Chapter 6

Comparative Analysis

6. Introduction

Solid lipid nanoparticles and nanostructured lipid carriers are two advanced drug delivery systems that have gained significant attention in the field of nanomedicine due to their potential to improve the bioavailability, stability, and controlled release of therapeutics. While both SLNs and NLCs are lipid–based nanocarriers, they differ fundamentally in their structure and composition, leading to variations in their drug–loading capacity, stability, and release profiles. SLNs are composed of a solid lipid matrix, while NLCs combine both solid and liquid lipids, allowing for improved flexibility in encapsulating lipophilic drugs. This comparative analysis explores the key differences and similarities between SLNs and NLCs, focusing on their formulation, performance, and applications in drug delivery.

6.1. Comparative analysis for pharmaceutical attributes

Table 6. 1: Comparative analysis between SLNs and NLCs for pharmaceutical attributes

Attributes	DOC–SLNs	DOC–NLCs	ERL–SLNs	ERL–NLCs	FA–DOC–SLNs	FA–DOC–NLCs	FA–ERL–SLNs	FA–ERL–NLCs
PS (nm)	118.42± 2.20	123.80± 2.10	102.66± 1.45	120.57± 2.76	128.33± 2.65	153.20± 2.52	125.40± 3.22	147.40± 3.32
PDI	0.212± 0.006	0.175± 0.004	0.217± 0.002	0.213± 0.003	0.250± 0.005	0.241± 0.005	0.245± 0.001	0.258± 0.001
ZP (mV)	-15.33± 0.59	-15.15± 0.43	-14.57± 0.32	-16.45± 0.32	-12.26± 0.22	-12.16± 0.45	-11.44± 0.15	-12.86± 0.55
% EE	73.47± 1.11	78.68± 1.41	77.53± 1.06	95.53± 1.52	73.16± 1.45	80.56± 1.85	78.84± 1.53	96.34± 1.55
% DL	3.15± 0.06	4.09± 0.01	4.20± 0.02	4.13± 0.03	3.17± 0.05	4.10± 0.05	4.16± 0.04	4.20± 0.02
% Release profile in pH 7.4	65.60± 1.80	72.60± 1.25	67.7± 2.71	70.72± 1.73	50.9± 2.50	45.90± 1.84	52.70± 2.30	49.70± 1.35
% Release profile in pH 5.5	70.23± 2.60	76.51± 1.65	69.13± 1.50	79.63± 1.50	90.14± 2.60	95.14± 1.67	85.24± 2.50	94.50± 1.88

Values are presented as mean±SD (n=3)

6.2. Pharmacokinetic study

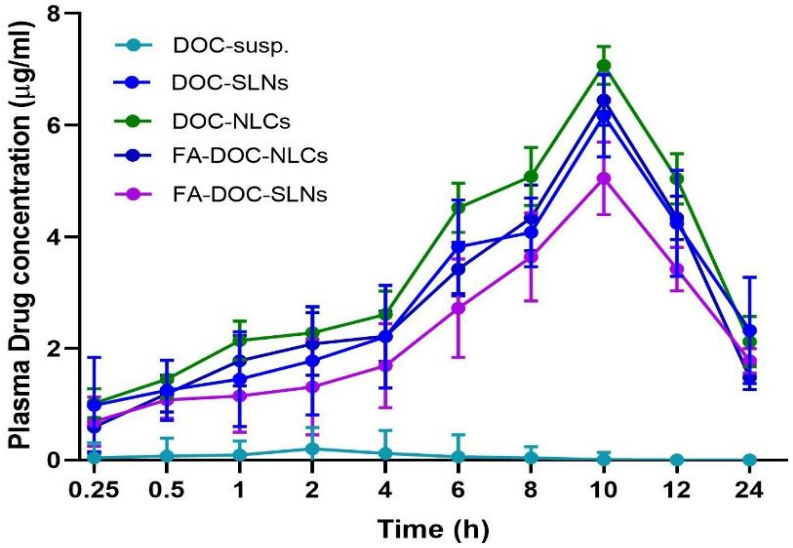

Figure 6. 1: Pharmacokinetic profile of DOC as suspensions, and their corresponding loaded SLNs, NLCs, FA–SLNs, and FA–NLCs after oral administration. DOC was administered equivalent to 10 mg/kg. 'susp.' indicates suspension. Data are presented as mean±SD (n=5).

Table 6. 2: Comparative pharmacokinetic profile of DOC–loaded lipid–based nanoformulations

Parameters	**DOC susp.**	**DOC–SLNs**	**DOC–NLCs**	**FA–DOC–SLNs**	**FA–DOC–NLCs**
T1/2 (h)	1.64± 0.40	11.65± 0.23**	8.54± 0.25**	10.27± 0.16*	6.95± 0.21*
Tmax (h)	2	10**	10**	10**	10**
Cmax (µg/ml)	0.20± 0.06	6.17± 0.54**	7.07± 0.44**	5.05± 0.27*	6.45± 0.31*
AUC_{0-t} (µg/ml*h)	0.85± 0.04	70.63± 2.07**	79.38± 1.78**	64.23± 1.84**	77.17± 1.67**
MRT_{0-t} (h)	3.72± 0.59	20.58± 0.51**	16.74± 0.48**	19.62± 0.68**	14.65± 0.72**
CL/F ((mg/kg)/(µg/ml)/h))	23.24± 0.27	0.17± 0.08**	0.17± 0.07**	0.22± 0.16**	0.22± 0.06**
Fr	-	83.06 ± 3.14	93.36± 3.21	75.56± 1.45	75.56± 1.27

Values are represented as Mean±SD, n=5. Statistical analysis was performed by one–way ANOVA followed by the Tukey P test with multiple comparisons and the level of significance *p<0.05 and **p<0.01 with respect to DOC suspension

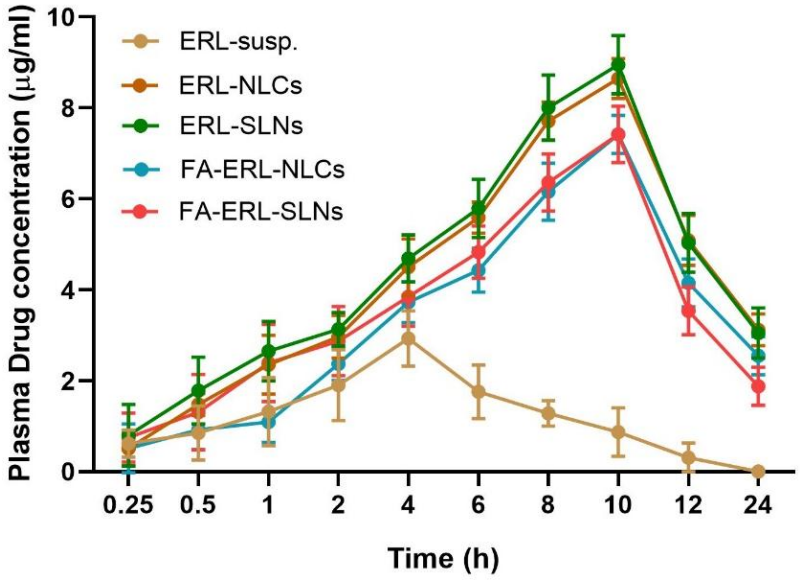

Figure 6. 2: Pharmacokinetic profile of ERL as suspensions, and their corresponding loaded SLNs, NLCs, FA–SLNs, and FA–NLCs after oral administration. ERL was administered equivalent to 30 mg/kg. Data are presented as mean±SD (n=5).

Table 6. 3: Comparative pharmacokinetic profile of ERL–loaded lipid–based nanoformulations

Parameters	**ERL susp.**	**ERL–SLNs**	**ERL–NLCs**	**FA–ERL–SLNs**	**FA–ERL–NLCs**
T1/2 (h)	2.67± 0.60	10.73± 0.28**	11.24± 0.24**	8.43± 0.33**	10.86± 0.37**
Tmax (h)	4	10**	10**	10 **	10 **
Cmax (µg/ml)	2.93± 0.15	8.95± 0.68**	8.65± 0.73**	7.42± 0.43**	7.22± 0.48**
AUC_{0-t} (µg/ml*h)	18.30± 0.56	115.94± 2.42**	117.15± 2.31**	87.76± 1.48**	92.68± 1.52**
MRT_{0-t} (h)	5.74± 0.35	19.31± 1.55**	20.17± 1.32**	15.77± 0.72**	19.89± 0.55**
CL/F ((mg/kg)/(µg/ml)/h))	2.56± 0.21	0.31± 0.05**	0.30± 0.06**	0.45± 0.08**	0.38± 0.08**
Fr	-	6.33± 1.23	6.40± 0.32	4.79± 1.16	5.06± 0.29

Values are represented as Mean±SD, n=5. Statistical analysis was performed by one–way ANOVA followed by the Tukey P test with multiple comparisons and the level of significance *p<0.05 and **p<0.01 with respect to ERL suspension

6.3. *In vivo* anticancer efficacy study

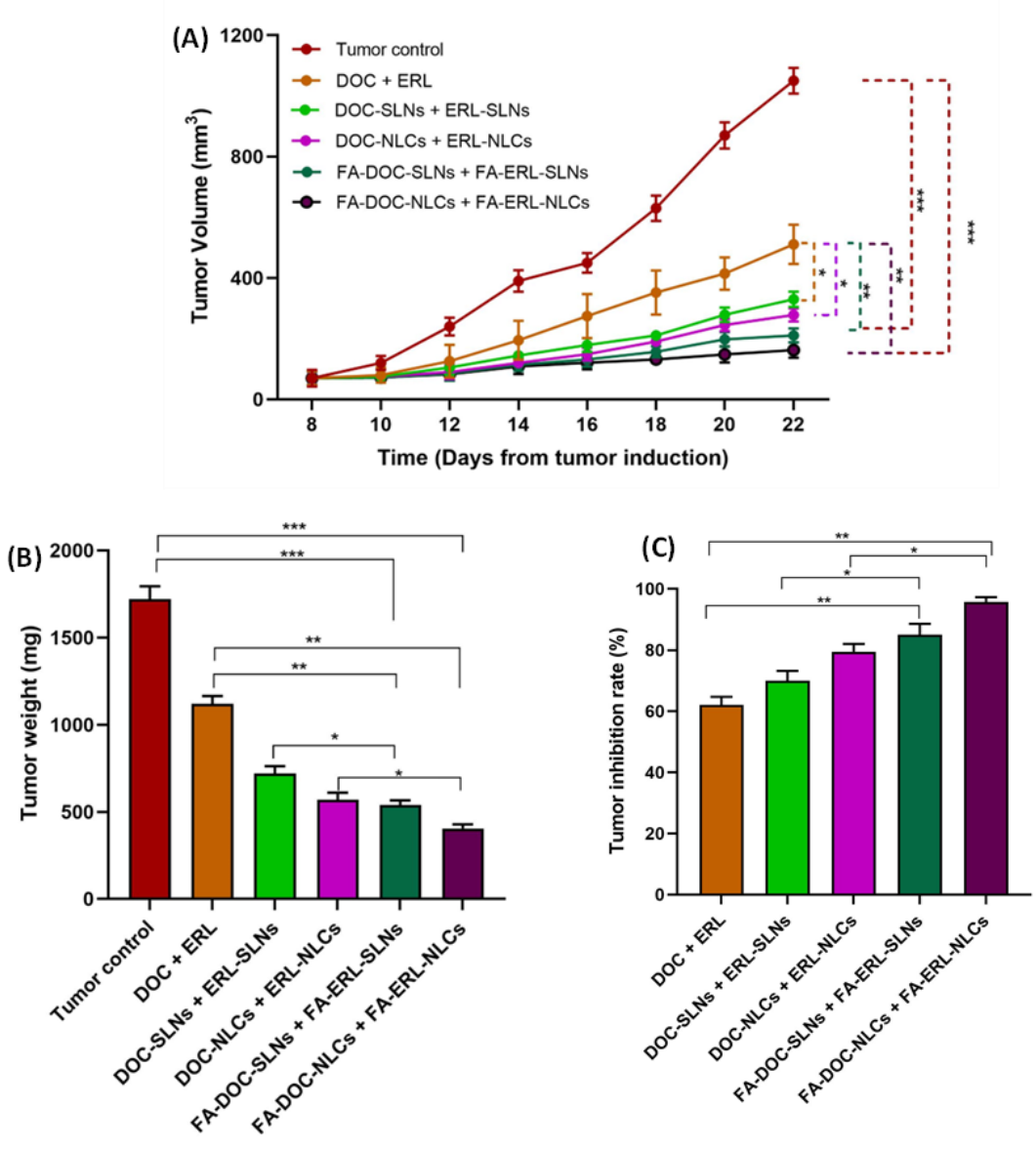

Figure 6. 3: Tumor regression analysis representing the tumor volume in different treatment groups with respect to time, tumor weight, and percent tumor growth inhibition. Data are presented as mean±SD (n=5). One–way ANOVA was employed for establishing the statistical analysis followed by the Tukey P test with multiple comparisons. The level of significance recorded as *p<0.05, **p<0.01, and ***p<0.001

6.4. Conclusion

The pharmacokinetic study revealed no statistically significant differences in oral bioavailability between SLNs and NLCs when administered at the same doses. Similarly, no notable differences in anticancer efficacy were observed between the two lipid–based nanoformulations, as evidenced by comparable tumor volume, tumor weight, and tumor inhibition rates. However, variations were identified in certain pharmaceutical properties, such as % entrapment efficiency, % drug loading capacity, and drug release profiles. In these parameters, NLCs demonstrated significantly superior performance compared to SLNs ($p<0.05$), indicating their potential advantages in drug delivery applications.