A Review On Formulation Development And Evaluation Of Liquisolid Compacts For Ibuprofen Liquisolid Capsules

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ABSTRACT:

Ibuprofen is a widely prescribed nonsteroidal anti-inflammatory drug (NSAID) used for pain, inflammation, and fever, but its poor aqueous solubility limits dissolution and oral bioavailability. To overcome these drawbacks, the liquisolid compact technique offers a promising approach by converting liquid drug solutions into dry, free-flowing, and compressible powders with enhanced dissolution properties.

The present study aimed to formulate and evaluate liquisolid compacts of ibuprofen in capsule dosage form. Ibuprofen was dissolved in non-volatile solvents such as polyethylene glycol 400, propylene glycol, and glycerin, then adsorbed onto microcrystalline cellulose (MCC) as a carrier and Aerosil 200 as a coating material. Sodium starch glycolate was incorporated as a superdisintegrant, and the resulting powders were filled into hard gelatin capsules. The prepared formulations were assessed for pre-compression flow properties and post-compression characteristics, including weight variation, drug content uniformity.

The results demonstrated significant improvement in dissolution rate compared with conventional ibuprofen capsules. Among the formulations, PEG 400-based liquisolid compacts exhibited the highest enhancement, releasing more than 85% of drug within 30 minutes versus less than 50% from conventional capsules. Improved wettability, increased surface area, and molecular-level dispersion of ibuprofen in the solvent system contributed to the faster release. FTIR and DSC studies confirmed compatibility of ibuprofen with excipients.

In conclusion, liquisolid compact technology successfully enhanced dissolution of ibuprofen in capsule form and represents a simple, economical, and industrially feasible approach for improving bioavailability of poorly soluble drugs.

KEYWORDS: Ibuprofen, liquisolid compact, capsule, dissolution enhancement, bioavailability

INTRODUCTION:

A liquisolid compact is a dosage form in which liquid medications (Drug solutions or suspensions in non-volatile solvents) are converted into dry, non-adherent, free-flowing and compressible powders by blending them with suitable carrier and coating materials. These powders can then be compressed into tablets or filled into Capsules. The final product is a tablet or capsule with improved dissolution rate and hence bioavailability of poorly soluble drugs. Those belonging to Biopharmaceutics Classification System (BCS) Class II (drugs with low solubility and high permeability). By dispersing the drug in a suitable non-volatile liquid vehicle and then converting it into a free-flowing, compressible powder using carrier and coating materials, the technique improves wettability, surface area, and dissolution profile of the drug, ultimately leading to enhanced bioavailability.

Why it works for BCS Class II drugs:

1. These drugs have limited dissolution in GI fluids, which is the rate-limiting step for absorption.
2. Liquisolid systems increase the surface area of the drug exposed to dissolution media.
3. The liquid state of the drug within the carrier matrix enhances wettability and molecular dispersion, leading to faster release.

In this method, the active pharmaceutical ingredient (API) is dissolved or suspended in a suitable non-volatile solvent such as propylene glycol, polyethylene glycol (PEG 200 or PEG 400), glycerine, or polysorbate 80. The resulting drug solution or suspension is then transformed into a dry, free-flowing, and compressible powder by blending with carrier materials (e.g., microcrystalline cellulose) and coating materials (e.g., colloidal silicon dioxide). This powder blend can be further processed into tablets or capsules, offering improved drug dissolution and bioavailability

ADVANTAGES:

1. Enhanced Solubility and Dissolution Rate
2. Enhanced bioavailability
3. Uniform drug distribution
4. Versatility of formulation
5. Ease of manufacturing
6. Better flow and compressibility

7. Reduced dose variability
8. Patient compliance
9. Flexibility in drug release

DISADVANTAGES:

1. Limited drug loading
2. Large tablet/capsule size
3. Moisture sensitivity
4. Drug precipitation risk
5. Stability issues
6. Process complexity
7. Limited to certain drugs
8. Cost factor

MATERIAL:

ngredient (INN)	**Quantity (mg)**	**Category / Roles**
Ibuprofen	2000 mg	Active drug
Glycerine	1000 mg	Non-Volatile Solvent
Microcrystalline Cellulose	4000 mg	Carrier Material
Collidal Silicon Dioxide	400 mg	Coating Material
Sodium Starch Glycolate	200 mg	Disintegrant
Magnesium Stearate	100 mg	Lubricant

Table 1. Material used in liquisolid capsules

METHOD:

1. Preparation of Liquid Medication

1. Accurately weigh Ibuprofen (e.g., 200 mg per capsule).

2. Measure the required quantity of non-volatile liquid vehicle (e.g Glycerine)

3. Transfer the vehicle into a mortar.Add ibuprofen gradually and triturate until a uniform solution or smooth suspension is formed.

This mixture is called liquid medication (W = drug + liquid vehicle).

2. Calculation of Carrier and Coating Material (Spireas Model)

1. Select:

Liquid-load factor (Lf) → determines how much liquid the carrier can hold. Excipient ratio (R =

carrier/coating).

2. Calculate:

Carrier quantity (Q) = W / Lf Coating quantity (q) = Q / R

Weigh the calculated amounts of Microcrystalline Cellulose (MCC) as carrier and Aerosil 200 as coating.

(If using example values: MCC ≈ 500 mg, Aerosil 200 ≈ 50 mg per capsule.)

3. Preparation of Liquisolid Powder

1. Place the entire carrier (MCC) into a mortar.

2. Add the liquid medication dropwise onto the carrier while continuously mixing.

3. Triturate gently until the liquid is fully absorbed and the mass appears dry and powdery.

4. Add coating material (Aerosil 200) in small portions.

5. Mix thoroughly until a free-flowing, non-sticky powder is obtained.

4. Addition of Functional Excipients

1. Pass Sodium Starch Glycolate (SSG), talc, and magnesium stearate through a sieve (40#).

2. Add SSG to the liquisolid powder and mix uniformly.

3. Add talc and mix gently.Add magnesium stearate at the end and blend lightly for 1–2 minutes to avoid over- lubrication.

5. Encapsulation

1. Select appropriate empty hard gelatin capsules (size 0 or 00 depending on bulk).

2. Set the capsule-filling machine or fill manually.

3. Fill each capsule with the prepared liquisolid powder blend.

4. Cap the capsules and wipe clean.

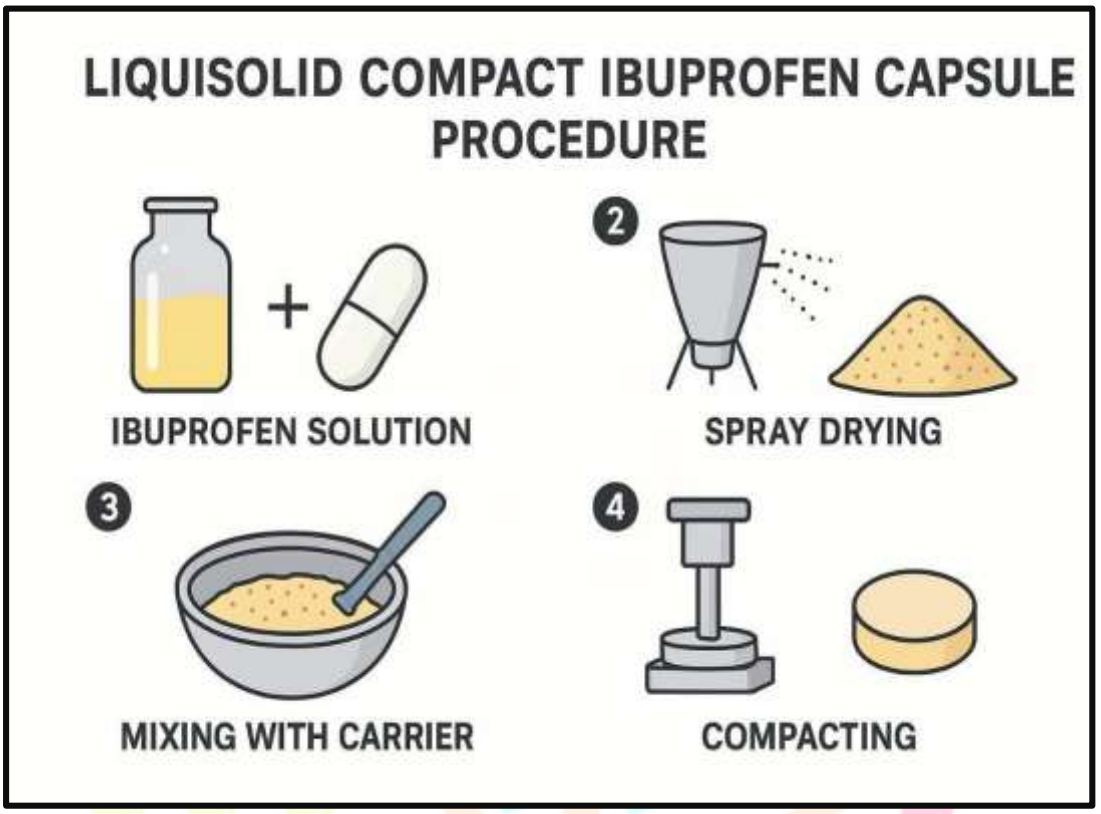

Fig1.Porcedure Use Of Liquisold Capsule

RESULTS AND DISCUSSION:

Pre-Compression study –

1. Angle of Repose

Measures flowability of powder.

Principle: Higher angle = poor flow; lower angle = good flow.

Formula:

$\theta = \tan^{-1} (h / r)$

Interpretation:

Angle of Repose	Flow Property
< 30°	Excellent
30–40°	Good
40–45°	Passable
> 45°	Poor

Table 2.Angle of repose in Pre-compreesion study

2. Bulk Density

Weight of powder / bulk volume. Indicates packing behaviour.

Formula:

Bulk density = Weight of powder / Bulk volume

3. Tapped Density

Density after tapping the measuring cylinder. Shows rearrangement and packing ability.

Formula:

Tapped density = Weight of powder / Tapped volume

4. Carr's Compressibility Index (%)

Measures compressibility of powder.

Formula:

CI (%) = [(Tapped – Bulk) / Tapped] × 100

CI (%)	**Flow Property**
5–15	Excellent
16–20	Good
21–25	Fair
>25	Poor

Table 3. Carr's Compressibility Index (%)

5. Hausner Ratio: Indicates flowability.

Formula: Hausner ratio = Tapped density / Bulk density

Hausner Ratio	Flow Property
1.00–1.11	Excellent
1.12–1.18	Good
1.19-1.25	Fair
>1.25	Poor

Table 4.Hausner ration pre compreesion study

1. **Moisture Content (LOD)** Measured by Loss on Drying. Important for hygroscopic powders.

Prevents clumping, microbial growth, and poor flow.

2. **Particle Size Analysis**

Affects flow, dissolution, and content uniformity.

Methods:

Sieve analysis Optical microscopy

Laser diffraction (advanced)

3. **Compatibility Study (Optional)**

For capsules containing:

Drug + excipients Liquisolid systems Oil-based systems **Performed by:**

FTIR DSC XRD

Ensures no chemical interaction.

4. **Pre-lubrication / Blending Study Evaluate:**

Blending time

Uniform distribution of lubricant (e.g., magnesium stearate) Segregation tendency

5. **Flow-through Hopper Study** Important for capsule filling machines. **Check:**

Time required for powder to pass Flow consistency

Bridging or sticking behavior

6. **Density-related Studies**

These help in capsule size selection. True density → by pycnometer

Bulk density + tapped density → to determine fill weight and capsule size

7. **Pre-formulation Stability Study**

Colour change Odour Agglomeration

Phase separation (for liquisolid systems)

Post-Compression Study-

1. **Weight Variation Test**

The weight of 20 capsules is measured individually. Average weight is calculated.

% deviation = The deviation should be within IP limits:

Average Weight -	% Deviation Allowed
< 300 mg -	± 10%
≥ 300 mg -	± 7.5%

Table 5.Weight Variation Test in post compression study

2. Disintegration Test

Checks the time required for capsule to break down in GI fluids. Conducted using disintegration apparatus at 37 ± 2°C. Standard limit for uncoated capsules: less than 30 minutes.

3. Drug Content Uniformity

Amount of Ibuprofen in each capsule measured spectrophotometrically. Acceptance range: 85–115% of labeled dose.

4. In-Vitro Dissolution Study

Carried out using USP Dissolution Apparatus II (paddle method). Typical parameters:

Medium: 900 mL phosphate buffer pH 7.2
Temperature: 37 ± 0.5°C Paddle speed: 50 rpm

Samples withdrawn at: 5, 10, 20, 30, 45, 60 min

% drug release is calculated.

Liquisolid compacts usually show faster dissolution than conventional tablets due to increased surface area and improved solubility.

5. FTIR / DSC / XRD (optional)

These studies confirm drug–excipient compatibility and solubility improvement:

Test -	Purpose
FTIR -	Detects chemical interaction
DSC -	Measures melting behavior and crystallinity
XRD -	Checks conversion of crystalline to amorphous form

Table 6. FTIR / DSC / XRD (optional) in post compression study

CONCLUSION –

The liquisolid compact technique is an effective and promising approach for enhancing the solubility and dissolution rate of poorly water-soluble drugs such as ibuprofen. By converting the drug into a liquid medication and adsorbing it onto suitable carrier and coating materials, the formulation improves wetting, surface area exposure, and overall drug release. Ibuprofen liquisolid compact capsules show significantly faster dissolution compared to conventional tablets or capsules, which may lead to improved bioavailability and faster onset of therapeutic action. The technique is simple, cost-effective, and easily scalable for industrial production. Overall, liquisolid compact technology offers a valuable strategy for overcoming solubility-related challenges and can be successfully applied to develop more efficient ibuprofen capsule formulations for enhanced patient outcomes.

The liquisolid compact capsule technique is a simple, effective, and economical method to enhance the solubility and dissolution rate of poorly water-soluble drugs. By converting the liquid drug or drug solution into a dry, free-flowing, and compressible powder, it significantly improves wetting, surface area exposure, and molecular dispersion of the drug. Suitable carrier–coating material combinations like microcrystalline cellulose and silica ensure good flowability and compressibility. Overall, liquisolid compacts offer a promising platform for improving drug release, bioavailability, and therapeutic performance, making them suitable for industrial-scale formulation.

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