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Nanoparticle and lipid nanocapsule formulations to enhance benznidazole dissolution: comparative evaluation and kinetic modeling

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INTRODUCTION & AIM

Benznidazole (BNZ), a poorly water-soluble drug, is the first-line treatment for Chagas disease. This study aimed to compare benznidazole-loaded nanoparticles (NPs) and lipid nanocapsules (LNCs), with diameters of approximately 50 nm, with the pure drug, focusing on dissolution enhancement and kinetic modeling to provide strategies for improving oral bioavailability.

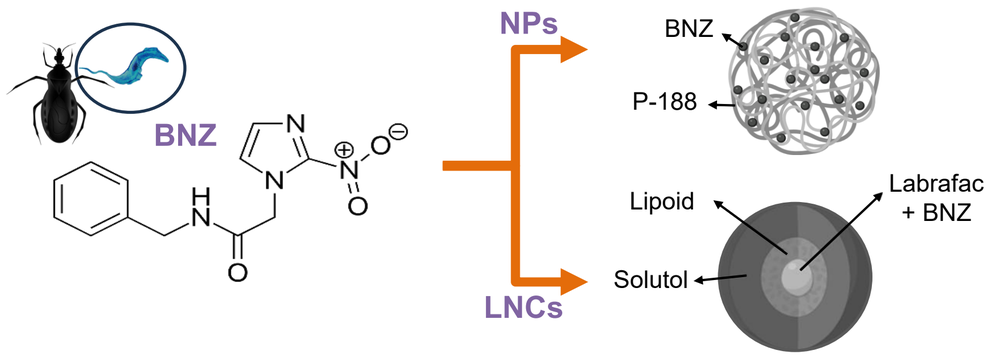


Figure 1. Structure of BNZ, NPs and LNCs.

METHOD

NPs obtaining: Liquid anti-solvent precipitation process[a].

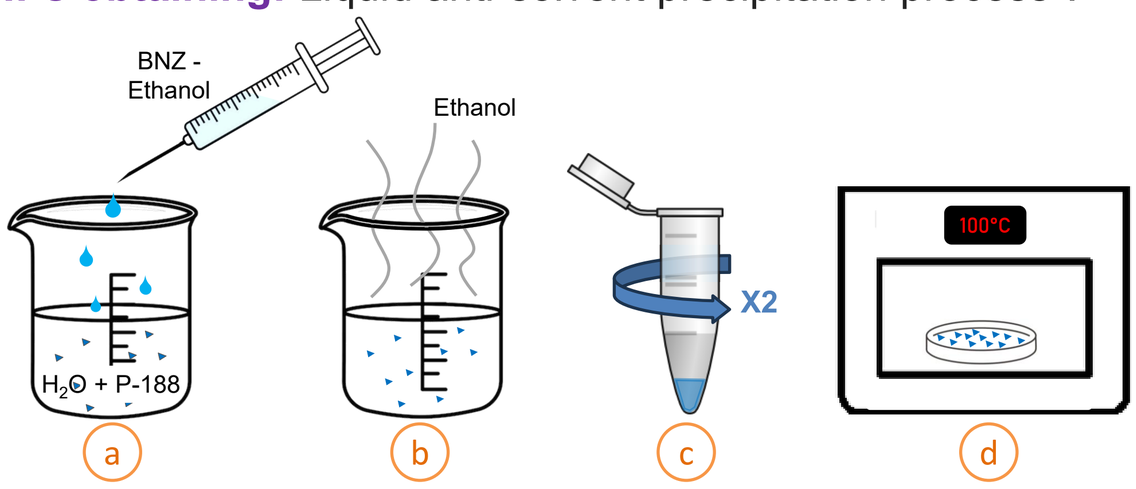


Figure 2. Steps for NPs preparations: a) dispersion, b) evaporation of ethanol, c) centrifugation, washing with water and centrifugation, d) oven drying.

LNCs obtaining: Phase inversion technique[b].

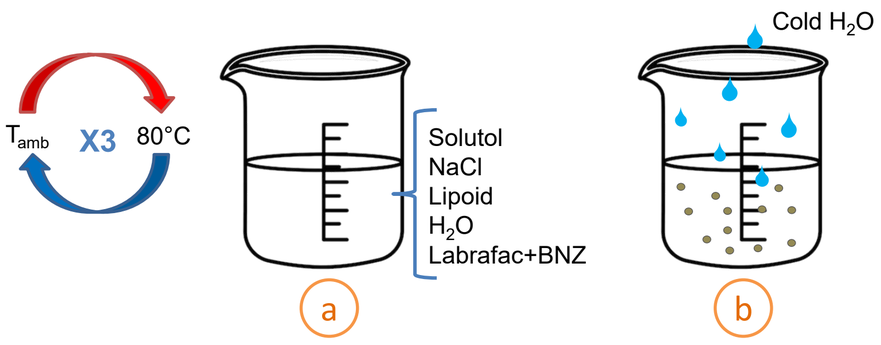
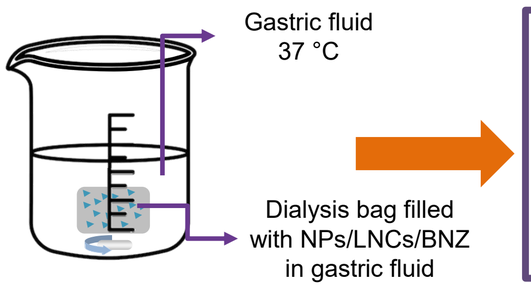


Figure 3. Steps for LNCs preparations: a) 3 cycles of heating and cooling, b) cold dissolution.

***In vitro* assay**



$$M_t = \frac{a * t}{1 + b * t}$$

a, b: model parameters

t: time

M_t: % of drug release in t

Figure 4. Dissolution test and Lumped-Gonzo Model equation.

RESULTS & DISCUSSION

The release profiles of BNZ are presented in the Figure 5, while Table 1 shows the model parameters and also those of pharmaceutical relevance associated with the profiles.

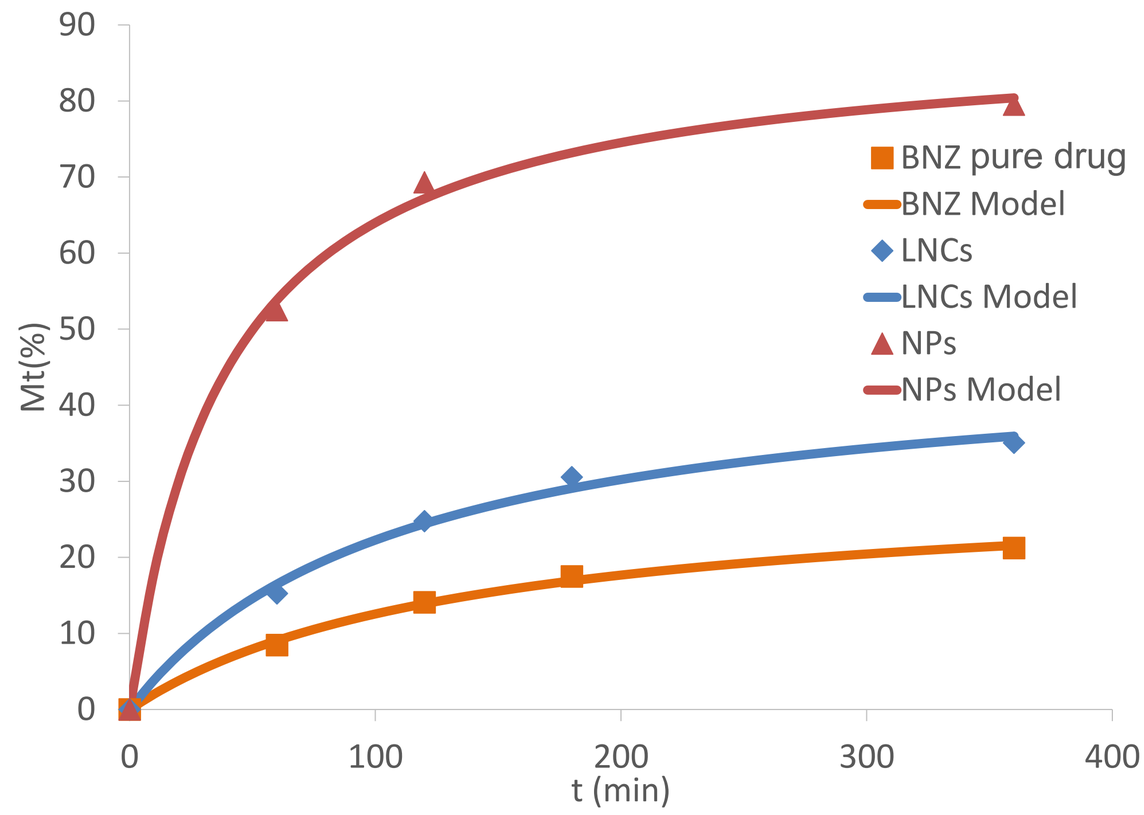


Figure 5. BNZ release profiles from NPs, LNCs or pure drug. The solid lines represent the modeled profiles while the markers are experimental points data.

Table 1. Model parameters and pharmaceutical relevance ones.

Systems	Model parameters			M_∞ (%)	$t_{20\%}$ (min)	$MDT_{20\%}$ (min)	DE_{360min} (%)
	a	b	R^2				
BNZ	0.2170	0.0073	0.9970	29.8	280.4	90.258	15.2
LNCs	0.4228	0.0090	0.9942	47.0	82.3	33.630	26.1
NPs	2.2631	0.0254	0.9981	89.2	11.4	5.215	66.6

CONCLUSION

Both formulations enhanced BNZ dissolution compared with the pure drug, with LNCs showing a moderate but sustained effect and NPs achieving a higher and faster release. These findings highlight the potential of nanocarriers, particularly NPs, as promising platforms for improving BNZ oral bioavailability.

REFERENCES

[a]Arrua EC, et al. Improving the oral delivery of benznidazole nanoparticles by optimizing the formulation parameters through a design of experiment and optimization strategy. Colloids Surf B Biointerfaces. 2022.

[b]Arrua EC, et al. Formulation of benznidazole-lipid nanocapsules: Drug release, permeability, biocompatibility, and stability studies, Int J Pharm. 2023.