Development of Anti-inflammatory and Antioxidant Cosmeceutical Products from Herbal Plant A

Chaluwan Cadin[a], Natthawat Semakul[a,*], and Saranya Juntrapirom[b,*]
[a]Department of Chemistry, Faculty of Science, Chaing Mai 50200, Thailand
[b]Chulabhorn Royal Pharmaceutical Manufacturing, Chonburi 20180, Thailand

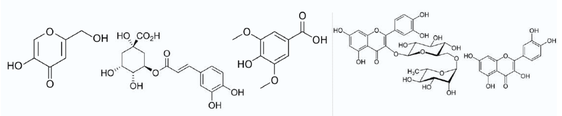
ABSTRACT

This study developed a cosmeceutical product with anti-inflammatory and antioxidant properties derived from the leaves of Herbal Plant A, as part of a cooperative education project conducted at the Chulabhorn Royal Pharmaceutical Manufacturing Facility. In this study, ultrasound-assisted extraction was evaluated using different solvents (i.e., methanol, 95% ethanol, 75%ethanol and 50% ethanol) followed by spray-drying encapsulation to improve stability and formulation into cream prototypes. Among the tested conditions, methanol yielded the highest total phenolic and flavonoid contents, which were associated with high antioxidant activity. High-performance liquid chromatography (HPLC) analysis identified major bioactive compounds, including chlorogenic acid, Kojic acid,Syringic acid rutin, and Quercetin, which are recognized for their roles in free radical scavenging and anti-inflammatory activity. Encapsulation via spray drying to improve extract stability, was characterized by Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), thermogravimetric analysis (TGA), and differential scanning calorimetry (DSC). The developed cream formulations demonstrated good physical stability without observable phase separation.

INTRODUCTION

Coastal herbal plant A with anti-Inflammatory and antioxidant properties

Major Bioactive Compounds



Kojic acid | Chlorogenic acid | Syringic acid | Rutin | Quercetin

- Phenolic compounds
- Flavonoid compounds

Pongprayoon et al., Planta Med., 1991, 57: 515–518

Mechanism of Action

ROS / Oxidative Stress → Inflammatory Pathway Activation → Prostaglandins & Niric Oxide → Skin Inflammation

Herbal Plant A (Phenolic & Flavonoid) → ROS Scavenging → Inhibition of Prostaglandins & NO → Reduced Skin Inflammation

Pongprayoon et al., Planta Med., 1991, 57: 515–518

Biological Properties

- Strong antioxidant activity
- Significant anti-inflammatory effect
- High phenolic and flavonoid content
- Potential skin protective properties

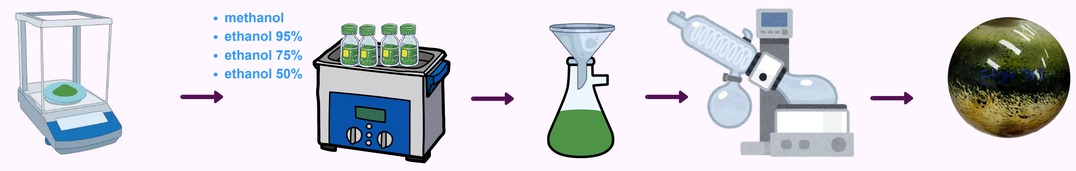
Meira et al., Rev. Bras. Farmacogn., 2012, 22(3): 682–713

Research Objective

- To enhance the extraction of anti-inflammatory and antioxidant compounds from Herbal Plant A leaves by ultrasonic extraction and to evaluate the effect of solvent type on the yield of bioactive compounds.
- To assess the antioxidant activities of the extracts.
- To develop an anti-inflammatory and antioxidant product from Herbal Plant A leaf extract.

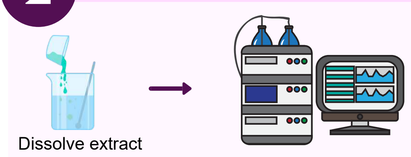
METHODOLOGY

1 Solvent Extraction

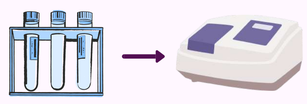


Weigh Dry leaves of Herbal Plant A → Extracted using different solvents via ultrasonic-assisted extraction (UAE) → Filtered and concentrated under reduced pressure → Crude extract

2 HPLC Analysis and Bioactivity Testing

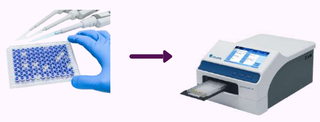


Dissolve extract to 1 mg/mL → Identify and quantify bioactive compounds by HPLC



Total Phenolic Content (TPC): Folin–Ciocalteu method
Total Flavonoid Content (TFC): Aluminum chloride colorimetric assay

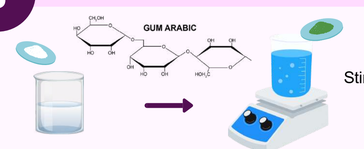
Chang et al., J. Food Drug Anal., 2002, 10, 178–182.



Antioxidant activity
DPPH, ABTS and FRAP Assay

Re et al., Free Radic. Biol. Med., 1999, 26, 1231–1237

3 Encapsulation



Prepare wall material solution (gum arabic) → Mix plant extract with the wall material solution (72% gum arabic : 28 %Extract) → Stir overnight → Feed the mixture into the spray dryer → encapsulated powder

Characterizations

Techniques	information
X-ray Diffraction (XRD)	crystalline/amorphous phase
Thermogravimetric Analysis (TGA)	thermal stability
Differential Scanning Calorimetry (DSC)	transition temperature
Fourier Transform Infrared Spectroscopy (FTIR)	functional groups

4 Formulation



Mix oil and water phases → Homogenization → pH adjustment and cooling

Physical property evaluation
- pH measurement
- Viscosity measurement

CONCLUSIONS

- Herbal Plant A extract showed strong antioxidant activity. The methanol extract had the highest phenolic and flavonoid contents, while 95% ethanol was selected for further use due to its lower toxicity and suitability for cosmeceutical applications.
- Characterization confirmed successful encapsulation, showing an amorphous structure, preserved functional groups, and improved thermal stability.
- Herbal Plant A shows potential as a cosmeceutical ingredient for skin protection and anti-inflammatory applications.
- Optimal processing conditions were not fully determined due to limited experimental trials; however, the results provide a foundation for further optimization and cosmeceutical development.

ACKNOWLEDGEMENT

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RESULTS AND DISCUSSION

1 Solvent Extraction

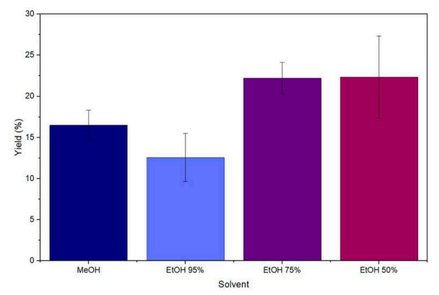


Figure 1. Extraction yield of Herbal Plant A using different solvents by ultrasonic-assisted extraction (UAE).

- The 75% ethanol and 50% ethanolextract showed slightly higher yield, possibly due to experimental variation or solvent–matrix interaction.

2 HPLC Analysis and Bioactivity Testing

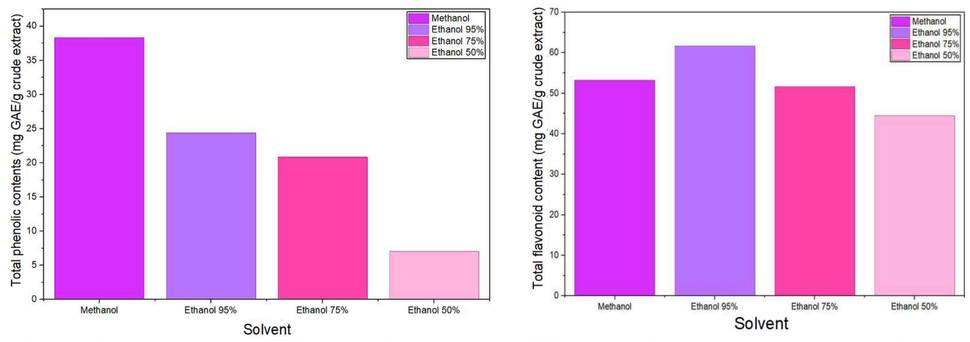


Figure 2. Total phenolic content (TPC) and total flavonoid content (TFC) of Herbal Plant A extracts obtained using different solvents.

- The methanol extract showed the highest total phenolic content (TPC) and ethanol 95% showed the highest total flavonoid contents (TFC).
- Methanol was avoided due to its toxicity, while ethanol was selected as a safer solvent for cosmeceutical applications.

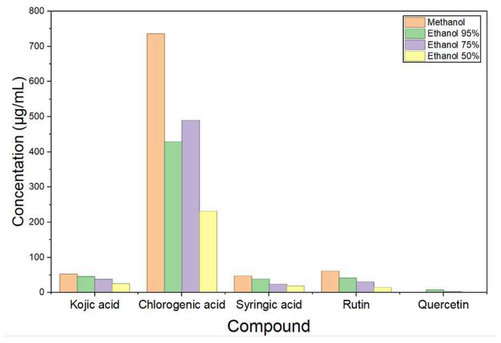


Figure 3. HPLC chromatographic analysis showing major bioactive compounds detected in extracts obtained using different solvents.

- HPLC analysis showed that the methanol extract contained the highest levels of bioactive compounds.
- Major compounds identified were chlorogenic acid, kojic acid, Syringic acid, rutin, and quercetin associated with antioxidant and anti-inflammatory activities.

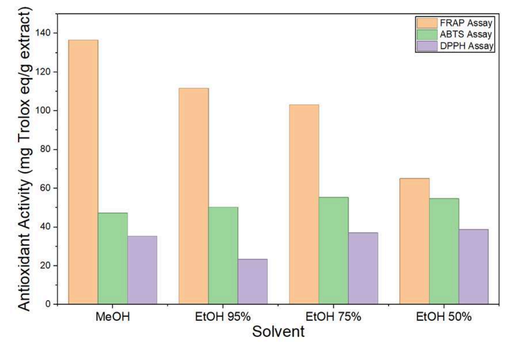


Figure 4. Antioxidant activity of the extracts evaluated by DPPH, ABTS, and FRAP assays.

- The MeOH extract showed strong free radical scavenging capacity.
- Higher antioxidant activity correlated with increased phenolic and flavonoid contents.
- These findings indicate that the extract has potential as a natural antioxidant source for cosmeceutical applications.

3 Encapsulation

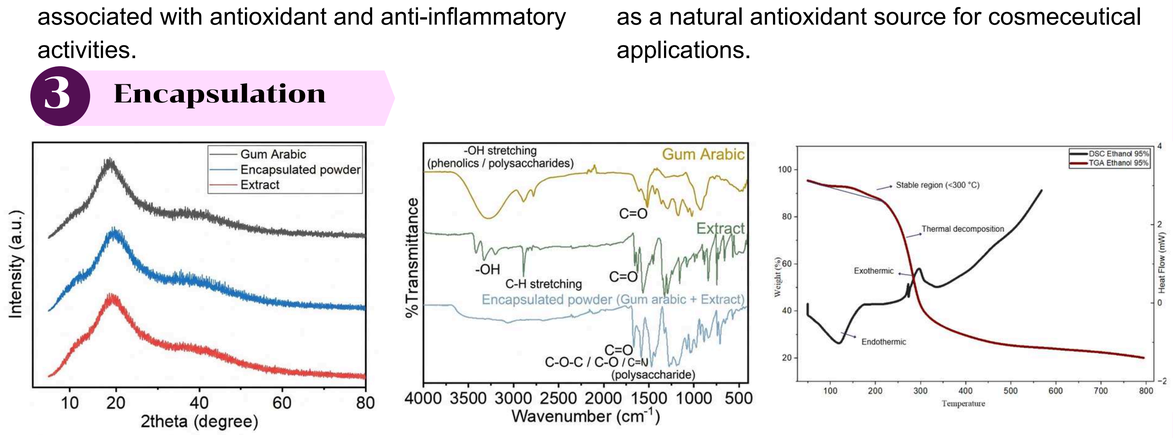


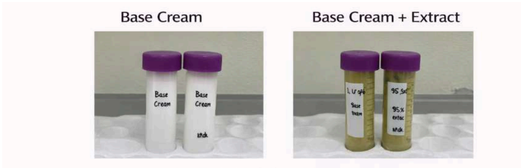
Figure 5. Characterization of encapsulated extract using (a) XRD, (b) FTIR and (c)TGA, DSC.

- XRD patten showed Broad peak at 2θ ≈ 20° indicates an amorphous structure.
- FTIR spectrum showed characteristic peaks of O–H, C–H, C=O, C=C, and C–O–C confirm the presence of functional groups of bioactive compounds after encapsulation.
- TGA & DSC: Sample remained thermally stable upto ~300 °C, In DSC analysis, endothermic peak (~100 °C) relates to analysis of moisture evaporation and exothermic peak (~270–300 °C) indicates structural change or decomposition.

4 Formulation

- The encapsulated extract was incorporated into a prototype cosmeceutical formulation.
- The formulation exhibited uniform appearance and good physical stability.
- No phase separation was observed during stability observation.

Table 1. Physical properties and stability evaluation of the developed cosmeceutical formulation containing encapsulated extract.



Comparison of Physical Properties

Property	Base Cream	Base Cream + Extract
Appearance	Homogenous, no phase separation	Homogeneous, no phase separation
Texture	Not tacky	Not tacky
pH	6.51	6.57
Viscosity (cP)	39,940	36,820