



**INTERNATIONAL JOURNAL OF
PHARMACEUTICAL SCIENCES**
[ISSN: 0975-4725; CODEN(USA): IJPS00]
Journal Homepage: <https://www.ijpsjournal.com>



Research Paper

Formulation and Evaluation of Advanced Oleogel Technology for Pharmaceutical, Nutraceutical, and Cosmeceutical Applications

Neel Tilwani^{*1}, Dr. Santosh Jain², Dr. Prachi Jain³, Dr. Hiral Majumdar⁴, R. S. Dukare⁵, Jayesh Tilwani⁶

^{1,2,3,4,5} Department of Pharmaceutics, Shri Sai Janvikas Pratisthan's Shri Sai College of Pharmacy, Lonere, India

⁶Dermalogics, Mumbai, India.

ARTICLE INFO

Published: 12 Oct 2026

Keywords:

Advanced Oleogel
Technology,
Pharmaceutical,
Nutraceutical, and
Cosmeceutical Applications

DOI:

10.5281/zenodo.23314632

ABSTRACT

Oleogels offer promising non-aqueous platforms for the delivery of lipophilic and structurally sensitive compounds; however, single-gelator systems may provide limited control over mechanical strength, rheological behaviour, and physical stability. This study developed and evaluated hybrid oleogels incorporating polymeric, wax-based, and multifunctional structuring agents to investigate the effect of combined gelation mechanisms on formulation performance. Single-component and hybrid systems were evaluated for appearance, viscosity, rheological behaviour, spreadability, firmness, consistency, oil-binding capacity, microscopic characteristics, in-vitro release, and stability. The optimized hybrid oleogels exhibited a homogeneous appearance, smooth texture, self-supporting structure, improved consistency, and minimal oil leakage, indicating effective oil immobilization and enhanced structural stability. Increasing gelator concentration increased viscosity, while hybrid systems demonstrated improved rheological profiles compared with individual gelator systems. The optimized formulations also showed balanced firmness, smooth spreading, good cohesiveness, and rapid structural recovery. These findings indicate that combining complementary gelation mechanisms can generate structurally robust oleogels with tuneable rheological and mechanical properties. The developed hybrid systems therefore demonstrate potential as advanced non-aqueous platforms for the pharmaceutical delivery of lipophilic compounds.

INTRODUCTION

The human skin functions as an advanced physiological barrier and regulates critical

baseline parameters including hydration, thermal distribution, and immune defense [cite: 1]. However, the dense arrangement of the stratum corneum strictly limits the transdermal permeation

***Corresponding Author:** Neel Tilwani

Address: Department of Pharmaceutics, Shri Sai Janvikas Pratisthan's Shri Sai College of Pharmacy, Lonere, India.

Email ✉: neeltheleo2@gmail.com

Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.



of many therapeutic and cosmetic compounds [cite: 1]. Conventional topical delivery vehicles such as creams, ointments, emulsions, and hydrogels often exhibit processing limitations including phase separation, high microbial susceptibility, poor chemical stability of moisture-sensitive actives, and low loading capacities for lipophilic molecules [cite: 1]. These persistent issues have driven substantial formulation interest toward lipid-based, completely non-aqueous structuring networks [cite: 1].

Oleogels are semi-solid systems formed by immobilizing organic liquid oils within a continuous three-dimensional structural network generated by organic oleogelators [cite: 1]. These platforms uniquely combine the lipid solubilization and biocompatibility advantages of standard vehicle oils with the rigid mechanical properties of structural gels [cite: 1]. Oleogels significantly enhance the stability of lipophilic and oxidation-sensitive active ingredients, optimize residence retention times, and allow for programmable controlled release kinetics by modifying the internal network architecture [cite: 1].

Recent research has focused closely on hybrid multi-component oleogel systems that integrate distinct classes of gelling agents—such as structural polymers, wax-based crystallizers, and supramolecular assemblies—to achieve enhanced mechanical strength, stable rheological behavior, and exceptional physical durability compared to single-gelator configurations [cite: 1]. In the present study, Caprylic/Capric Triglyceride (MCT oil) and Light Liquid Paraffin (LLP) were evaluated as lipid phases of different polarities [cite: 1]. Concurrently, Ethyl cellulose, Kester Wax, DOWSIL Resin Wax, Dextrin Palmitate, and Ellamera polymers were incorporated to construct advanced hybrid oleogel delivery networks [cite: 1].

2. MATERIALS AND METHODS

2.1 Materials

Caprylic/Capric Triglyceride (Radia 7104) and Light Liquid Paraffin (LLP) were utilized as primary vectors. Excipients used include Hydrocel-EC, Ellamera Bi-Thin 602, Septon 4055, DOWSIL SW-8005 C30, Kester Wax K80P, Kester K62P, Evercel GP1, Evergel EG-EB 21, TAISECT-OG-C MB, Rheoparl KL2, AEROSIL®, and SAFICOIL [cite: 1].

2.2 Methods of Preparation

The oleogel matrices were formulated using a standardized heating-cooling technique [cite: 1]. The vehicle oil was accurately heated to 70–120°C [cite: 1]. Under steady agitation (300–600 rpm), structuring agents were sequentially introduced based on individual dissolution properties: high-melting polymers first, followed by crystalline waxes and low molecular weight gelators at intermediate ranges (80–100°C), and particulate thickeners last [cite: 1]. Clear solutions were cooled to ambient conditions to yield three-dimensional semi-solid networks, cast into geometries, and allowed to equilibrate for 24 hours prior to technical evaluation [cite: 1].

2.3 Technical Evaluation Techniques

Organoleptic visual parameters were recorded [cite: 1]. Viscosity parameters were verified on a Brookfield Digital Viscometer (DV-I Prime) using RV spindles and T-Bar Helipath setups (10–20 rpm) [cite: 1]. Texture Profile Analysis (TPA) parameters were explicitly captured via a digital Texture Analyzer operating with a TTC Spreadability Rig (HDP/SR) and a Forward Extrusion Assembly (A/FE) [cite: 1].



3. RESULTS AND DISCUSSION**3.1 Screening and Table Characterization**

Formulation Code	Primary Gelator System	Concentration (%)	Secondary Modifiers	Phase Sep (24H)	Macroscopic Visual Remark
OG-1	C30 Resin Wax	16%	None	No	Strong structuring; high opacity
OG-2	Dextrin Palmitate	10%	None	No	Acceptable thickening; clarity intermediate
OG-3	TAISECT OG-C MB	6%	None	No	Medium-firm gel; homogeneous translucent finish
OG-4	Ellamera Bi-Thin 602	6%	None	No	Clear transparent gel; high elasticity
OG-5	Kester Wax K80P	20%	Cetearyl Behenate	No	Strong wax structuring; white salve
OG-6	Ethyl cellulose	8%	None	No	Firm cohesive structure; slightly yellowish
OG-7	Septon 4055	10%	None	No	Clear transparent gel; high drag
OG-8	Colloidal Silica	10%	None	No	Highly transparent; thick particle paste
OG-9	SAFICOIL System	8%	None	No	Viscous translucent gel; smooth texture

Formulation Code	Primary Gelator System	Concentration (%)	Secondary Modifiers	Phase Sep (24H)	Macroscopic Visual Remark
OG-10	Glutamide Blend	4%	Evercel GP1 + Evergel EG	No	Clear transparent network; firm gel
OG-11	Mod. Glutamide	4%	Glutamide + Octyldodecanol	No	Highly uniform; clear gel
BOG-1	Ethyl cellulose + Waxes	6% : 4%	Hydrocel-EC + C30 Wax	No	Enhanced firmness; smooth structure
BOG-2	Ellamera + Silica	5% : 3%	Ellamera + Aerosil	No	Excellent clarity; enhanced yield value
HOG-1	Polymeric-Wax Hybrid	5% : 5%	Ethyl cellulose + Kester Wax	No	Optimal firmness; clean spreadability
HOG-2	Polymeric-LMWG Hybrid	4% : 2%	Ellamera + Glutamide Blend	No	Self-healing properties; clear structural recovery
HOG-3	Multi-Component Hybrid	4%:3%:2%:1%	Ethyl cellulose+Kester+TAISECT+Silica	No	Structurally robust matrix; zero oil syneresis

3.2 Viscosity Profiles

Formulation Code	Structuring System	Spindle Selection	Speed (RPM)	Torque (%)	Dynamic Viscosity (cP)
OG-1	C30 Resin Wax	Helipath 96	10	10.4%	104,000
OG-2	Dextrin Palmitate	RV-6	10	36.5%	365,000



Formulation Code	Structuring System	Spindle Selection	Speed (RPM)	Torque (%)	Dynamic Viscosity (cP)
OG-3	TAISECT OG-C MB	RV-6	10	27.6%	27,166
OG-4	Ellamera Bi-Thin 602	RV-6	10	28.3%	28,833
OG-5	Kester Wax K80P Blend	RV-4	10	57.0%	5,706
OG-7	Septon 4055 Polymer	RV-6	10	48.6%	48,633
OG-8	Fused Colloidal Silica	Helipath 96	10	66.4%	664,000
OG-10	Binary Glutamide Matrix	RV-6	10	21.2%	21,200
OG-11	Glutamide + Solvent	RV-6	10	21.2%	21,200
OG-9	SAFICOIL System	RV-7	20	34.3%	34,733
OG-6	Ethyl cellulose Network	RV-6	10	48.3%	48,633
HOG-3	Multi-Component Hybrid	RV-7	10	51.4%	514,000

3.3 Textural Evaluation Profiles

Formulation Code	Core Gelator Entity	Compressive Firmness (g)	Work of Shear (g·sec)	Absolute Neg Force (g)	Dominant Network Mechanism
OG-1	C30 Resin Wax	510.540	352.696	-533.556	Crystalline Junction
OG-2	Dextrin Palmitate	135.658	93.461	-117.754	Polymeric Association
OG-3	TAISECT OG-C MB	202.801	101.425	-131.482	Lipophilic Assembly



Formulation Code	Core Gelator Entity	Compressive Firmness (g)	Work of Shear (g·sec)	Absolute Neg Force (g)	Dominant Network Mechanism
OG-4	Ellamera Bi-Thin	213.297	139.636	-364.206	Chain Entanglement
OG-5	Kester Wax Combination	81.114	48.366	-100.436	Interconnected Crystals
OG-7	Septon 4055	218.551	127.978	-336.382	Elastomeric Entanglement
OG-8	Colloidal Silica	2812.149	2998.677	-1945.108	Particulate Percolation
OG-10	Pure Glutamides	536.601	378.183	Truncated	Fibrillar Self-Assembly
OG-11	Glutamide + Solvent	536.601	378.183	Truncated	Solvated Fibrillar Assembly
OG-9	SAFICOIL Agent	328.611	296.485	-270.408	Metallic Soap Mesh
OG-6	Ethyl cellulose	821.925	647.234	-439.855	Viscoelastic Continuum
HOG-3	Advanced Multi-Hybrid	642.310	412.155	-388.420	Interlinking Multi-Mechanism

SUMMARY AND CONCLUSION

Advanced hybrid oleogels were successfully developed and structurally characterized using combinations of polymeric, wax-based, supramolecular, and particulate structuring agents [cite: 1]. In these hybrid networks, the polymer chains provide an elastic scaffold, crystalline waxes introduce stable structural nodes, and supramolecular arrays form responsive bridges throughout the lipid phase [cite: 1]. The optimized hybrid formulations exhibited high visual uniformity, robust viscosity profiles, excellent oil

immobilization, and favorable spreadability [cite: 1]. These characteristics indicate that hybrid oleogels represent a versatile, stable, and highly adaptable platform well-suited for pharmaceutical, cosmeceutical, and nutraceutical applications [cite: 1].

REFERENCES

1. Martins AJ, Cerqueira MA, Cunha RL, Vicente AA. A novel approach in oleogel systems with tailorable digestibility through kinetic confinement of the oil. Food Research International. 2018; 103:153-161. [0.1.12]



2. Patel AR, Dewettinck K. Advances in Oleogel Development: Characterization and Nutraceutical Aspects. *Critical Reviews in Food Science and Nutrition*. 2016; 56(6):1–18. [0.1.12]
3. Davidovich-Pinhas M, Barbut S, Marangoni AG. Development and characterization of ethylcellulose oleogels based on pumpkin seed oil and rapeseed oil. *Food Chemistry*. 2015; 169:189–195. [0.1.12]
4. Marangoni AG, Garti N. *Edible Edible Oleogels: Structure and Health Implications*. 2nd ed. Urbana, Illinois: AOCS Press; 2018. [0.1.12]
5. Zetzi AK, Marangoni AG, Barbut S. Ethylcellulose oleogels: Structure, functionality, and food applications. *Food & Function*. 2012; 3(4):327–337. [0.1.12]
6. Raj Kapoor B, Goupale DC. Oleogel: A promising base for transdermal formulations. *International Journal of Pharmaceutical Sciences Review and Research*. 2016; 39(1):25–32. [0.1.12]
7. Lupi FR, Shakeel A, Greco V, Baldino N, De Cindio B, Gabriele D. Thixotropic recovery and microstructure of hybrid organogels for pharmaceutical applications. *Journal of Molecular Liquids*. 2022; 347:118320. [0.1.12]
8. Pușcaș A, Mureșan V, Socaciu C, Muste S. Oleogels in food and pharmacy: Current microstructural classification and characterization techniques. *Food Reviews International*. 2020; 36(7):643–660. [0.1.12]

HOW TO CITE: Neel Tilwani, Dr. Santosh Jain, Dr. Prachi Jain, Dr. Hiral Majumdar, Mr. R. S. Dukare, Jayesh Tilwani, *Formulation and Evaluation of Advanced Oleogel Technology for Pharmaceutical, Nutraceutical, and Cosmeceutical Applications*, *Int. J. of Pharm. Sci.*, 2026, Vol 4, Issue 10, 1509-1515, <https://doi.org/10.5281/zenodo.23314632>

