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Evaluation of the Physicochemical Properties of PLGA–TPGS Nanoparticles as Functional Biomaterials for Ocular Applications

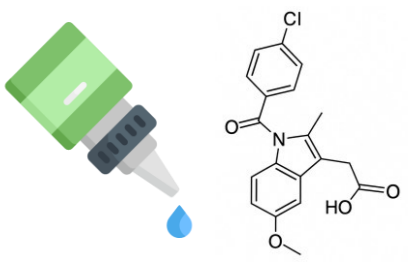
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Introduction

Corneal epithelial injuries are common and clinically significant due to **pain**, **inflammation, the risk of infection**, and **potential vision loss [1]**.

Conventional eye-drop treatments with NSAIDs



Indomethacin (IND)

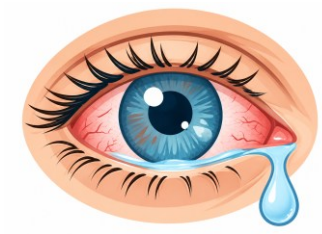
Effective in COX inhibition, but have **low solubility** (BCS Class II) [2].

The challenge of ocular bioavailability



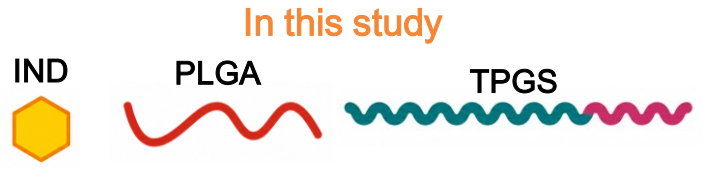
Less than 5% of the topically administered dose **reaches intraocular tissues.**

Consequences

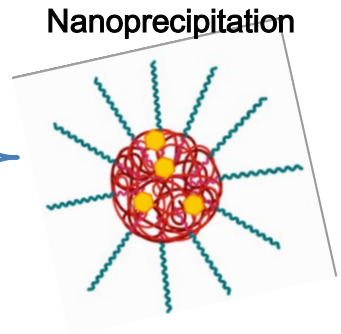


Frequent administration
Increased side effects

In this study



Nanoprecipitation





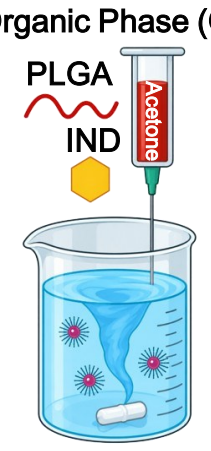
- **Sustained release**,
- Enhanced **corneal permeability**,
- Reduced dosing Frequency,
- **Improved efficacy** and safety.

Methodology

Preparation of nanoparticles by nanoprecipitation

Step 1: Organic phase added dropwise to the aqueous phase

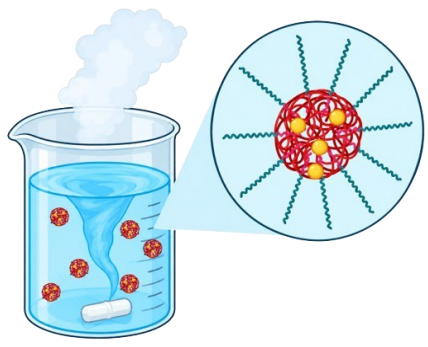
Organic Phase (OP)



Aquous Phase (AP)
0.05% TPGS (w/w)

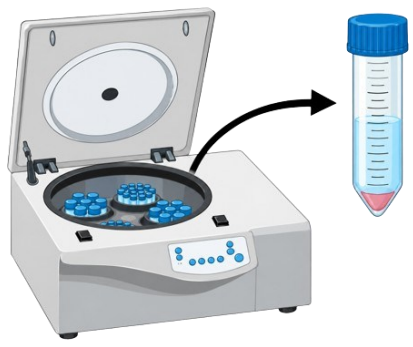
Step 2: Solvent evaporation

20 min post-addition stirring + 30 min rotary evaporation



Step 3: Purification by ultracentrifugation [3]

4 °C | 37,600 × g | 30 min



Characterization

- Dynamic Light Scattering **(DLS)**
- Transmission Electron Microscopy **(TEM)**
- Thermogravimetric Analysis **(TGA)**
- Differential Scanning Calorimetry **(DSC)**

Results and Discussion

Table 1. Hydrodynamic size, polydispersity index (PdI), and zeta potential (ζ) of nanoparticles before and after the purification.

Sample	Size (nm)	PdI	ζ (mV)
NB before	167.1	0.163	-6.86
NB after	154.5	0.077	-26.6
NIND before	2018	0.828	-6.23
NIND after	188	0.114	-23.3

Purification **reduced** particle **size** and **PDI**, **increased surface charge**, and preserved **spherical morphology**.

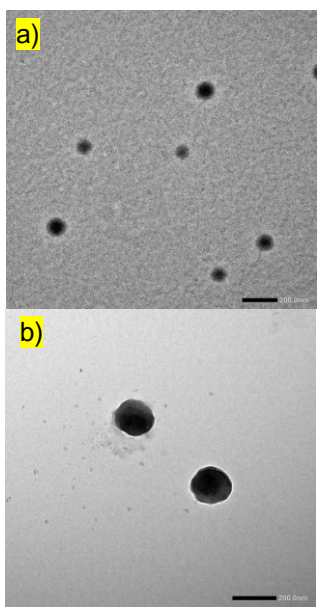


Figure 2. TEM of (a) NB and (b) NIND nanoparticles.

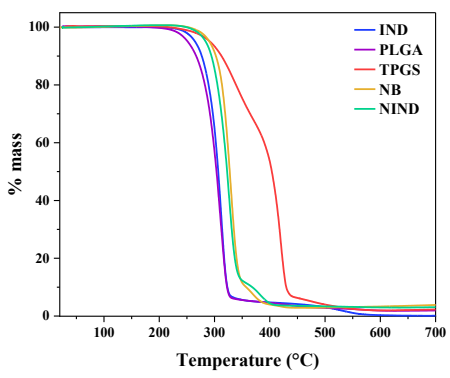


Figure 3. TGA analysis of lyophilized nanoparticles and their individual components.

Nanoparticles showed **thermal profiles distinct** from the **pure components.** The characteristic **melting peak of IND** was **absent in NIND**, suggesting drug encapsulation in a **less crystalline/amorphous state**.

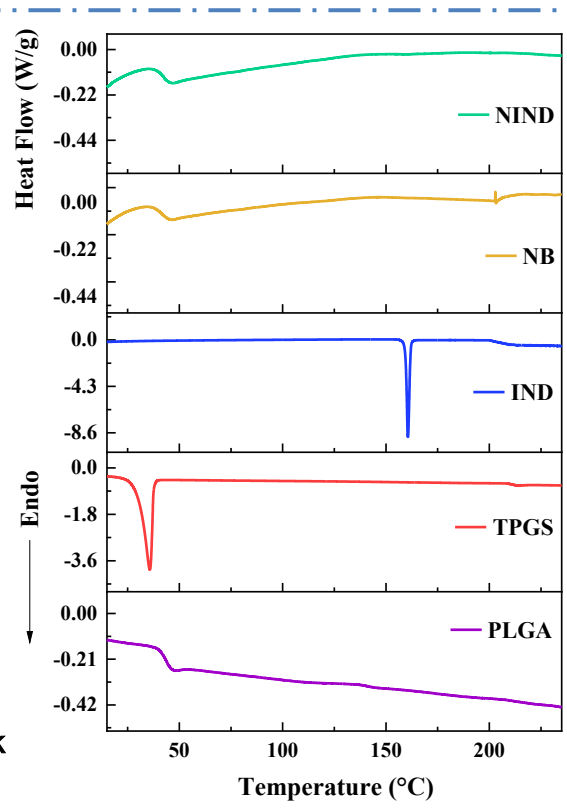


Figure 4. DSC thermograms of pure PLGA, TPGS, IND, and lyophilized nanoparticles.

Conclusion

PLGA–TPGS **nanoparticles** containing indomethacin were **successfully developed**, with **suitable physicochemical characteristics**, **spherical morphology**, and promising **potential for ocular drug delivery**.

References and Aknowledgements