RESEARCH PAPER

# Formulation and Evaluation of Nano-Emulgel of Corosolic acid reach fraction of Psidium Guajava Leaves

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**Abstract:**
The objective of this study was to formulate and characterize a Nanoemulgel formulation of guava (Psidium guajava L.) leaves for topical anti-inflammatory use. The flavonoids, tannins, triterpenoids like Corosolic, and other phenolic compounds that possess anti-inflammatory properties were identified to be present in the leaves of the guava plant by qualitative phytochemical screening after the leaves were collected and analyzed pharmacognostically. After the optimization of the oil-in-water Nano emulsion formulation of guava leaf extract based on droplet size, polydispersity index, zeta potential, and thermodynamic stability, it was mixed with a suitable gelling agent to formulate a Nanoemulgel with the desired viscosity, spread ability, and homogeneity for topical use.
Pentacyclic triterpenoids have lagged in drug development due to their poor bioavailability. Recent research addresses this challenge by formulating Nano emulsion-based Nanoemulgel to enhance their bioavailability.

**Keywords:** *Psidium guajava L*, Corosolic acid, Nano-emulsion, Nanoemulgel
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## 1. Introduction:

Psidium guajava, also known as guava, is a tropical plant that has been used in ethnomedicine for the treatment of various conditions such as diarrhea, wounds, and diabetes. The leaves, fruits, and bark of the plant are rich in bioactive compounds such as flavonoids, phenolics, and terpenoids that have been shown to have antioxidant and antimicrobial properties (Chechani et al., 2024).
Psidium guajava, also referred to as guava, is known to possess a wide range of phytoconstituents, including triterpenoids such as Corosolic acid, which has been identified as a major bioactive compound of Psidium guajava. Corosolic acid, also referred to as 2α,3β,23-trihydroxyurs-12-en-28-oic acid, is an ursane pentacyclic triterpenoid that has been found to be abundant in guava fruits at a concentration of up to 1.14 mg/g, along with alcoholic extract (Diwakar et al., 2016; Bag et al., 2019).
This molecule has a rigid tetracyclic backbone with hydroxyl groups at C-2, C-3, and C-23, and a carboxylic acid group at C-28, which facilitates hydrogen bonding and membrane interactions that are the basis for its lipid solubility and ability to self-assemble into vesicular structures. Guava's phytoprofile includes corosolic acid, which is supplemented by flavonoids like quercetin and rutin and other triterpenoids (5.10 mg of ursolic acid per gram of extract) (Butt et al., 2025).
Corosolic acid's structural stability and polarity gradient facilitate its extraction yields of 0.5-2% w/w from guava leaves, positioning it as a lead isolate for nanoencapsulation studies targeting bioavailability enhancement (Kareem et al., 2024). Considering the this all fact about Corosolic acid current research focuses on the formulation development of Corosolic reach fraction of Psidium guajava.
Nanoemulsions are usually produced using high-energy techniques, such as high-pressure homogenization or ultrasonication, which break down a coarse emulsion into sub-200 nm droplets, or low-energy techniques, such as spontaneous emulsification, for lipophilic drugs such as corosolic acid from Psidium guajava. In a PubMed-indexed method, corosolic acid nanoemulsions were formulated by evaluating oil phases (e.g., ethyl oleate), surfactants (Cremophor EL:Tween 80 at a 1.5:1 ratio), and cosurfactants (ethanol), resulting in a Km ratio of 4:1 at 30°C by dropwise addition under stirring, producing transparent nanoemulsions with particle sizes around 100 nm, PDI <0.2, and zeta potential stability (Li et al., 2024; Kumar et al., 2019).
The procedure involves dissolving 1 mg of corosolic acid in 1 g of oil phase with 12 mg of ferulic acid as co-active agent, mixing surfactants/cosurfactant, and dripping into the aqueous phase at a controlled temperature until nanoemulsification is indicated by clarity, followed by storage at room temperature. High

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shear techniques are appropriate for your NLC research (e.g., lacosamide), ensuring >90% entrapment through enhancement of lipid solubility, while low shear techniques are appropriate for guava triterpenoid isolation (Liu et al., 2019).

Nanoemulsions improve the solubility and biocompatibility of poorly water-soluble compounds such as corosolic acid extracted from Psidium guajava by reducing the size of the droplets to 20-200 nm, which increases the interfacial area and facilitates dissolution and absorption across biological membranes. The kinetic stability of nanoemulsions is superior to conventional emulsions and inhibits phase separation while facilitating lymphatic uptake to circumvent first-pass effects, which is essential for lipophilic phytoconstituents in epilepsy or neuroprotective agents evaluated in your zebrafish and rat maze models (Preeti et al., 2023; Jaiswal et al., 2015).

This adaptability enables various delivery routes, such as oral, transdermal, or intranasal, with controlled release patterns that shield the active ingredients from degradation, enhancing entrapment efficiency (>90%) and minimizing the frequency of administration for sustained therapeutic concentrations. In nanoformulations similar to our research, many research shown reduced particle sizes (<150 nm, PDI <0.3), enhanced permeability in behavioral study endpoints, and compatibility with surfactants such as Tween 80.

## 2. Material and Method:

### 2.1 Plant material and extraction:

Fresh *Psidium guajava* leaves that were collected from Nandurbar, Maharashtra, shade dried and Authenticated from Botanical survey of India. To create a dry Corosolic acid rich extract, dried, powdered leaves were macerated with Petroleum ether followed by extracted in a Soxhlet apparatus with 70% ethanol for eight hours. The resulting extract was filtered and concentrated at temperature 40–45 °C. The extract was store in vials until future process.

### 2.2 Fractionation of *Psidium guajava*:

Ethanolic extract was put in a activated silica column with chloroform, tolune (70:30),

the marc was subjected further and then fractionated with Methanol for 8–10 hours using methanol (1:10 w/v), Ethanol various fractions were collected and kept in amber vials at 4 °C after the extract was concentrated and vacuum-dried to constant weight. The fractions were subjected to TLC and HPTLC (results were previously published) after confirmation of Corosolic acid in the fraction it was selected for the development of formulation.

### 2.3 Nano-emulsion Formulation Development of Psidium gunjava extract:

The active agent, oil phase, surfactant, co-surfactant, and aqueous phase, respectively, were guava leaf extract standardized to 5% w/w (Corosolic acid rich), coconut oil, Tween 80, propylene glycol, and filtered water. A Milli-Q system was used to provide purified water, and all reagents were of analytical or pharmacopeial quality. The formula as given in Table 1.

**Table 1: Formula for the preparation of Nano emulsion**

| Component | % w/w | Function |
|---|---|---|
| Guava leaf extract (rich in Corosolic acid) | 5 | Active agent |
| Coconut oil | 10 | Oil phase (carrier) |
| Tween 80 | 10 | Surfactant |
| Propylene glycol | 3 | Cosurfactant |
| Purified water | Up to 100 | Continuous phase |

### 2.4 Design Expert applied for the Batches:

Independent Variables (Factors)

Based on your formulation, the major variables that influence particle size are:

- ✓ MCT oil (%) we used Coconut oil as medium chain triglyceride
- ✓ Tween 80 (%)
- ✓ Propylene glycol (%)

we keep the guava leaf extract constant at 5% and adjust other component ratios as depicted in Table 2.

**Table 2: Application of design expert in formulation of Nanoemulgel**

| Batch | MCT Oil (%) | Tween 80 (%) | Propylene glycol (%) | Water (%) | Particle Size (nm) |
|---|---|---|---|---|---|
| 1 | 10 | 10 | 3 | 72 | 158 |
| 2 | 10 | 8 | 3 | 72 | 137 |
| 3 | 8 | 12 | 4 | 71 | 155 |
| 4 | 11 | 11 | 2 | 71 | 151 |
| 5 | 9 | 13 | 3 | 70 | 148 |
| 6 | 13 | 7 | 4 | 71 | 165 |

| | | | | | |
|---|---|---|---|---|---|
| 7 | 7 | 13 | 5 | 70 | 149 |
| 8 | 10 | 12 | 3 | 70 | 153 |
| 9 | 11 | 9 | 5 | 70 | 146 |
| 10 | 9 | 11 | 5 | 71 | 150 |

As per the above batches we have decide Formula of optimum batch
Tween-80: 8.0 % w/w
MCT oil: 10.0 % w/w
Guava leaf extract: 5.0 % w/w (fixed)

## 3. **Results and Discussion:**

### 3.1 **Plant Material and Extraction of Psidium gunjava:**

The good quality guava leave was collected for Nandurbar district and analyse. The macroscopic and microscopic characters of *Psidium guajava* was shown in Figure 1.

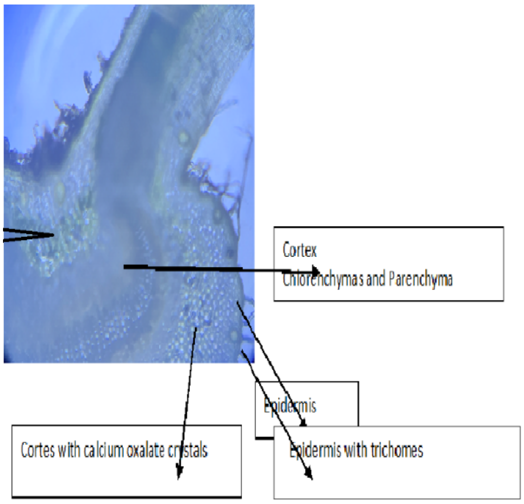


**Figure 1: Microscopic charecteristics of Psidium Guajava**

### 3.2 Fractionation of *Psidium guajava*:

The yield of extracts was calculated using the formula given below and the extractive yield was given Table 5:

$$\%Yield = \frac{\text{Weight of dried extract (g)}}{\text{Weight of initial plant powder (g)}} \times 100$$

**Table 2: Extractive yield of various fractions of *Psidium guajava***

| Sr. No | Fraction | Percentage Yield |
|---|---|---|
| 1 | Chloroform and toluene (70:30) | 4 % |
| 2 | Methanolic Fraction | 3 % |
| 1 | Alcoholic fraction | 27% |

### 3.3 Model assessment of $2^3$ factorial Design Expert:

After putting the data in Design Expert® software for, Fit summary applied to data in that 2FI Model had been suggested by the software for all the responses. The statistical evaluation was performed by using ANNOVA. Results are shown in (Table 3 and 4). The coefficients with more than one factor term in the regression equation represent interaction terms. It also shows that the relationship between factors and responses is not always linear. When more than one factor are changes simultaneously and used at different levels in a formulation, a factor can produce different degrees of responses.

**Table No 3 : Results of Analysis of Variance for Measured Response (Particle Size)**

| **Source** | **Sum of Squares** | **df** | **Mean Square** | **F-value** | **p-value** | |
|---|---|---|---|---|---|---|
| Model | 4239.00 | 6 | 706.50 | 1413.00 | 0.0204 | |
| A-Tween 80 | 3280.50 | 1 | 3280.50 | 6561.00 | 0.0079 | |
| B-PEG 400 | 760.50 | 1 | 760.50 | 1521.00 | 0.0163 | |
| C-MCT oil | 180.50 | 1 | 180.50 | 361.00 | 0.0335 | **Significant** |
| AB | 12.50 | 1 | 12.50 | 25.00 | 0.1257 | |
| AC | 4.50 | 1 | 4.50 | 9.00 | 0.2048 | |
| BC | 0.5000 | 1 | 0.5000 | 1.00 | 0.5000 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Residual | 0.5000 | 1 | 0.5000 | | | |
| Cor Total | 4239.50 | 7 | | | | |

**Table No 4: Results of Analysis of Variance for Measured Response (%EE)**

| **Source** | **Sum of Squares** | **df** | **Mean Square** | **F-value** | **p-value** | |
|---|---|---|---|---|---|---|
| Model | 627.75 | 6 | 104.63 | 837.00 | 0.0265 | **Significant** |
| A-Tween 80 | 528.12 | 1 | 528.12 | 4225.00 | 0.0098 | |
| B-PEG 400 | 78.12 | 1 | 78.12 | 625.00 | 0.0255 | |
| C-MCT oil | 0.1250 | 1 | 0.1250 | 1.0000 | 0.5000 | |
| AB | 6.13 | 1 | 6.13 | 49.00 | 0.0903 | |
| AC | 15.12 | 1 | 15.12 | 121.00 | 0.0577 | |
| BC | 0.1250 | 1 | 0.1250 | 1.0000 | 0.5000 | |
| **Residual** | 0.1250 | 1 | 0.1250 | | | |
| **Cor Total** | 627.88 | 7 | | | | |

**3.4 Response Surface Plot Analysis:**

The particle size of the Nanoemulsion is a fundamental factor because it decides the rate and extent of extract release as well as extract absorption. The smaller particle size offers a larger interfacial surface area for extract absorption and improves the bioavailability. The calculation of polydispersity index takes into account the particle mean size, the refractive index of the solvent, the measurement angle and the variance of the distribution. Low polydispersity index value might be associated with a high homogeneity in the particle population, whereas high polydispersity index values suggest a broad size distribution or even several populations.

From the 3D response surface plot (Figure 2) and nanoemulsion being nanoparticulated structures, formulation batch amongst all the design batches giving least particle size will be preferred more and selected as an optimized batch. Where F8 Design Batch, Higher oil (X3=7%) increases particle size with sufficient surfactant (F8), the size remains low (120 nm), confirming the dominant role of surfactant in controlling droplet size the actual formulation batch show 137 nm.

From the 3D response surface plot (Figure 3), In terms of entrapment efficiency (Y2), the 3D plot indicates that the prepared nanoemulsions exhibited entrapment efficiency values between 68% and 93%. The results revealed that increasing surfactant (Tween 80) and co-surfactant (PEG 400) concentrations significantly reduced droplet size while improving entrapment efficiency. This can be attributed to enhanced interfacial stabilization and increased solubilization of the extract. Among the tested formulations, Batch F8 (13% Tween 80, 5% PEG 400, 7% MCT oil) showed the lowest particle size (120 nm) and the highest %EE (93%), thereby representing the optimized formulation suitable for further evaluation.

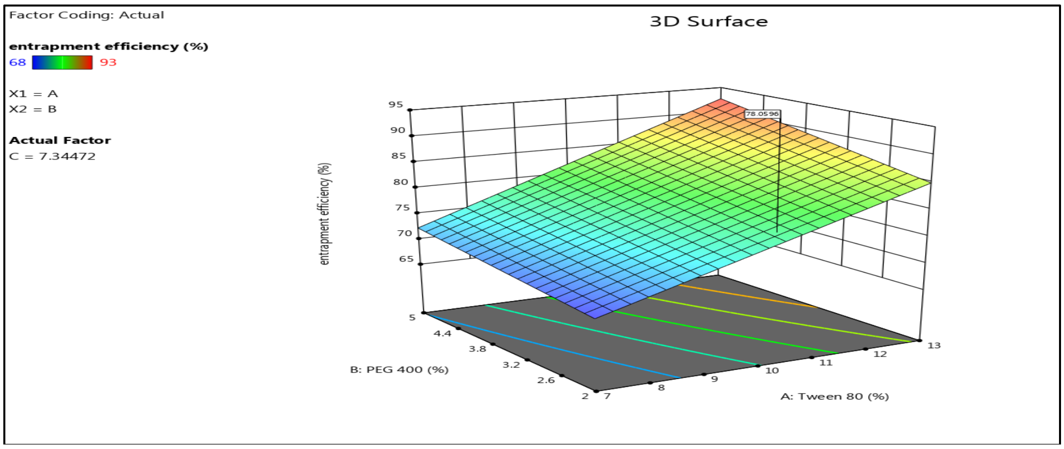


**Figure 2: Response surface plots for X1, X2 and X3 on Mean Particle Size (Y1)**

**Figure 3: Response surface plots for X1, X2 and X3 on %EE (Y2)**

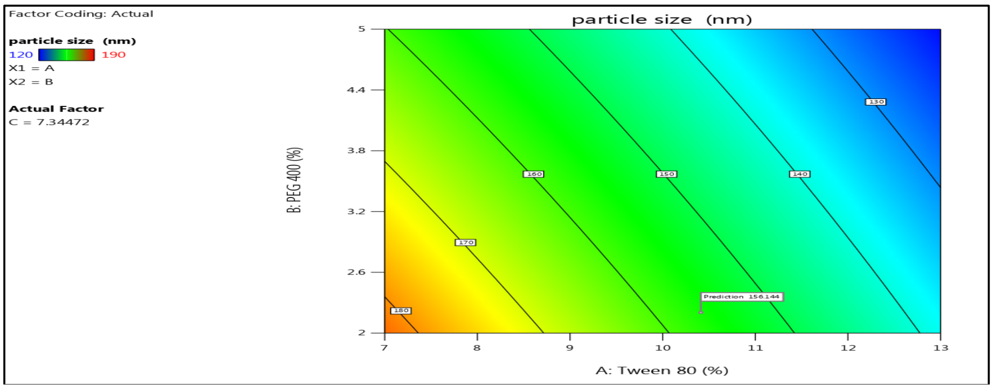


**Figure 4: Contour plots for X1, X2 and X3 on Mean Particle Size (Y1)**

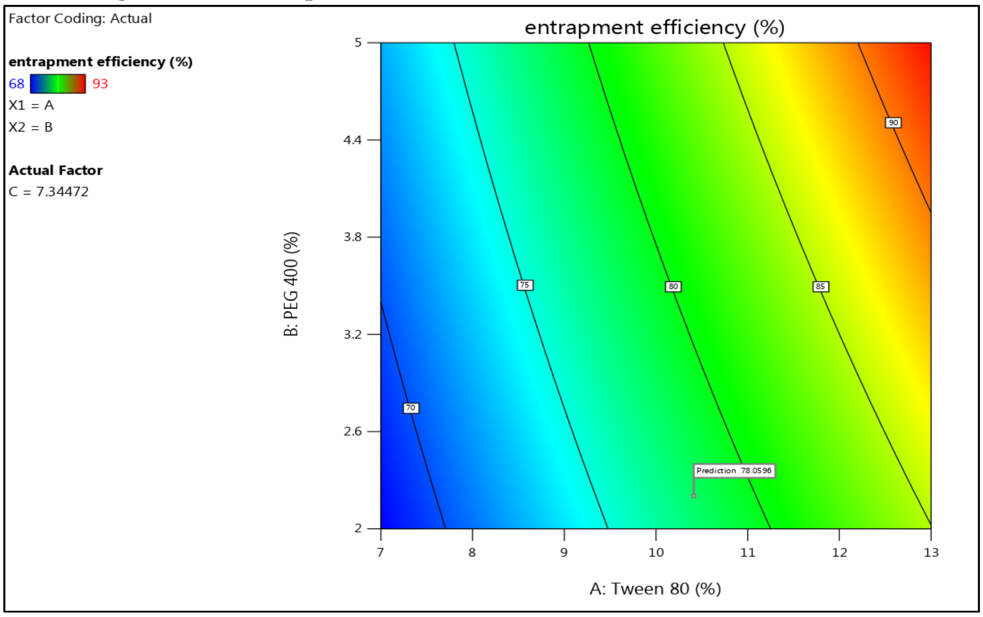


**Figure 4: Contour plots for X1, X2 and X3 on %EE (Y2)**

Figure 7 and 8 illustrated Contour plots in QbD are graphical representations that depict the relationship between critical quality attributes (CQAs) and critical process parameters (CPPs). These plots are useful for visualizing the design space and understanding how changes in process parameters may affect product quality. Both indicate a flat contour and that the critical quality attribute is relatively insensitive to changes in the associated process parameters within that region. This suggests a robust design space where variations in those parameters are less likely to impact product quality. Both response show optimized result in design space.

**3.3.1 Nano-emulsion of Psidium gunjava extract:**

Propylene glycol had no discernible effect within the examined range, whereas MCT oil and Tween 80 concentrations had a substantial impact on the particle size of guava leaf nanoemulsions, according to the Design-Expert optimization. The ten experimental runs' particle sizes ranged from 137 to 165 nm, showing that all formulations were in the nano-size range but that there was noticeable variation based on the amounts of oil and surfactant.

To create fine, stable nano-sized droplets, preparation usually involves combining oil and extract, adding surfactant and cosurfactant, and then gradually titrating into water while stirring (frequently followed by ultrasonication or high-shear homogenization). Compared to crude extracts or traditional administration methods, these nanoemulsions have improved pharmacological effects and have demonstrated improvements in corosolic acid's solubility and bioavailability.[15] The particle size of average 137 nm was achieved with above coated method.

With an R2 of 0.91 and an adjusted R2 of 0.87, the multiple linear regression model produced was: Particle size = 170 + 3.0 (MCT oil) − 2.5 (Tween 80) − 1.0 (Propylene glycol), indicating high model fit and predictive accuracy. While the negative coefficient for Tween 80 showed that higher surfactant levels decreased particle size, consistent with improved interfacial stabilization at higher surfactant concentrations, a positive coefficient for MCT oil suggested that increasing oil percentage tended to increase droplet size. The model recommended an optimum batch that included 10% w/w MCT oil, 8% w/w Tween 80, 3% w/w propylene glycol, 5% w/w guava leaf extract, and 100% pure water that had been sonicated for eight minutes. This composition confirmed that these factor levels are appropriate for producing a small and homogeneous droplet size nanoemulsion by producing a predicted particle size that was around the experimentally observed minimum (about 137 nm). When compared to coarse emulsions, such sub-200 nm droplets are anticipated to improve medication release and skin penetration from a topical administration standpoint, provided that the surfactant and co-solvent levels stay within routinely utilized dermal ranges.

The pH of the nanoemulsion was found to be 4.5 which was slightly acidic and good for the topical application. The viscosity was noted id 242 cP with 100 RPM and 63 Spindle.

### 3.4 Nanoemulgel formulation:

The self-nanoemulsifying method was used for stable Nanoemulgel formulation by incorporating it into a Carbopol hydrogel matrix at a 1:1 ratio under stirring. This approach enhances stability and skin permeation for lipophilic phytoconstituents like terpenoids.

Contour plot is shown the axes clearly present the two formulation factors: MCT oil (%) on X-axis and Tween 80 (%) on Y-axis as depicted in in Figure 4.

Propylene glycol: 3.0 % w/w (fixed)

Purified water: 72.0 % w/w (q.s. to 100)

Sonication time: 8 minutes

4. Discussion:

a. **Discussion:**

Simple leaves with elliptic to oblong blades that occasionally lean toward oval are produced by the plant and are positioned oppositely along the stem. Mature leaves have a leathery feel, a noticeably elevated venation, and are relatively big (about 5–15 cm long and 3–7 cm wide). They are dull green adaxially and whiter beneath. The abaxial surface is pubescent, especially along the veins, giving the lamina a distinctive hairy aspect that is helpful for pharmacognostic identification. The lamina has an acute to rounded apex and an entire, smooth edge (Kaur et al., 2017; Okoye, 2021).

*Psidium guajava*, or guava, has many different phytochemical components, especially in its leaves, which are frequently utilized in traditional medicine. Flavonoids, tannins, phenolic acids, triterpenoids, saponins, and alkaloids are among the main classes found in the plant. Its potent antioxidant, anti-inflammatory, antimicrobial, and antidiabetic properties are thought to be largely attributed to flavonoids such as quercetin, guaijaverin, avicularin, rutin, kaempferol, myricetin, and apigenin, as well as phenolic acids such as gallic, chlorogenic, caffeic, and ellagic acids. The plant's pharmacological profile is further enhanced by triterpenoids and related compounds like Corosolic acid, oleanolic acid, ursolic acid, and guajanoic acid, as well as essential oil components like α-terpineol, β-caryophyllene, and limonene, which provide additional anti-inflammatory, hepatoprotective, and antimicrobial effects. Our results are in agreement with previous reports (Jiménez-Escrig et al., 2008; Ugbogu et al., 2022; Chandrasekaran et al., 2023).

An HPTLC method for analyzing corosolic acid in various *Psidium guajava* leaves was developed using the isolated substance. Chloroform, toluene, and methanol (4:4:1) were determined to be the most appropriate of the various mobile phases tested and produced well-resolved peaks. Corosolic acid showed up as a single band at Rf 0.68 ± 0.03 with this mobile phase. Their superimposable UV spectra and 3D chromatograms showed that the band at RF 0.68 ± 0.03 produced from sample solutions was the same as standard corosolic acid (0.68).

A appropriate platform for improving the solubility and skin penetration of the chosen anti-inflammatory medication, which is otherwise poorly water soluble, was supplied by the nanoemulsion-based formulation. In addition to increasing interaction with the stratum corneum and facilitating drug partitioning into epidermal layers, the nanometric droplet size and wide interfacial area are known to shield the encapsulated drug from oxidation and hydrolysis, improving stability and bioavailability. Additionally, the improved nanoemulsion demonstrated favorable physicochemical characteristics that promote its application as a flexible carrier for topical distribution, including transparency, kinetic stability against creaming or phase separation, and simplicity of scale-up.

Propylene glycol is comparatively insignificant within the measured range, but the Design-Expert analysis unequivocally shows that MCT oil and Tween 80 are the crucial formulation variables controlling particle size in the guava leaf nanoemulsion. The significant ANOVA ($F = 26.7$, $P = 0.001$) and fitted linear model ($R^2 = 0.91$, adjusted $R^2 = 0.87$) show that the model has strong predictive power and that the chosen parameters account for the majority of the size variability. While the negative coefficient for Tween 80 indicates that increased surfactant concentrations successfully reduce size by enhancing interfacial stability, the positive coefficient for MCT oil indicates that increasing oil content tends to enlarge droplet size.

The optimized composition (10% MCT oil, 8% Tween 80, 3% propylene glycol, 5% guava extract, water q.s.) corresponds to the minimum observed size (~137 nm). The contour and response-surface plots support these statistical findings by showing a clearly defined region where moderate MCT oil combined with relatively higher Tween 80 yields the smallest particles. These sub-200 nm droplets are preferred for topical systems because, in comparison to coarse emulsions, they usually improve medication release and skin penetration while being physically stable when enough surfactant is present. All things considered, the model-guided optimization not only finds an effective formulation space but also offers a mechanistic explanation: in order to retain small, homogenous droplets appropriate for cutaneous nanoemulsion distribution, oil loading must be balanced by sufficient surfactant.

In addition to improving patient acceptability and having a non-greasy feel, the gel matrix reduced runoff and increased the length of time that nanoscale droplets were in contact with the inflammatory tissue. This led to a better and longer-lasting anti-inflammatory response when compared to traditional gel formulations, as has also been reported for other NSAID nanoemulgels. A promising strategy for optimizing topical medication administration and therapeutic efficacy in inflammatory disorders is provided by the nanoemulgel system's synergistic combination of hydrogel and nanoemulsion properties.

## 3 Conclusion:

The present research successfully encompassed the entire development cycle, starting from the taxonomically authenticated collection of *Psidium guajava* leaves and their pharmacognostic characterization, through to formulation and in vivo evaluation. Macroscopic and microscopic evaluations, together with preliminary phytochemical screening and literature data, confirmed the presence of abundant flavonoids, tannins, triterpenoids including corosolic and which was confirmed by using HPTLC. Corosolic acid was widely associated with analgesic and anti-inflammatory activities in guava leaves. These findings justified the selection of guava as a promising natural candidate for topical management of inflammatory conditions.

Building on this phytochemical theory, a guava leaf extract nanoemulsion was created and then added to a gel foundation to create a nanoemulgel that could be applied topically. In comparison to traditional semi-solid systems, the optimized nanoemulsion's nanometric droplet size is known to improve drug solubilization, skin penetration, and retention within cutaneous tissues, while conversion into a gel matrix enhances spreadability, residence time, and patient acceptability.

**Conflict of Interest:**

Authors are hereby declaring that there is no conflict of interest.

**References:**


1. Chechani B, Roat P, Hada S, Yadav DK, Kumari N. *Psidium guajava*: An Insight into Ethnomedicinal Uses, Phytochemistry, and Pharmacology. Comb Chem High Throughput Screen. 2024;27(1):2-39. doi: 10.2174/1386207326666230426093315. PMID: 37170987.
2. Rajkumar Diwakar, Irfan Shaikh, Himanshu Dawda, Usha Mukundan. Phytochemical analysis of corosolic and ursolic acid in guava. World Journal of Pharmaceutical Research, 2016, 5; 3; 1318-1327.
3. Bag BG, Garai C, Ghorai S. Vesicular self-assembly of a natural ursane-type dihydroxy-triterpenoid corosolic acid. RSC Adv. 2019 May 15;9(27):15190-15195. doi: 10.1039/c9ra02801c. PMID: 35514858; PMCID: PMC9064250.
4. Butt E, Altemimi AB, Younas A, Butt MS, Jalal M, Bhatty M, Abdi G, Aadil RM. Guava (*Psidium guajava*): A brief overview of its therapeutic and health potential. Food Chem X. 2025 Sep 14;31:103027.
5. Kareem A. T, Kadhim E. J. Psidium guajava: A Review on Its Pharmacological and Phytochemical Constituents. Biomed Pharmacol J 2024;17(2).
6. Li H, Tan X, Qin L, Gatasheh MK, Zhang L, Lin W, Hu F, Yan R, Alshammri MK, Shen Y, Abbasi AM, Qi J. Preparation, process optimisation, stability and bacteriostatic assessment of composite nanoemulsion containing corosolic acid. Heliyon. 2024 Sep 21;10(19):e38283.
7. Kumar M, Bishnoi RS, Shukla AK, Jain CP. Techniques for Formulation of Nanoemulsion Drug Delivery System: A Review. Prev Nutr Food Sci. 2019 Sep;24(3):225-234.
8. Liu Q, Huang H, Chen H, Lin J, Wang Q. Food-Grade Nanoemulsions: Preparation, Stability and Application in Encapsulation of Bioactive Compounds. Molecules. 2019 Nov 21;24(23):4242.
9. Preeti Sambhakar S, Malik R, Bhatia S, Al Harrasi A, Rani C, Saharan R, Kumar S, Geeta, Sehrawat R. Nanoemulsion: An Emerging Novel Technology for Improving the Bioavailability of Drugs. Scientifica (Cairo). 2023 Oct 28;2023:6640103.
10. Jaiswal M, Dudhe R, Sharma PK. Nanoemulsion: an advanced mode of drug delivery system. 3 Biotech. 2015 Apr;5(2):123-127.
11. Kaur P., Kaur R., Saini N. Pharmacognostical and phytochemical evaluation of leaf and stem of Euphorbia hirta L. J Pharmacogn Phytochem., 2017; 6(6):454-459.
12. Okoye F. B. C. Pharmacognostic evaluation of three Apocynaceae plants that share similar ethnomedicinal uses. Heliyon., 2021; 7(11): e08439-45.
13. Jiménez-Escrig A. *Psidium guajava*: A review of its traditional uses, phytochemistry and pharmacology. J Ethnopharmacol., 2008; 117(1):1-27.
14. Ugbogu E. A. The ethnobotanical, phytochemistry and pharmacological activities of *Psidium guajava* L. Arab J Chem., 2022; 15(5):103701-10.
15. Chandrasekaran R. Review of phytochemicals present in *Psidium guajava* plant and its mechanism of action on medicinal activities. Biomed Pharmacother., 2023; 165:115041-49.
16. Ariasti M., Muhsin, L. B. Analgesic activity test of Inggu leaf (Ruta angustifolia [L.] Pers) with Tail Flick and Writhing Test method. Journal of Natural Sciences and Mathematics Research, 2024; 10(2): 139-147.
17. Meka G., Chintakunta R. Analgesic and anti-inflammatory activity of quinoxaline derivatives: Design synthesis and characterization. Results in Chem., 2023; 5: 100783-89.