Supercritical CO_2-based process to clean and sterilize FFP2 facial masks

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1. Introduction

The Covid-19 pandemic led to a huge consumption of single-use facial masks (*i.e.* surgical masks and Filtering Face-Piece respirators like N95/FFP2) to avoid spreading the virus throughout the population. However, this tremendous use brought the critical situation of masks shortage to the global society.
In order to overcome facial masks deficit, several research teams investigated new methodologies to reuse facial masks. Cumulative solutions, such as hydrogen peroxide, ethylene oxide and autoclave, enable a complete decontamination after mask treatment [1-3]. Nevertheless, to avoid the loss of the masks filtration capacity, they cannot be wetted or washed. Therefore, it becomes crucial to find an effective procedure to clean the masks allowing both for a microbiologically security and the preservation of the filtration efficiency.
Supercritical Carbon Dioxide ($ScCO_2$)-based processes could help to clean these protective masks thanks to its solvent properties and sterilizing abilities. In this study, we explored different varying parameters (pressure, temperature and cosolvents) to clean FFP2 protective masks. Our ultimate goals were to be able to (i) clean and sterilize the FFP2 masks and (ii) to preserve the filtration efficiency of FFP2 masks after our $scCO_2$- based treatment.

2. Materials and Methods

To do so, we developed a full experimental set up to clean and sterilize the FFP2 masks using $scCO_2$-based treatments (**Fig. 1**).

The cleaning procedure was performed using a deposit of soiling solution on the masks to mimic dirty conditions (*i.e.* a mixture of bovin serumalbumin and sheep erythrocytes). To evaluate the biocide effect (*i.e.* effective killing of biological elements) of our treatment we added a biologic indicator, which are spores of *Geobacillus stearothermophilus*, to the soiling solution. We also investigated the filtration performance of the FFP2 masks after the ($scCO_2$)-based treatment.

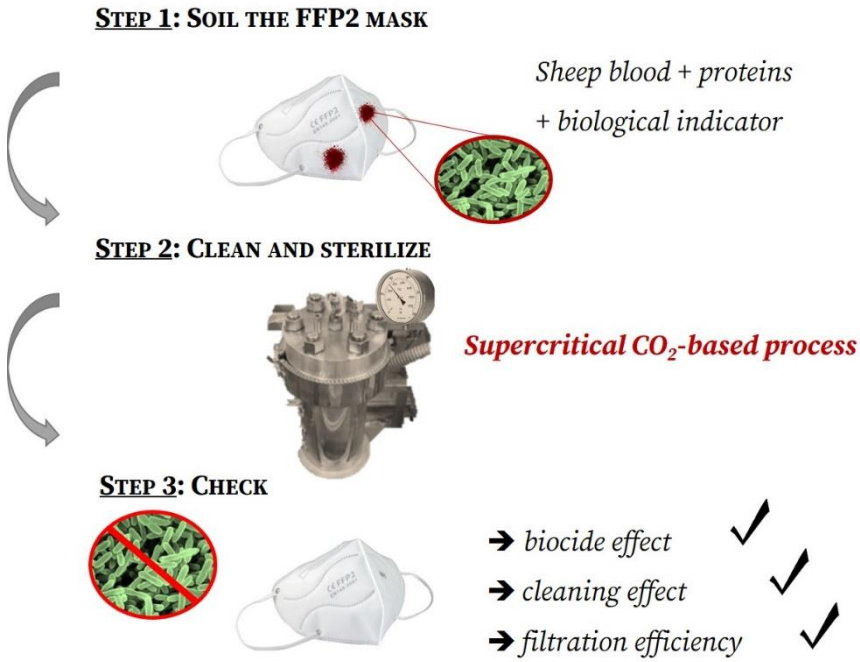

Figure 1. Sketch of our protocol to clean and sterilize FFP2 masks based on supercritical CO_2-based process.

3. Results and discussion

To assess the $scCO_2$ treatments effect on both cleaning, sterilizing and filtration capacities, we compared both treated and untreated FFP2. Our treatment led to good results: indeed, (i) the first visual quantification confirmed that the treatment was efficient to remove both blood and proteins strains. (ii) The $scCO_2$-based treatment totally inactivated spore's population (> 6 $\log_{10}$ of the initial spore deposit). In addition, (iii) one or even two cycles of the $scCO_2$ treatment did not alter the filtration performances, the filtration efficiencies were higher than 98.9% (SD = 0.05%), above the minimal 94% required for normative certification of FFP2. This method relies on the use of supercritical CO_2 and the use of a co-solvent to sterilize and clean FFP2 masks, without altering filtration performances. Therefore, it is an effective $scCO_2$-based treatment to reach all the required steps to reuse facial masks [(4)].

4. Conclusions

Our $scCO_2$-based process is the first procedure meeting all the safety microbiological requirements to reuse facial masks, while preserving the filtration properties of FFP2 masks. Our method does not require a complex facility; therefore, this one-step approach could be easily implemented within different societal units (*i.e.* hospitals, rest home, *etc*.) to reuse FFP2 masks.

References

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