Development of an innovative decontamination method tailored for the Biomedical and Food industry based on the utilization of supercritical carbon dioxide (scCO2)

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The project aims to develop and optimize an innovative method for preserving solid food products using carbon dioxide in its supercritical state. The goal is to achieve a high level of product conservation through a non-thermal pasteurization process, which maintains product safety while preserving nutritional and organoleptic properties, an increasingly relevant need in the context of clean-label and minimally processed food demand.

The process is based on a patented technology developed by University of Padua. It involves pressurizing food items within a Modified Atmosphere Packaging (MAP) system containing carbon dioxide until supercritical conditions are reached. Under these thermodynamic conditions, CO_2 exhibits enhanced diffusivity and solvating power, effectively inactivating microorganisms and enzymes without requiring thermal treatment, thus minimizing impact on product texture, flavor, and appearance.

The initial phase of the project will consist of the selection of products of industrial interest, based on criteria such as structure, composition, water activity, and shelf-life sensitivity. This will be followed by a comprehensive analysis of the selected products, aimed at evaluating their behaviour and responsiveness to supercritical CO_2 processing.

The core innovation lies in the integration of a bi-directional valve into the packaging system, designed to allow more precise control of pressure dynamics and gas exchange, thereby improving the overall performance and repeatability of the process. The optimization of both packaging and process parameters will be carried out in parallel, with particular attention to the interaction between packaging material, sealing performance, and process kinetics.

In a later phase, the project will assess the scalability and feasibility of industrial implementation. This includes the design of pilot and industrial-scale systems, technical and economic feasibility studies, and the development of process protocols suitable for integration into existing food manufacturing lines. The ultimate goal is to provide an advanced, clean, and energy-efficient pasteurization solution that enhances shelf life while aligning with sustainability goals.

Additionally, the potential application of this technology to biomedical products will be explored. This opens new avenues for cross-sector innovation in the preservation and sterilization fields.

The research is in collaboration with Goglio S.p.A., leader in advanced flexible packaging technologies, whose support underscores the project's industrial relevance and alignment with sustainable, future-oriented food processing strategies.

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