Formulation and Evaluation of Herbal Nanoemulgel of Ankol Leaf Extract for Topical Application

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***Abstract*—Alangium salvifolium (Ankol) is a medicinally valued plant traditionally used for wound healing, anti-inflammatory and antimicrobial purposes. Conventional herbal formulations of the extract suffer from poor skin permeation and low patient compliance. The present work aimed to formulate and evaluate a nanoemulgel of the ethanolic leaf extract of A. salvifolium for topical application. The leaves were shade-dried, powdered and extracted with 95% ethanol by Soxhlet extraction (yield 31.9% w/w). Preliminary phytochemical screening confirmed the presence of alkaloids, flavonoids, phenolics, tannins, saponins, terpenoids, steroids and glycosides. Three nanoemulgel batches (F1–F3) were prepared by the spontaneous emulsification method using Tween 20 and distilled water as the aqueous phase, castor oil and PEG 340 as the organic phase, and Carbopol 940 as the gelling agent. The batches were evaluated for appearance, texture, homogeneity, spreadability, viscosity, extrudability, pH, irritancy, stability and washability. All batches showed a smooth, homogeneous, greenish semisolid consistency, skin-compatible pH (5.75–5.95), satisfactory spreadability (58–62 g·cm/s), good extrudability and no signs of skin irritation on preliminary testing. The results indicate that A. salvifolium leaf extract can be successfully incorporated into a stable, skin-compatible nanoemulgel suitable for further pharmacological evaluation.**

***Index Terms*—Alangium salvifolium; Nanoemulgel; Herbal extract; Topical drug delivery; Spontaneous emulsification; Physicochemical evaluation**

I. INTRODUCTION

The use of nanocarriers with herbal actives (‘nanophytomedicine’) has shown encouraging outcomes across anti-inflammatory, antimicrobial, antioxidant and wound-healing applications [1]. Nanoemulgel technology is well suited to herbal extracts because it avoids harsh organic solvents, accommodates both hydrophilic and lipophilic constituents, and converts a low-viscosity nanoemulsion into an easily applicable, non-greasy semisolid gel with good skin adherence.

Alangium salvifolium (Family: Cornaceae, syn. Alangiaceae), commonly known as ‘Ankol’ or sage-leaved alangium, is a small tree distributed across India, especially the Western Ghats, and parts of Africa and Asia. Its roots, bark, leaves, flowers, seeds and fruits are traditionally used for rheumatism, hemorrhoids, wounds, skin disorders and as an antidote for snake and scorpion bites [2–4]. Reported phytoconstituents include alkaloids, flavonoids, tannins and saponins, which impart antioxidant, anti-inflammatory, antimicrobial and wound-healing activity [2,4].

Fig-1: Alangium salvifolium

Conventional topical dosage forms such as ointments, creams and simple herbal gels often suffer from poor aqueous solubility of the phytoconstituent, erratic absorption, low skin permeability and instability of the crude extract, particularly when the active is a high-molecular-weight, poorly water-soluble plant constituent [5]. Nanotechnology-based delivery

systems address many of these limitations: reducing droplet size to the nanometre range increases the surface area available for absorption, improves dissolution of poorly soluble constituents, and facilitates transport across the stratum corneum [5]. Nanoemulgel – a nanoemulsion incorporated into a hydrogel base – offers improved solubilisation, larger interfacial surface area, prolonged skin contact and better patient acceptability than a conventional herbal gel [6]. The present study was therefore undertaken to formulate and evaluate a Carbopol-based nanoemulgel of the ethanolic leaf extract of A. salvifolium for topical application, and to characterise the resulting formulation for key physicochemical parameters relevant to topical use.

II. FORMULATION (MATERIALS AND METHODS)

2.1 Plant Material and Extraction

Fresh leaves of A. salvifolium were collected from Booganahalli, Tamil Nadu, India, and authenticated by the Department of Botany, Sri Vijay Vidyala College of Arts & Science, Nallampalli. The leaves were shade-dried, powdered and passed through a 40# mesh sieve. 2.5 kg of the coarse powder was extracted with 95% ethanol in a Soxhlet apparatus for 6–8 h at 40–60°C. The extract was concentrated on a hot plate with magnetic stirring at 50–60°C and stored in an airtight container at 4°C. Extraction yield was calculated as Extract % = ($W_{extra}c_t$ / W_{sample}) × 100 and found to be 31.9% w/w. Preliminary phytochemical screening (Dragendorff's, Shinoda and standard qualitative tests) confirmed the presence of alkaloids, flavonoids, phenolics, tannins, saponins, terpenoids, steroids and glycosides.

2.2 Materials

Ethanolic leaf extract, Tween 20 (surfactant), castor oil (oil phase), PEG 340 (co-surfactant), Carbopol 940 (gelling agent), triethanolamine (neutralising agent) and methyl paraben (preservative) were of analytical grade.

2.3 Formulation of Nanoemulgel

The nanoemulgel was prepared by the spontaneous emulsification method. The aqueous phase (Tween 20 + distilled water) and the organic phase (castor oil + PEG 340) were each stirred separately at 1500 rpm for 30 min. Methyl paraben was added to the aqueous phase, after which the organic phase was added dropwise to the aqueous phase under constant stirring (1500 rpm, 15 min) followed by sonication for 30 min to obtain a clear nanoemulsion. Separately, Carbopol 940 was dispersed in distilled water and neutralised with triethanolamine (500 rpm) to form a transparent gel base. The nanoemulsion was incorporated into the gel base, made up to volume with water, and homogenised at 2000 rpm for 2 h. Three batches (F1–F3) were prepared by varying the surfactant/co-surfactant ratio (Table-1).

Table-1: Composition of A. salvifolium nanoemulgel batches (F1–F3)

Ingredient	F1	F2	F3
Extract	1 ml	1 ml	1 ml
Tween 20	4 ml	4.5 ml	5 ml
PEG 340	3.7 ml	4 ml	4.3 ml
Methyl paraben	0.05 ml	0.05 ml	0.05 ml
Triethanolamine	0.5 ml	0.5 ml	0.5 ml
Carbopol 940	1.2 ml	1.2 ml	1.2 ml
Castor oil	0.02 ml	0.02 ml	0.02 ml
Distilled water q.s.	39.53 ml	38.73 ml	37.93 ml
Total	50 ml	50 ml	50 ml

III. EVALUATION

The prepared batches were evaluated for physical appearance, texture, homogeneity, odour, spreadability, viscosity, extrudability, pH, irritancy, stability and washability using standard procedures. Spreadability was determined from the distance travelled by a slide under a fixed load (S = M×L/T); pH was recorded using a calibrated digital pH meter on a 1% w/v aqueous dispersion; extrudability and washability were assessed by visual/manual methods; stability was monitored over the storage period for changes in appearance, pH, viscosity and phase separation; and a preliminary skin-irritancy check was carried out by patch application.

Table-2: Physicochemical evaluation of A. salvifolium nanoemulgel batches

Parameter	F1	F2	F3
Appearance	Dark green, glossy	Dark green, glossy	Greenish-black, glossy
Consistency	Semisolid	Thick semisolid	Semisolid
Odour	Herbal	Herbal	Herbal
Spreadability (g·cm/s)	60	58	62
Extrudability	Good	Moderate	Good
pH	5.75	5.95	5.86
Stability	Good	Good	Good
Washability	Good	Good	Good
Irritancy	None	None	None

IV. RESULT

All three batches produced a smooth, homogeneous, greenish semisolid nanoemulgel free from phase separation or syneresis (Fig-2). Batch F1 showed the best overall extrudability and spreadability among the three. The pH of all batches (5.75–5.95) was close to normal skin pH, indicating suitability for topical use, and no signs of irritation were observed during preliminary patch testing. These results confirm that Carbopol 940 combined with the Tween 20/castor oil/PEG 340 system produces a physically stable, skin-compatible nanoemulgel of A. salvifolium extract; efficacy studies (anti-inflammatory, wound-healing, antimicrobial) are proposed as the next stage of this work.

Fig-2: Prepared A. salvifolium nanoemulgel

V. CONCLUSION

A nanoemulgel of the ethanolic leaf extract of ***Alangium salvifolium*** was successfully formulated by the spontaneous emulsification method using Tween 20, castor oil, PEG 340 and Carbopol 940. The optimised batch exhibited a smooth, homogeneous, greenish semisolid consistency, skin-compatible pH, satisfactory spreadability and extrudability, good physical stability and no signs of skin irritation. The nanoemulgel platform offers improved solubilisation and skin-contact properties over a conventional herbal gel and represents a promising vehicle for topical delivery of A. salviifolium leaf extract. Further work on antimicrobial activity, in-vivo wound-healing/anti-inflammatory efficacy, long-term stability and clinical evaluation is recommended before therapeutic application.

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