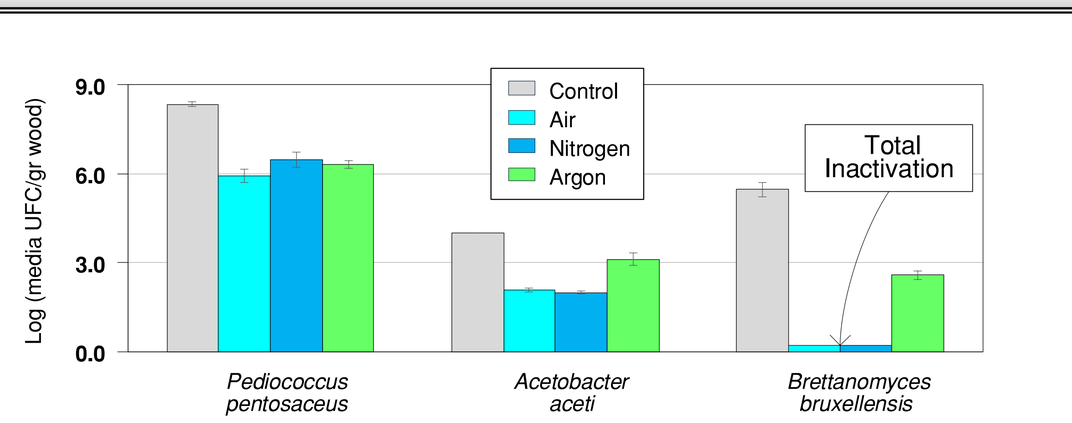

Fig. 4. Reduction obtained with each treatment: Plasma Gas Air, Nitrogen and Argon (UFC/gr wood

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