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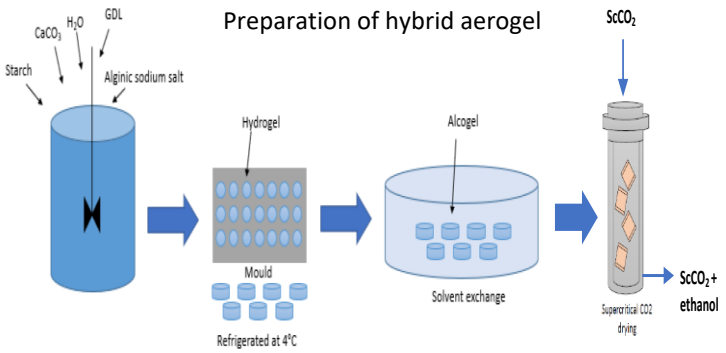
Enhancing Drug Delivery: Advancements in Hybrid Aerogels and Supercritical CO_2 Drying

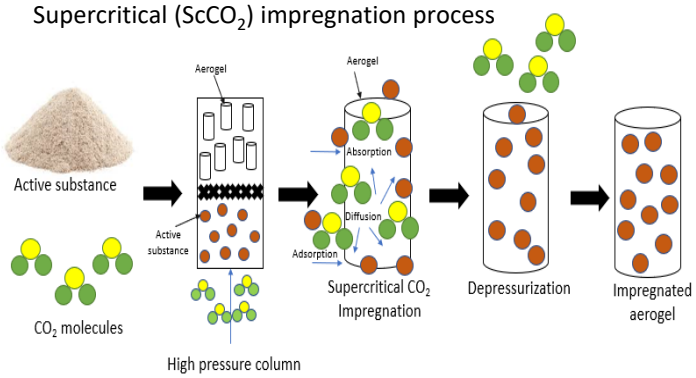
Supercritical fluid technology is a new approach in the pharmaceutical industry that uses supercritical fluids, mainly carbon dioxide (CO_2), to enhance drug delivery systems. These fluids exhibit unique properties of liquids and gases, making them ideal for aerogel production in drug delivery applications.

Aerogels are open porous materials with large specific surface areas and high pore volume, making them attractive for drug carriers. They have been studied for their biodegradability and biocompatibility, making them promising carriers for drug delivery systems. Polysaccharides like cellulose, starch, and alginates are used to prepare organic aerogels, which are relatively inexpensive, highly biocompatible, and non-toxic.

Preparation of hybrid aerogel



Supercritical ($ScCO_2$) impregnation process



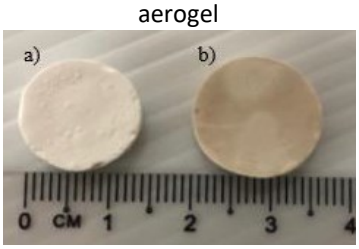
Oral administration is the most common route for drug delivery, and recent studies have focused on the pharmacokinetic and pharmacodynamic properties of drugs. Researchers are now using polysaccharides to prepare oral film-coated drugs, potentially for disease prevention and treatment. Hybrid aerogels made from variations of polysaccharides have shown

potential for improving mechanical strength and tailoring drug delivery to a fast or controlled released system.

Hybrid alginate/starch aerogels were synthesised and dried using supercritical CO_2 ($ScCO_2$). The results showed that increasing the starch content by 15wt% reduced volume shrinkage and increased thermal stability, making them more promising for drug delivery systems and biomedical applications.

Supercritical drying of blank hybrid alginate/starch aerogel

Impregnation of *Labisa pumila* into hybrid alginate/starch aerogel



In-situ impregnation was the best method for producing amorphous *Labisia pumila* encapsulated in the aerogels, as the drug loading is higher, and the aerogels offer accurate dose delivery. Further investigation is needed to find the most suitable organic solvent with high solubility with *Labisia pumila* and immiscible with CO_2 to increase compound loading. This research lays the groundwork for future studies on drug delivery methods by combining hybrid aerogels and herbal materials. With additional research and improvements, hybrid aerogels have the potential to be an effective tool for precise and efficient drug delivery. This has the potential to benefit patients and advance the fields of pharmaceuticals and biomedicine.

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