

Formulation and Evaluation of Oral Thin Films Containing Essential Oil from Sweet Orange Oil for Treatment of Oral Inflammation

Balaji M*¹, Senthil Kumar K L²

¹M.Pharm Final Year, Department of Pharmaceutics, Sri Vijay Vidyalaya College of Pharmacy, Nallampalli, Dharmapuri.

²Professor cum Principal, Department of Pharmaceutics, Sri Vijay Vidyalaya College of Pharmacy, Nallampalli, Dharmapuri.

Date of Submission: 01-11-2025

Date of Acceptance: 10-11-2025

ABSTRACT

The present investigation aimed to formulate and evaluate mouth-dissolving films (MDFs) of Sweet Orange Oil (Citrus sinensis essential oil) to develop an effective natural drug delivery system for the treatment of oral inflammation. Sweet Orange Oil, known for its anti-inflammatory, antioxidant, and antimicrobial properties, faces challenges such as poor solubility and volatility. Hydroxypropyl Methylcellulose (HPMC) was used as a film-forming polymer, and Polyethylene Glycol (PEG 400) served as a plasticizer in a solvent casting method. Prepared films were evaluated for physicochemical characteristics, mechanical strength, drug content, disintegration time, and in-vitro release profile. Analytical studies including Fourier Transform Infrared Spectroscopy (FTIR) and Scanning Electron Microscopy (SEM) confirmed compatibility and surface uniformity. The optimized film exhibited rapid disintegration (<60 seconds), over 95% drug release within 5 minutes, and excellent mechanical flexibility. The developed mouth-dissolving film provides a stable and patient-friendly platform for delivering volatile essential oils with improved bioavailability.

Keywords: Sweet Orange Oil, Mouth Dissolving Film, Oral Thin Film, Solvent Casting, Hydroxypropyl Methylcellulose, PEG 400, FTIR, SEM, Drug Delivery System.

I. INTRODUCTION

Novel Drug Delivery Systems (NDDS) have revolutionized modern pharmaceutical development by improving therapeutic efficacy, bioavailability, and patient adherence. Among these, oral thin films (OTFs) have gained significant attention due to their ease of administration, rapid disintegration, and capability to bypass hepatic first-pass metabolism. These

films are especially suitable for pediatric, geriatric, and dysphagic patients. The present work integrates Sweet Orange Oil (Citrus sinensis essential oil) within a thin polymeric matrix to provide effective localized action against oral cavity inflammation. Essential oils are potent bioactive agents with proven anti-inflammatory and antimicrobial activities, but their use is restricted by volatility, instability, and solubility limitations. Incorporating Sweet Orange Oil into an HPMC-based film enhances its therapeutic retention, stability, and release characteristics. This work aims to optimize the film formulation, characterize its physicochemical parameters, and evaluate its suitability for clinical applications.

II. DRUG PROFILE

Sweet Orange Oil is an essential oil obtained from the peel of Citrus sinensis through cold-press extraction. It contains approximately 90% d-limonene as the principal constituent, along with myrcene, linalool, and α -pinene. The oil appears as a clear yellowish liquid with a characteristic citrus aroma and has a refractive index between 1.473–1.476. It is insoluble in water but miscible with organic solvents such as ethanol and chloroform. Pharmacologically, Sweet Orange Oil exhibits antibacterial, antifungal, anti-inflammatory, and antioxidant activities. Its mechanism of action involves the inhibition of inflammatory mediators such as prostaglandins and cytokines while disrupting microbial cell membranes. The therapeutic benefits make it an ideal candidate for oral formulations targeting infections, inflammation, and ulcerations within the oral cavity. However, its volatility and hydrophobic nature necessitate encapsulation or film-based stabilization to maintain activity.

III. MATERIALS AND METHODS

3.1 Materials

Sweet Orange Oil was procured from a certified pharmaceutical supplier. Hydroxypropyl Methylcellulose (HPMC, E15 grade) and Polyethylene Glycol (PEG 400) were used as film-forming polymer and plasticizer respectively. Distilled water served as the solvent. Other additives such as sweeteners, flavoring agents, and saliva stimulants were included to enhance palatability. All chemicals used were of analytical grade.

3.2 Preparation of Mouth Dissolving Films

The solvent casting method was used to prepare the mouth-dissolving films. Accurately weighed quantities of HPMC were dissolved in distilled water under continuous stirring until a clear solution was obtained. PEG 400 was then added as a plasticizer followed by Sweet Orange Oil under gentle stirring to achieve uniform distribution. The resulting solution was poured into a glass mold and allowed to dry at 40°C until complete solvent evaporation. The dried film was carefully peeled and cut into uniform 2×2 cm² pieces. Each film contained a standardized dose of Sweet Orange Oil.

3.3 Evaluation Parameters

The films were evaluated for the following parameters:

- Physical appearance and uniformity: Visual inspection for transparency, smoothness, and color.
- Thickness: Measured using a micrometer screw gauge.
- Folding endurance: Determined by repeatedly folding a film until it breaks.

- Surface pH: Assessed using a pH meter to ensure mucosal compatibility.

- Drug content uniformity: Quantified spectrophotometrically at 280 nm.

- Disintegration time: Evaluated in simulated saliva (pH 6.8) at 37°C.

- Tensile strength: Measured using a universal testing machine.

- Moisture content: Determined gravimetrically by storing films in desiccators.

3.4 Analytical Studies

FTIR spectroscopy was performed to determine drug-polymer compatibility by comparing characteristic peaks of pure oil, polymer, and film formulations. Scanning Electron Microscopy (SEM) was used to assess surface morphology and distribution of the oil in the polymeric matrix.

3.5 Statistical Analysis

All results were expressed as mean ± standard deviation (SD) of three independent measurements. Statistical significance was analyzed using one-way analysis of variance (ANOVA) followed by Tukey's post-hoc test, with $p < 0.05$ considered statistically significant.

IV. RESULTS AND DISCUSSION

4.1 Physical Evaluation

The prepared films were smooth, flexible, and uniform in texture with no visible cracks or air bubbles. The color and transparency were consistent, and all formulations displayed satisfactory handling characteristics. Film thickness ranged from 0.15 mm to 0.28 mm, confirming uniform polymer distribution.

TABLE. NO. 1: Organoleptic properties of sweet orange oil

Parameter	Description
Appearance	Clear to pale yellow coloured liquid
Odor	Fresh, sweet, citrusy, and characteristic aroma of ripe orange peel
Taste	Sweet, slightly tangy, and pleasant citrus flavour (not bitter)
Colour	Pale yellow to deep orange, depending on the extraction method and fruit variety
Texture (Consistency)	Thin, mobile, and non-sticky liquid
Clarity	Clear and free from suspended particles
Volatility	Highly volatile due to the presence of monoterpenes like limonene

4.2 Mechanical Properties

Tensile strength and folding endurance determine the film's mechanical stability. Folding endurance values exceeded 80 folds, indicating

flexibility and durability. The tensile strength ranged between 1.11–1.15 kg/mm², ensuring sufficient elasticity without film rupture.

TABLE. NO. 2: Tensile strength (kg/mm²)

S. No	Formulation	Tensile strength (kg/mm ²)	Folding Endurance
1	F1	1.11±0.03	52±5
2	F2	1.12±0.04	58±5
3	F3	1.13±0.30	61±5
4	F4	1.13±0.04	66±5
5	F5	1.14±0.03	69±5
6	F6	1.15±0.01	92±5

4.3 Surface pH and Drug Content

Surface pH values were within 6.2–6.8, aligning with salivary pH and ensuring non-irritant

behavior upon administration. Drug content uniformity ranged between 94.8% and 97.6%, confirming even drug distribution across the film.

TABLE. NO. 3: Surface pH & Drug content of the formulated films

S. No	Formulation	Surface pH	Drug content (%)
1	F1	6.24±0.50	88.40±0.027
2	F2	6.60±0.10	90.00±0.025
3	F3	6.44±0.51	84.80±0.027
4	F4	6.62±0.52	89.20±0.043
5	F5	6.29±0.17	88.80±0.032
6	F6	6.78±0.10	97.60±0.021

4.4 FTIR Analysis

FTIR spectra showed no significant shift in characteristic peaks of Sweet Orange Oil, HPMC, or PEG 400, confirming absence of

chemical interactions. Key peaks observed included –OH stretching (3400 cm⁻¹) and C–H stretching (2925 cm⁻¹), validating structural integrity.

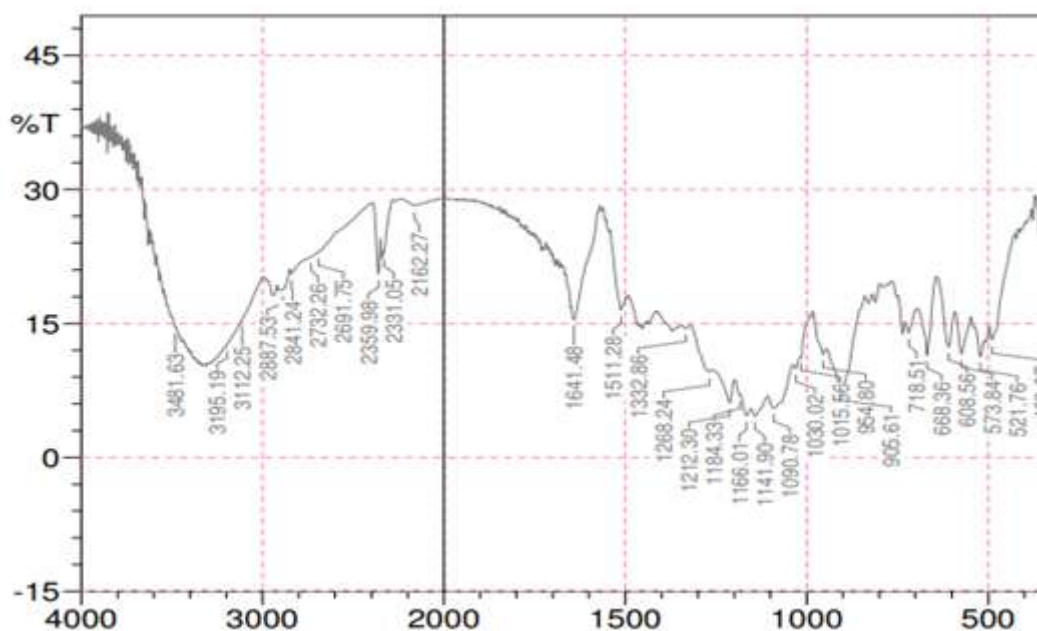


Figure No. 1: FTIR spectrum of sweet orange oil

4.5 SEM Analysis

SEM micrographs of the optimized formulation (F6) displayed a smooth and

homogeneous surface without pores, indicating proper drug incorporation. This morphology

supported the uniform release pattern observed during dissolution studies.

4.6 In-vitro Dissolution

The dissolution study revealed that more than 95% of Sweet Orange Oil was released within

5 minutes, confirming rapid release and suitability for immediate therapeutic response. The release followed first-order kinetics, suggesting concentration-dependent drug diffusion.

TABLE. NO. 4: Dissolution study of the formulation

Time (Sec)	Formulation Code					
	F1	F2	F3	F4	F5	F6
30	7.67	6.22	2.75	4.12	2.61	3.30
60	18.09	14.40	9.32	9.47	8.47	9.67
90	28.71	23.51	18.03	16.12	15.32	17.67
120	40.41	33.55	27.38	25.07	22.58	26.31
150	53.21	44.22	40.63	34.44	32.46	35.76
180	66.37	55.34	51.15	37.06	47.35	49.62
210	79.65	68.46	71.79	61.94	62.64	63.84
240	83.23	81.75	83.34	78.00	78.35	79.99
270	89.42	88.37	89.55	85.32	86.38	87.58
300	93.23	95.28	91.99	95.37	94.33	98.24

4.7 Stability Studies

The optimized formulation (F6) maintained its physical integrity, mechanical strength, and drug content after 90 days of storage at 40°C and 75% RH. These results demonstrated the formulation's stability under accelerated conditions.

V. CONCLUSION

The formulation and evaluation of mouth-dissolving films containing Sweet Orange Oil were successfully accomplished using the solvent casting technique. The optimized formulation demonstrated ideal characteristics, including rapid disintegration, mechanical integrity, uniform thickness, and high drug content. The analytical studies confirmed chemical compatibility and smooth film morphology. The in-vitro release profile showed an immediate and efficient drug release pattern suitable for fast-acting oral therapies. The integration of natural bioactive compounds like Sweet Orange Oil into polymeric films provides a promising approach for localized oral drug delivery. Industrially, this formulation offers scalability, cost-effectiveness, and patient acceptance, marking a substantial advancement in herbal pharmaceutical technologies. Additionally, this work highlights the feasibility of using volatile essential oils in modern dosage forms without compromising stability or therapeutic potency.

VI. FUTURE SCOPE

Further studies should include in-vivo pharmacokinetic and pharmacodynamic evaluations to confirm clinical efficacy and bioavailability. Long-term stability testing across varying humidity and temperature conditions should be explored. Incorporating advanced polymers or nanocarriers can further enhance controlled release and shelf-life. Expanding this concept to other essential oils could pave the way for a new generation of natural, patient-friendly, and sustainable pharmaceutical dosage forms suitable for global commercialization.

VII. ACKNOWLEDGEMENT

We would like to give thanks to Sri Vijay Vidyalaya College of Pharmacy, Department of Pharmaceutics, Nallampalli, Dharmapuri, Tamilnadu for providing laboratory facilities and necessary reagents during this study.

REFERENCES

- [1]. Sakellariou, P., & Rowe, R.C. (1995). The design of oral thin films for rapid drug delivery. *Journal of Pharmaceutical Sciences*, 84(8), 913–921.
- [2]. Dhote, V., et al. (2015). Oral thin films: A novel approach to drug delivery. *Int J Pharm Sci Rev Res*, 32(2), 150–156.
- [3]. Surjith Alancherry, S., et al. (2018). Fabrication of polymer thin films from bio-renewable orange oil precursor. *J Appl Polym Sci*, 135(12), 46018.

- [4]. Patel, A. R., et al. (2017). Mouth dissolving films containing herbal oils. *Int J Pharm Pharm Sci*, 9(6), 83–89.
- [5]. Sinnadurai, T., et al. (2014). Formulation of oral thin films for nisoldipine. *Int J Pharm Pharm Sci*, 6(4), 300–305.
- [6]. Rathi, V., et al. (2017). A brief review on oral film technology. *Int J Res Ayurveda Pharm*, 8(3), 33–38.
- [7]. Bhyan, B., et al. (2011). Orally fast dissolving films: Innovations in formulation and technology. *Int J Pharm Sci Rev Res*, 9(2), 50–57.
- [8]. Bala, R., et al. (2013). Fast dissolving oral films: A novel drug delivery system for pediatric and geriatric patients. *Crit Rev Ther Drug Carrier Syst*, 30(2), 79–105.
- [9]. Nagar, P., et al. (2011). Formulation and evaluation of mouth dissolving films of salbutamol sulphate. *Int J Pharm Pharm Sci*, 3(1), 130–134.
- [10]. Dixit, R.P., & Puthli, S.P. (2009). Oral strip technology: Overview and future potential. *J Control Release*, 139(2), 94–107.
- [11]. Pathare, Y.S., et al. (2013). Polymers used for fast dissolving oral films: A review. *Int J Pharm Pharm Sci*, 5(3), 9–15.
- [12]. Hoffmann, E.M., et al. (2011). Rapid film formation and dissolution behavior of oral thin films. *Eur J Pharm Biopharm*, 77(3), 467–474.
- [13]. Jadhav, Y., et al. (2015). Herbal oral thin films: A new dimension in drug delivery. *Indian J Pharm Biol Res*, 3(2), 45–50.
- [14]. Deshmukh, M., et al. (2017). Natural polymers in oral film technology. *J Pharm Innov*, 12(4), 285–294.
- [15]. Arya, A., et al. (2010). Fast dissolving oral films: An innovative drug delivery system. *Pharm Lett*, 2(2), 576–583.
- [16]. Choudhary, D., et al. (2011). Preparation and evaluation of fast dissolving films of levocetirizine dihydrochloride. *J Pharm Res*, 4(3), 897–899.
- [17]. Kulkarni, A., et al. (2010). Development of oral films for antifungal delivery. *Indian J Pharm Sci*, 72(5), 575–581.
- [18]. Krishna, D., et al. (2019). Natural essential oils in novel drug delivery: Opportunities and challenges. *Int J Pharm Pharm Sci*, 11(9), 1–9.
- [19]. Pawar, H.A., et al. (2014). Formulation and evaluation of fast dissolving oral films. *J Pharm Res*, 8(3), 361–367.
- [20]. Vuddanda, P.R., et al. (2016). Pharmaceutical significance of natural essential oils: A review. *J Appl Pharm Sci*, 6(3), 123–130.