CHAPTER 3

AIM AND OBJECTIVES

Aim:

The primary aim of this research is to formulate and evaluate a mesoporous silica nanoparticle (MSN)-based antiarthritic gel as a targeted drug delivery system. This system aims to improve the solubility, permeability, and bioavailability of poorly soluble drugs and enhance the targeted delivery to arthritic sites, thereby maximizing therapeutic efficacy while minimizing systemic side effects.

Objectives:

1. **Synthesis, Surface modification and Characterization of Mesoporous Silica Nanoparticles (MSNs):** The first objective is to synthesize mesoporous silica nanoparticles. MSNs will act as the drug carriers due to their high surface area, tunable pore sizes, and excellent biocompatibility.

   Characterization of MSNs: MSNs will be characterized using techniques such as

   - **Fourier-Transform Infrared Spectroscopy (FTIR): (**to confirm the presence of characteristic peaks for organic functional groups that can indicates successful surface modification.
   - **Differential Scanning Calorimetry (DSC)** (to analyze thermal properties),
   - **Scanning Electron Microscopy (SEM)** and **Transmission Electron Microscopy (TEM)** (to study nanoparticle morphology),
   - **Brunauer-Emmett-Teller (BET) analysis** (to measure the surface area of MSNs).
   - **pXRD** (to understand the effect of surface modification on the structural integrity and crystallinity)

2. **Loading of Antiarthritic Drugs into MSNs:** Poorly soluble antiarthritic drugs will be loaded into the mesoporous silica nanoparticles. This step will focus on improving the drug's solubility and dissolution rate to ensure efficient drug delivery.

3. **Enhancing Solubility and Dissolution Rate:** One of the major challenges in drug formulation is the poor solubility of certain drugs. This objective focuses on using MSNs to enhance the solubility and dissolution rate of the selected antiarthritic drugs.

4. **Enhancing Drug Permeability:** In addition to solubility, many drugs face challenges with permeability. By incorporating the drug into MSNs, this objective aims to improve the permeability of the poorly permeable antiarthritic drugs, ensuring higher absorption and bioavailability.

5. **Formulation of MSN-Loaded Nanogel:** This objective focuses on the formulation of a topical gel incorporating MSN-loaded antiarthritic drugs. The goal is to create a targeted drug delivery system that will ensure the drug is released at the desired site of action (arthritic joints), enhancing local bioavailability while minimizing systemic exposure.

6. **Characterization of the MSN-Loaded Nanogel:** After formulation, the nanogel will be characterized using advanced techniques such as:

    - **Texture Analyzer** (to study gel properties like spreadability and cohesiveness),
    - **Brookfield Viscometer** (to study viscosity and rheological properties of the gel)
    - **Zetasizer** (to study the Zeta potential of the gel that indicate the nano particle stability in the formulation)
    - **Drug Release Profile** (to study the drug release form the nanogel)

7. **Stability of the antiarthritic Nanogel**

   The objective to perform stability study in accelerated and long-term stability conditions on the Nanogel's appearance, viscosity, drug content, microbial count and pH at definite intervals to establish the good shelf life and to provide flexibility in storage options.

8 **Dermatokinetics Study:** The final objective is to perform in-vivo studies to assess the bioavailability and dermatokinetics of the formulated MSN-loaded nanogel. This will provide insight into how well the formulation delivers the drug to the targeted site and its overall therapeutic efficacy.