Network pharmacology guided development and optimization of curcumin and sesame oil nanostructured lipid carriers for psoriasis

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Introduction

Psoriasis is a chronic inflammatory skin disease requiring long-term management. Natural compounds such as curcumin and sesame oil have antioxidant and anti-inflammatory properties, but poor solubility, low stability, and limited skin permeability limit their use. This study developed and optimized a nanostructured lipid carrier (NLC) co-loaded with curcumin and sesame oil using response surface methodology, achieving a particle size of ~132 nm, PDI 0.208, and sustained curcumin release over 24 h. Physicochemical characterization confirmed nanoscale, spherical, and amorphous particles, and in vitro assays showed good biocompatibility and strong antioxidant activity. Network pharmacology analysis identified key targets and pathways (TNF, IL1B, IL10, CASP3; IL-17, TNF, oxidative stress), supporting multi-target therapeutic potential. This dual-evidence approach highlights curcumin–sesame oil NLCs as a promising platform for psoriasis treatment

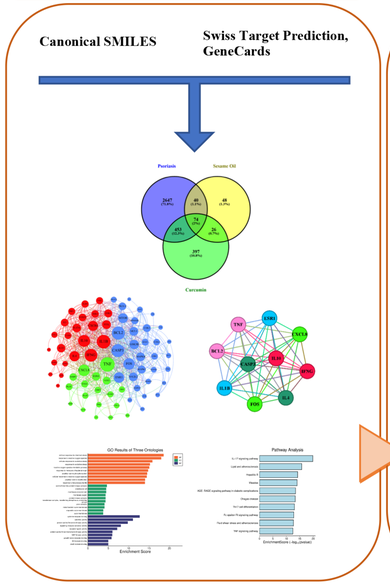
Methods

A nanostructured lipid carrier (NLC) co-loaded with curcumin and sesame oil was designed and optimized using response surface methodology (RSM). Two independent variables—liquid-to-solid lipid ratio (0.25–0.40) and homogenization time (5–10 min)—were evaluated to minimize particle size (PS) and polydispersity index (PDI). The optimized formulation was characterized for physicochemical properties (DLS, SEM, XRD), in vitro curcumin release, biocompatibility (MTT assay on human fibroblasts), and antioxidant activity (DPPH assay). Network pharmacology analysis was performed to identify overlapping targets of curcumin, sesame oil, and psoriasis and to explore involved pathways

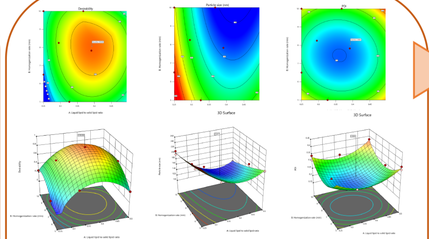
Results

Psoriasis is a chronic inflammatory skin disease requiring long-term management. Natural compounds such as curcumin and sesame oil have antioxidant and anti-inflammatory properties, but poor solubility, low stability, and limited skin permeability limit their practical use. This study aimed to develop, optimize, and characterize nanostructured lipid carriers (NLCs) co-loaded with curcumin and sesame oil for potential dermal application in psoriasis, integrating network pharmacology to explore therapeutic relevance.The NLC formulation was optimized using response surface methodology with liquid-to-solid lipid ratio (0.36) and homogenization time (8 min) as variables, achieving a desirability score of ~0.903. The optimized NLCs had a particle size of ~132 nm, low polydispersity (PDI 0.208), and spherical, amorphous morphology confirmed by DLS, SEM, and XRD. In vitro release studies demonstrated sustained curcumin release over 24 h. MTT assays on human fibroblasts indicated minimal cytotoxicity, and DPPH assays confirmed preserved antioxidant activity.Network pharmacology identified 74 overlapping targets of curcumin, sesame oil, and psoriasis, including TNF, IL1B, IL10, and CASP3, involved in inflammation, oxidative stress, and apoptosis. GO and KEGG analyses highlighted modulation of IL-17, TNF, and oxidative stress pathways, supporting multi-target therapeutic potential.These findings indicate that curcumin–sesame oil NLCs are a promising platform for psoriasis treatment. However, results are limited to in vitro studies, and predicted mechanisms require experimental validation. Future research should include in vivo and clinical evaluations to confirm therapeutic efficacy.

I. Network pharmacology



II. Experimental design and Optimization



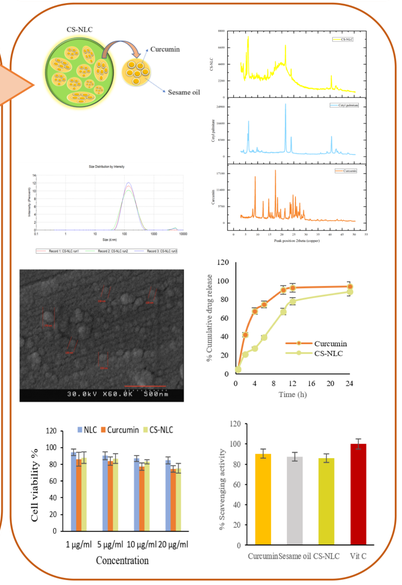
Variables and their levels in the experiment design

Independent variables	Levels -1	Levels 1	Dependent variables	Units	Goal
Liquid lipid to solid lipid ratio (A)	0.25	0.40	PS	nm	Min
Homogenization time (B) (min)	5	10	PDI	-	Min

Experimental design matrix and results of D-optimal design

Run	A	B	PS	PDI
1	0.4	7.25	170	0.29
2	0.29575	5	180	0.29
3	0.4	10	128	0.36
4	0.25	10	210	0.34
5	0.33475	7.825	128	0.18
6	0.25	10	198	0.31
7	0.277	8.25	170	0.23
8	0.4	5	150	0.36
9	0.3205	10	130	0.31
10	0.4	5	153	0.34
11	0.29575	5	185	0.28
12	0.4	10	127	0.38
13	0.25	6.5	230	0.27

II. In vitro evaluation of CS-NLCs



Conclusions

Curcumin–sesame oil NLCs were successfully developed and optimized, demonstrating controlled release, preserved antioxidant activity, and minimal cytotoxicity. Network pharmacology suggested multi-target potential against key inflammatory and oxidative pathways in psoriasis. These results provide a promising basis for future in vivo and clinical studies of herbal nanoformulations for chronic inflammatory skin diseases