The 5 th Biopharm Scientific Annual Meeting
BSAM5, Alger le 28 juin 2025

DESIGN AND CHARACTERIZATION OF LIPID-BASED NANOCARRIERS FOR ENHANCED TOPICAL ANTIFUNGAL THERAPY

D. MANCER [1*], F. AGOUILLAL[2,3,4], K. DAOUD [1]

[1]Laboratory of Transfer Phenomena, Faculty of Mechanical and Process Engineering, University of Science and Technology Houari Boumediene (USTHB), Algiers, Algeria
[2]Centre de Recherche Scientifique et Technique en Analyses Physico-Chimiques, CRAPC, Tipaza, Algeria
[3]Unité de Recherche en Analyses Physico-Chimiques des Milieux Fluides et Sols, URAPC-MFS/CRAPC, Algiers, Algeria
[4]Laboratory of Reaction Engineering, Faculty of Mechanical and Process Engineering, University of Science and Technology Houari Boumediene (USTHB), Algiers, Algeria

Abstract

This study developed ciclopirox olamine (CPX)-loaded solid lipid nanoparticles (SLNs) to address the drug's poor bioavailability and short half-life. Using a high-speed homogenization-ultrasonication method optimized by central composite design, the SLNs achieved a size of 247.66 nm, a Span of 2.405, and 91.57% encapsulation efficiency. Structural analyses confirmed successful drug incorporation, and in vitro drug release tests showed sustained drug release compared to free CPX, highlighting SLNs as a promising strategy for improved topical antifungal therapy.

Key-words : *Ciclopirox olamine; Solid lipid nanoparticles (SLNs); Encapsulation; Topical drug delivery*

1-INTRODUCTION

Ciclopirox olamine (CPX) is a broad-spectrum antifungal agent limited by poor bioavailability and a short half-life. Solid lipid nanoparticles (SLNs) have emerged as a promising strategy to enhance CPX delivery by improving stability, controlling release, and promoting penetration through skin and nails. When incorporated into nail lacquers, SLNs offer sustained release, prolonged nail adhesion, and improved local bioavailability, making them an effective approach for treating fungal nail infections.

2-MATERIAL & METHODES

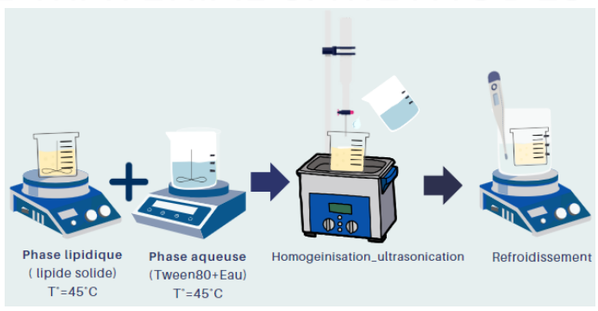

Figure 1: High-speed ultrasonic homogenization process.

Table 1: Central composite design for the optimization of ciclopirox olamine-loaded nanoparticles

N°	Coded variables			d_{eq} (nm)	Span	EE (%)
	X_1	X_2	X_3			
1	-	0	0	333,325	4,33	86,837
2	0	-	0	222,711	2,624	89,94
3	+	-	+	291,885	3,127	79,312
4	-	+	-	244,147	2,459	82,337
5	0	0	0	212,45	3,58	88,29
6	-	-	-	384,811	1,52	86,061
7	+	+	+	292,549	2,534	78,07
8	0	0	0	218,923	3,9	90,354
9	-	+	+	222,605	3,71	87,246
10	0	0	+	184,661	3,25	89,716
11	0	0	-	184,916	2,98	90,974
12	+	0	0	365,211	4,09	82,57
13	+	-	-	323,717	3,05	93,147
14	+	+	-	197,603	3,47	88,569
15	0	+	0	228,748	2,8	87,652
16	-	-	+	211,406	3,52	93,457
17	0	0	0	250,745	3,98	87,225

3-RESULTS & DISCUSSION

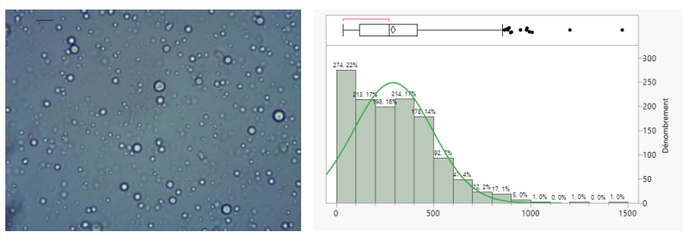

Figure 2: Microscopic observation and granulometric distribution of the SLN

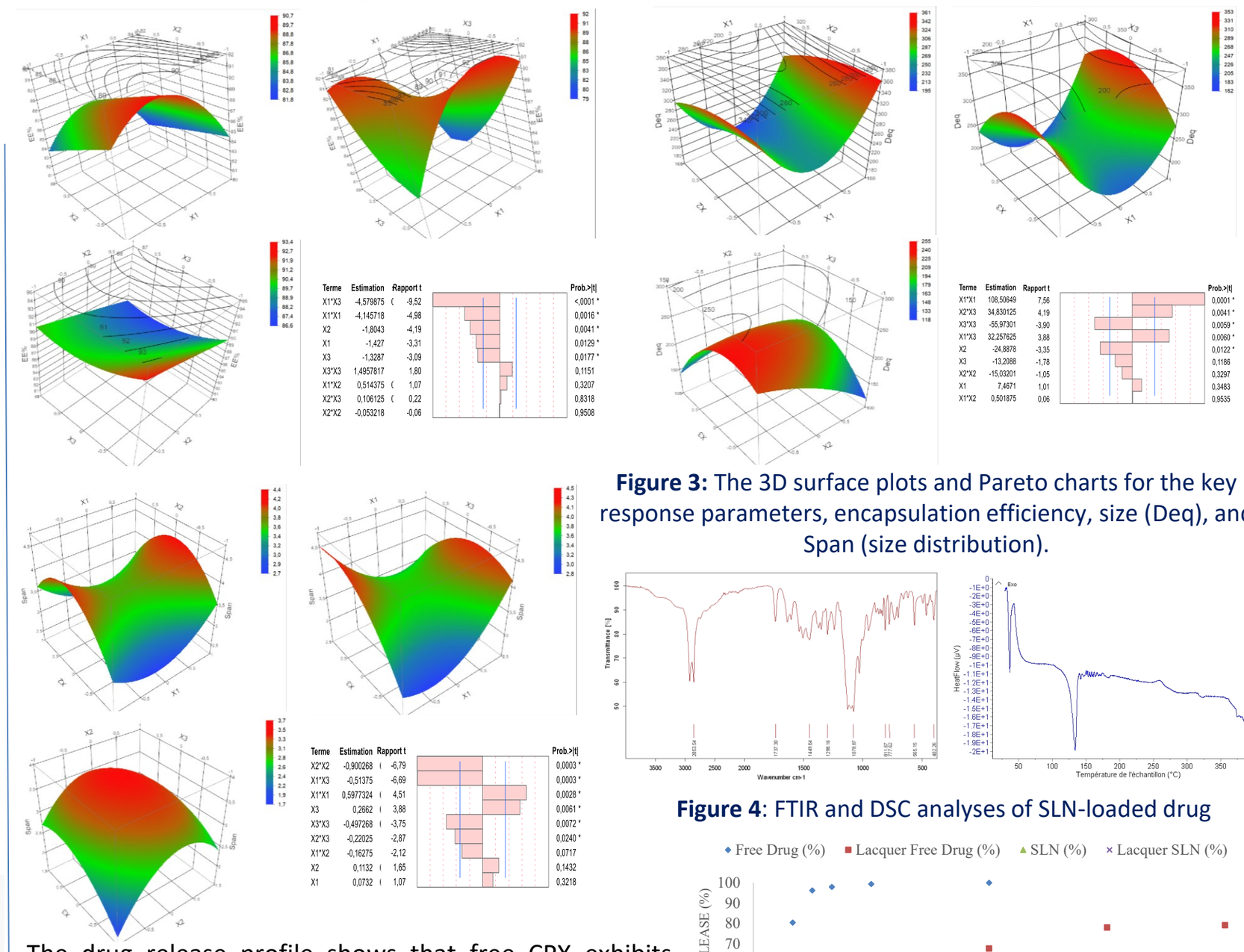

Figure 3: The 3D surface plots and Pareto charts for the key response parameters, encapsulation efficiency, size (Deq), and Span (size distribution).

Figure 4: FTIR and DSC analyses of SLN-loaded drug

The drug release profile shows that free CPX exhibits rapid and complete release within 10 hours, while SLN and lacquer-based formulations significantly slow the release. Notably, lacquer SLNs demonstrated the most sustained release over 48 hours, highlighting their potential to prolong drug availability and enhance therapeutic efficacy in topical applications.

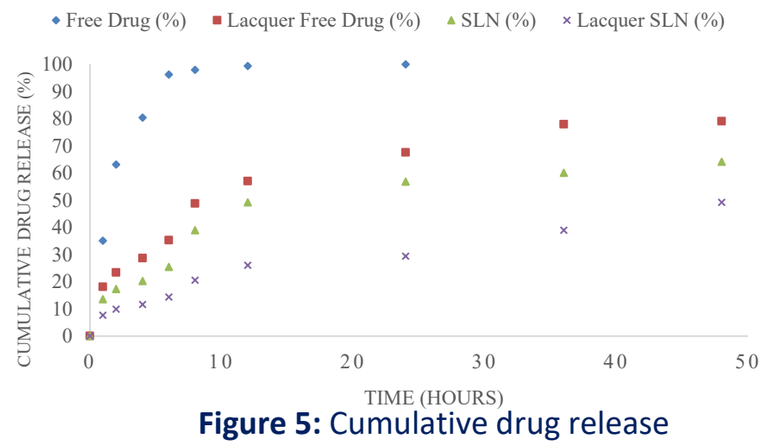

Figure 5: Cumulative drug release

4-CONCLUSION

The 3D surface plots illustrate the influence of independent variables these plots reveal significant interactive effects among formulation variables, guiding the identification of optimal conditions. The Pareto charts highlight the statistical significance of each factor and their interactions, supporting model reliability and response sensitivity. The FTIR spectrum confirms the chemical integrity of CPX within the SLNs, showing no major peak shifts or loss of functional groups, while the DSC thermogram indicates successful drug encapsulation, evidenced by the disappearance or broadening of CPX's characteristic melting peak. Together, these data affirm the robustness of the formulation strategy, supporting the development of a stable and efficient SLN system for topical antifungal delivery.

References

Rarokar, N. R., Menghani, S. S., Kerzare, D. R., Khedekar, P. B., Bharne, A. P., Alamri, A. S., ... & Asdaq, S. M. B. (2022). Preparation of terbinafin-encapsulated solid lipid nanoparticles containing antifungal Carbopol® hydrogel with improved efficacy: in vitro, ex vivo and in vivo study. *Pharmaceutics*, *14*(7), 1393.

Almawash, S. (2023). Solid lipid nanoparticles, an effective carrier for classical antifungal drugs. *Saudi Pharmaceutical Journal*, *31*(7), 1167-1180.

Fatima, F., Aleemuddin, M., Ahmed, M. M., Anwer, M. K., Aldawsari, M. F., Soliman, G. A., ... & Alshehri, S. (2022). Design and evaluation of solid lipid nanoparticles loaded topical gels: repurpose of fluoxetine in diabetic wound healing. *Gels*, *9*(1), 21.