Supercritical CO₂: a ‘green’ route for the encapsulation of drugs

INTRODUCTION

Supercritical Carbon-dioxide (CO₂) is fast becoming an important commercial and industrial solvent of choice, largely due to its solubility efficiency and low environmental impact. In many instances, supercritical CO₂ can replace the use of hazardous solvents as well as limit the use of precious water resources. Due to its “green” characteristics, much research has focused on using supercritical CO₂ as solvent for the preparation of pharmaceutical and food products. At the Centre for Scientific and Industrial Research (CSIR), we have already developed and patented an encapsulation method using supercritical CO₂ and we are currently investigating the development of a novel transdermal drug delivery system using this technology to further strengthen our expertise in this field.

SUPERCRITICAL CO₂ – AN OVERVIEW

When CO₂ is raised above its critical pressure of 73.8 bar and critical temperature of 31.1 ºC, it becomes supercritical (Figure 1). In the supercritical phase, CO₂ possesses a unique combination of properties: it has the density of a liquid, giving it salting characteristics similar to liquid solvents, yet it has a gas-like viscosity, imparting on it favourable mass transfer properties. The density of supercritical CO₂ can also be easily “tuned” by small changes in pressure which means that its solvent power can be altered without changing its molecular structure.

CO₂, as replacement for conventional solvents is increased by its perceived “green” properties: it is non-flammable, non-toxic, recyclable and relatively inert. In addition, the difficulties posed with residual solvent are eliminated since CO₂ is gaseous at ambient conditions and can thus be removed from the product completely.

These favourable characteristics have led to a number of applications in which supercritical CO₂ is used as processing medium. For instance, small molecules such as caffeine, essential oils, omega-3 fats and spices can be extracted. Solubility of CO₂ in various polymers allows for impregnation with CO₂, which results in homogenous blends. Upon CO₂ venting, PEG-PVP hydrogen-bond interactions were initiated. Thus, with supercritical CO₂ technology, it was possible to form PEG-PVP polymer networks in rapid time without the use of high temperatures or toxic solvents.

CONCLUSIONS

• The use of supercritical CO₂ as “green” solvent is showing rapid growth internationally.
• Supercritical CO₂ technology is particularly useful in the food and pharmaceutical industries;
• The CSIR has already successfully encapsulated sensitive active ingredients using supercritical CO₂ as process medium; and
• With supercritical CO₂ as solvent, transdermal drug delivery systems can be prepared in rapid time without the use of toxic solvents or elevated drying temperatures.

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REFERENCES