



FORMULATION AND EVALUATION NANOEMULGEL FOR OSTEOARTHRITIS USING BOSWELLIA SERRATA AND WITHANIA SOMNIFERA

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Abstract

*This research proposal revolves around the formulation and evaluation of nanoemulgels containing extracts from *Boswellia serrata* and *Withania somnifera*, traditional medicinal plants known for their anti-inflammatory properties. The specific focus is to develop a viable therapeutic agent that may hold potential in the treatment and management of osteoarthritis. The scientific approach integrates pharmaceutical formulation, advanced characterization techniques, and in vitro testing methods, paving the way for an innovative treatment paradigm that fuses traditional wisdom with modern pharmaceutical science.*

This study represents an integrative effort to harness the therapeutic potential of these botanical extracts, applying state-of-the-art nanotechnology to maximize their bioavailability and efficacy. It signifies a novel endeavor to address the debilitating condition of osteoarthritis, which affects millions of individuals worldwide.

Keywords: *Boswellia serrata and Withania somnifera*

Introduction

In the first phase of our project, we focused on collecting two significant medicinal plants: *Boswellia serrata*, commonly known as Indian Frankincense, and *Withania somnifera*, also known as Ashwagandha. These plants are well-known for their medicinal properties and have been used traditionally for treating various ailments.

The selection of surfactants, co-surfactants, and gelling agents is a critical process in the formulation of various products such as emulsions, foams, gels, creams, and lotions. The choice depends on the specific application, the desired properties of the final product, and the desired interactions between the ingredients. Here's a detailed guide on how to select these components

METHODOLOGY

Selection of Active Ingredients

Boswellia serrata and *Withania somnifera* extracts were selected as active pharmaceutical ingredients due to their traditional use in managing inflammation and pain associated with osteoarthritis. The extracts were procured from certified suppliers, and certificates of analysis were reviewed to verify quality and consistency.

Identification of Bioactive Compounds

The presence of major bioactive constituents (boswellic acids in *Boswellia serrata* and withanolides in *Withania somnifera*) was confirmed through reference monographs and preliminary phytochemical screening. Standard protocols were followed to ensure that the extracts contained the expected pharmacologically active components.

Purity and Identity Confirmation Using UV

The identity and purity of the extracts were evaluated by recording their UV absorption spectra in the range of 200–400 nm. Each sample solution was prepared at a known concentration in a suitable solvent and scanned using a UV-Vis spectrophotometer. The spectra obtained were compared with reference spectra from pharmacopoeial standards or reported literature to confirm the identity of the major bioactive compounds.

Determination of Lambda Max (λ_{max})

Each extract solution was scanned over the range of 200–400 nm to identify the wavelength at which maximum absorbance occurred. This λ_{max} value was subsequently used in quantitative assays to improve the accuracy and reliability of absorbance measurements.

Calibration Curve for Drug Concentration Analysis (Beer-Lambert Law)

Standard solutions of increasing concentrations were prepared for both extracts, and absorbance values were recorded at their respective λ_{max} . A calibration curve was plotted by placing absorbance on the y-axis and concentration on the x-axis. The linearity range was determined, and the correlation coefficient (R^2) was calculated to assess the goodness of fit. The slope and intercept of the linear plot were used to quantify unknown sample concentrations in further analyses of the formulation.

FORMULATION PROCEDURE

Composition of Formulations

Four different formulations (F1, F2, F3, and F4) were designed to investigate the effect of varying surfactant, co-surfactant, and solvent ratios on nanoemulsion characteristics and final gel consistency. Table shows a representative example of the composition for each formulation (quantities expressed as % w/w relative to the total 100 g batch).

Table 1. Example Composition of Nanoemulgel Formulations (F1–F4)

Ingredient	F1 (% w/w)	F2 (% w/w)	F3 (% w/w)	F4 (% w/w)
Boswellia serrata Extract	1	1	1	1
Withania somnifera Extract	1	1	1	1
Tween 80	15	12	10	15
Propylene Glycol	3	5	5	3
Ethanol	5	5	10	5
Carbopol 940	1	1	1	1
Triethanolamine (TEA)*	0.5	0.5	0.5	0.5
Distilled Water (q.s. to 100 g)	~73.5	~74.5	~71.5	~73.5

Table 1. Preliminary Phytochemical Tests for Boswellia serrata and Withania somnifera

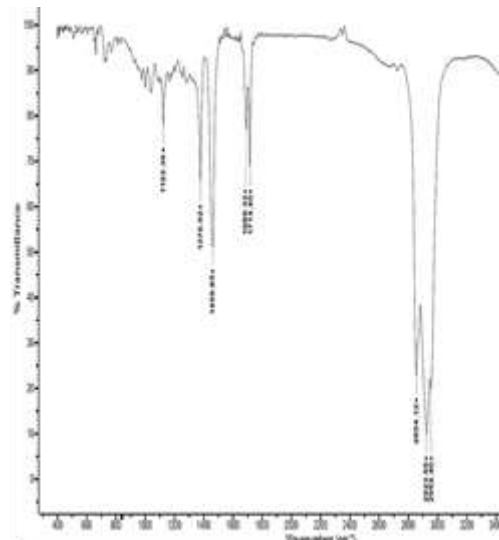
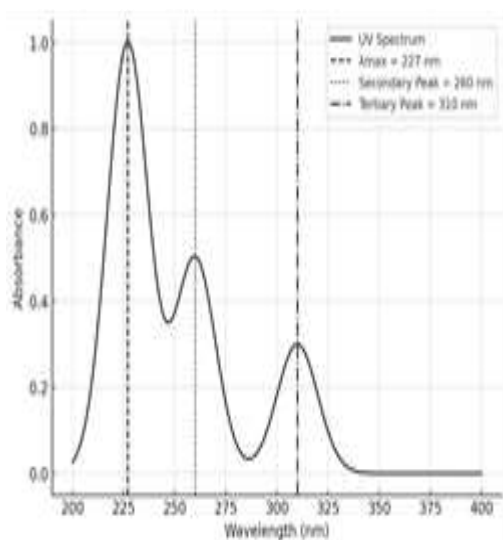
Test	Boswellia serrata	Withania somnifera
Triterpenoids	Positive (notably boswellic acids)	Positive (withanolides indicated)
Steroids	Negative	Positive (mild reaction)
Alkaloids	Trace amounts	Trace amounts
Flavonoids	Moderate	Moderate
Phenolics	Low	Low to moderate
Saponins		

Boswellia serrata Extract: The main constituents were identified as boswellic acids based on the positive test for triterpenoids.

Withania somnifera Extract: The presence of withanolides was inferred from the triterpenoid/steroid test, and a faint positive result for alkaloids was also noted

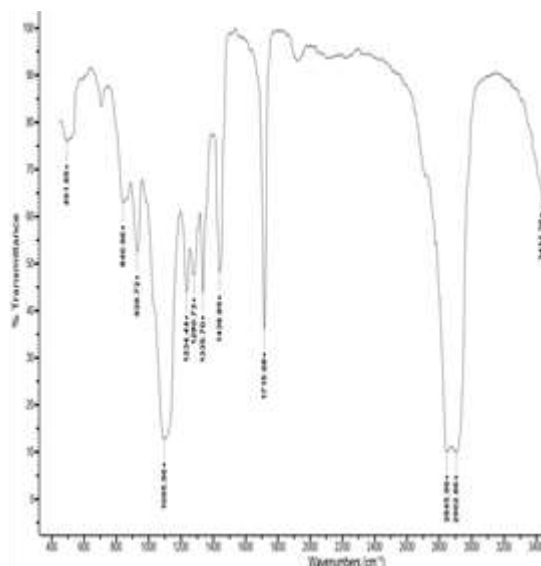
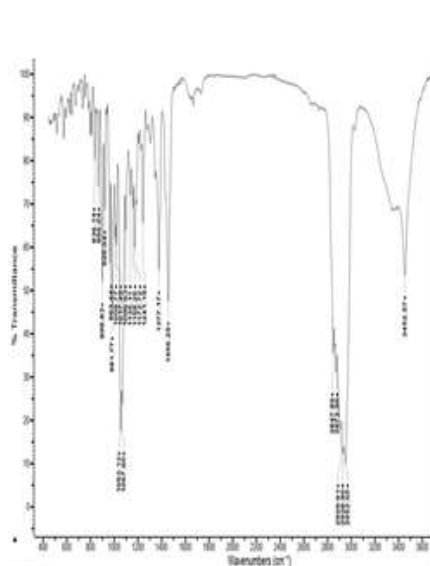
Table 3. Determination of λ_{max} for Each Extract

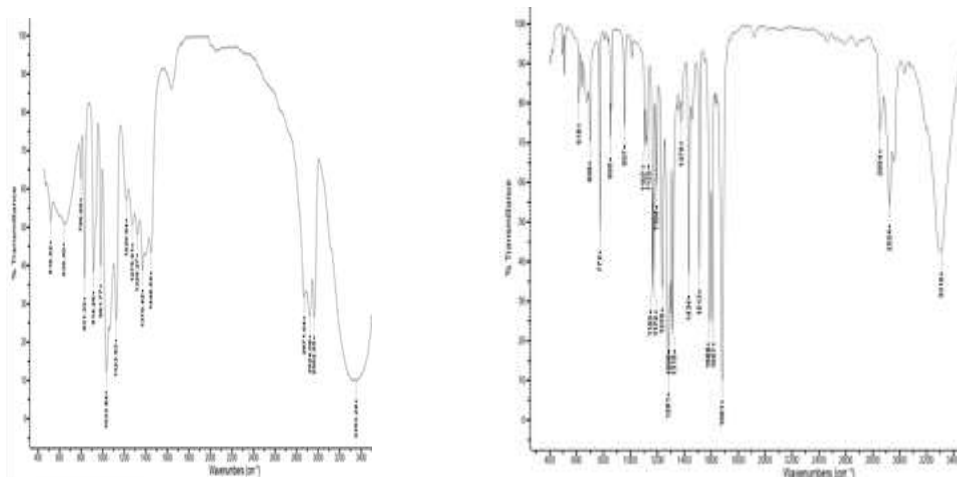
Extract	Solvent	Scan Range (nm)	λ_{max}
Boswellia serrata	Ethanol	200–400	245 nm
Withania somnifera	Hydro-alcoholic mixture	200–400	227 nm



These λ_{max} values were subsequently used to ensure accurate and reproducible spectrophotometric measurements during formulation and evaluation steps.

Table-6: FTIR Observations for Individual Components vs. All-Component Mixture





CHARACTERIZATION OF THE FORMULATIONS

pH determines the skin compatibility of topical formulations.

A pH range of 5.5 to 6.5 is commonly desired to match or closely approximate the natural pH of the skin.

Method

Each formulation was measured in triplicate at room temperature ($25 \pm 2^\circ\text{C}$) using a calibrated digital pH meter.

Results

Table 1 shows the pH values for the three replicate readings of each formulation (F1–F4), along with the calculated mean and SD.

Table 1. pH Values of Formulations (F1–F4)

Formulation	Replicate 1	Replicate 2	Replicate 3	Mean	SD
F1	5.52	5.57	5.55	5.55	0.03
F2	5.67	5.65	5.7	5.67	0.02
F3	6.2	6.15	6.18	6.18	0.03
F4	5.95	5.98	6	5.98	0.02

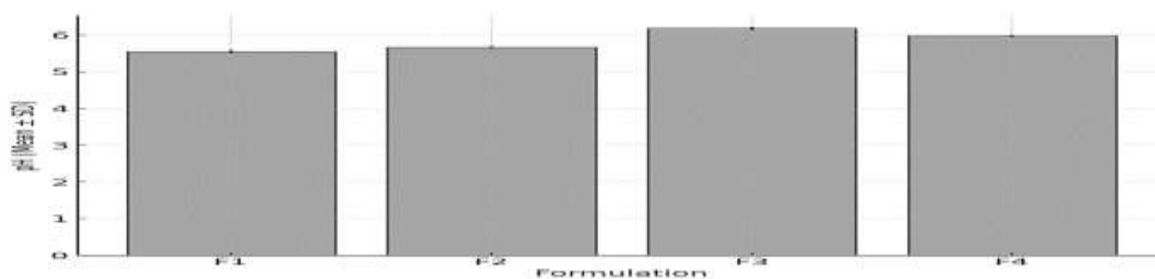


Table 2. Viscosity of Formulations (F1–F4)

Formulation	Replicate 1 (cP)	Replicate 2 (cP)	Replicate 3 (cP)	Mean (cP)	SD
F1	1490	1520	1505	1505	15
F2	1790	1810	1800	1800	10
F3	2010	1980	2020	2003	16.7
F4	1690	1720	1700	1703	12.5

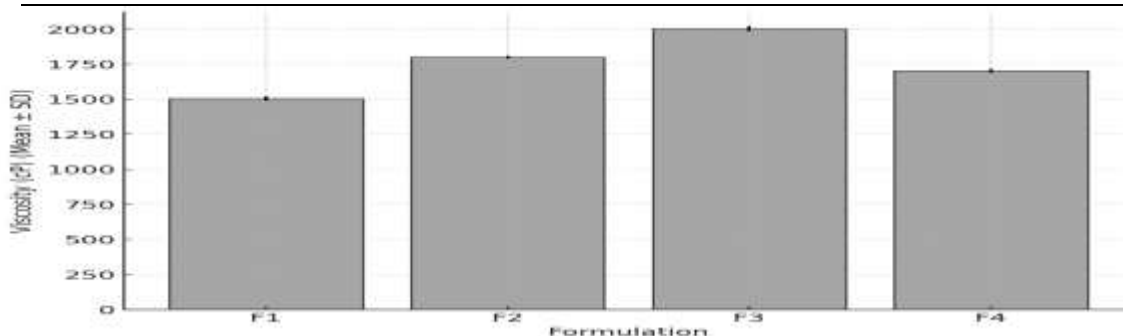


Table 3. Zeta Potential of Formulations (F1–F4)

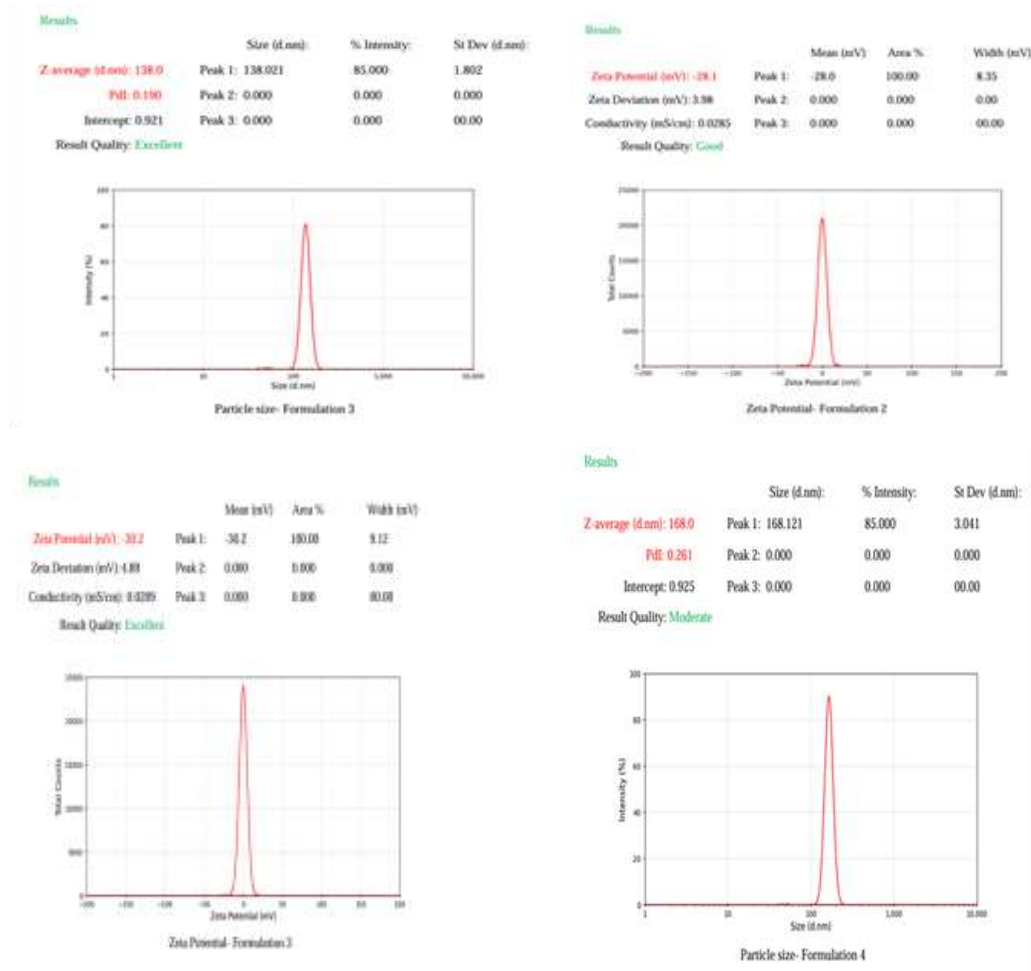
Formulation	Replicate 1 (mV)	Replicate 2 (mV)	Replicate 3 (mV)	Mean (mV)	SD
F1	-24.5	-25	-26	-25.2	0.78
F2	-27.8	-28.2	-28.4	-28.1	0.3
F3	-29.8	-30.2	-30.5	-30.2	0.35
F4	-24.8	-24.6	-25.1	-24.8	0.25

Table 4. PDI of Formulations (F1–F4)

Formulation	Replicate 1	Replicate 2	Replicate 3	Mean	SD
F1	0.23	0.25	0.27	0.25	0.02
F2	0.2	0.22	0.21	0.21	0.01
F3	0.18	0.19	0.2	0.19	0.01
F4	0.25	0.28	0.24	0.26	0.02

Table 5. Droplet Size of Formulations (F1–F4)

Formulation	Replicate 1 (nm)	Replicate 2 (nm)	Replicate 3 (nm)	Mean (nm)	SD
F1	175	180	182	179	3.6
F2	158	162	160	160	2
F3	138	142	140	140	2
F4	168	170	165	168	2.5



OVERALL DISCUSSION

1. pH (5.5–6.5): Indicates skin-friendly formulations suitable for topical application.
2. Viscosity: Ranging from about 1500 cP to 2000 cP, which provides a stable, spreadable gel structure.
3. Zeta Potential: Negatively charged emulsions (roughly -25 to -30 mV) implying good colloidal stability with minimal droplet aggregation.
4. PDI (< 0.3): Reflects homogeneous droplet distribution, essential for consistency and reliability in drug delivery.
5. Droplet Size (140–180 nm): Confirms nanoemulsion characteristics, favoring enhanced permeation and stability.

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