BeNature
BioLab

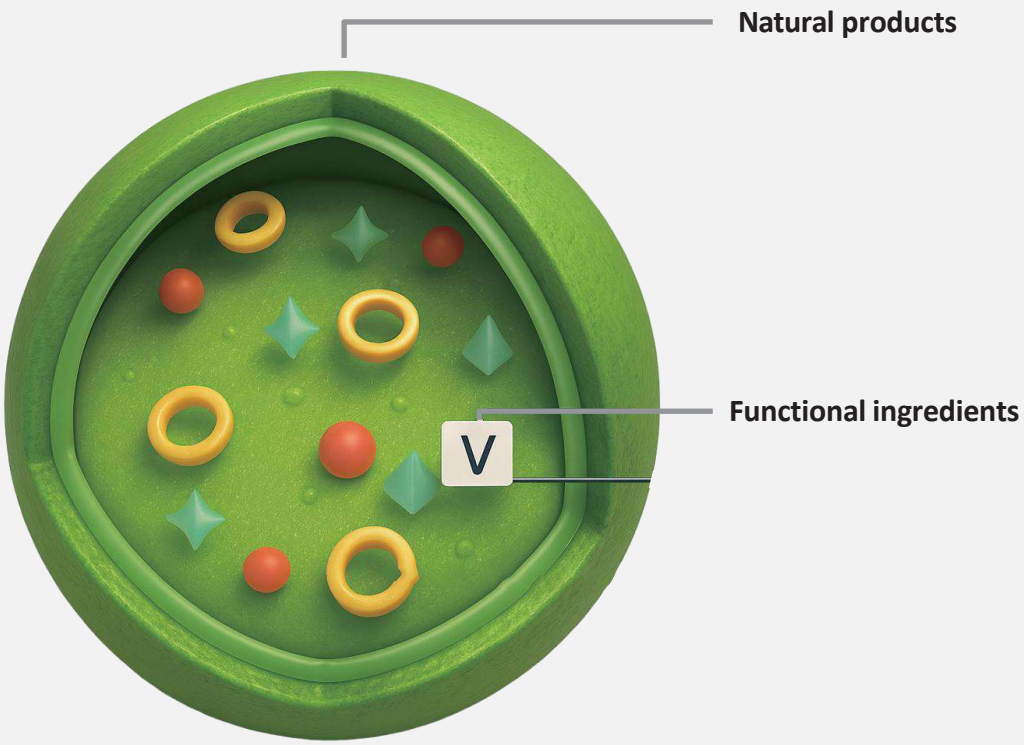
ECOSPHERE
ECOSOLUTION

HOT MELT EXTRUSION PLANT
SOFTENING TECHNOLOGY

BeNatureBiolab has developed a proprietary technology HME-DDS™
(Hot-Melt Extrusion DrugDelivery System) to maximize the efficacy
of rich natural compounds derived from nature.
Using this eco-friendly extrusion platform,
The company is actively conducting research and development
For applications in functional foods, cosmetic ingredients, and pharmaceuticals.

Plant Softening Technology Patent Filed (No. 10-2023-0140467)
BeNatureBiolab owns exclusive processing technology for solvent-free plant softening.

ECOSPHERE



- **Made from 100% natural exosome**
- **High effective ingredient content**
- **Increased acceptance of fat-soluble ingredients**

Plant Softening Technology gently breaks down rigid cell walls, enabling formulation of whole plant materials without loss of active compounds.

This technology is based on BeNatureBiolab's proprietary HME-DDS™ (Hot-Melt Extrusion Drug Delivery System) platform.

The plant is reconstituted while maintaining its physiological activity and is manufactured in a safe and ECOSPHERE or ECOSOLUTION.

Completely absorbed by the skin

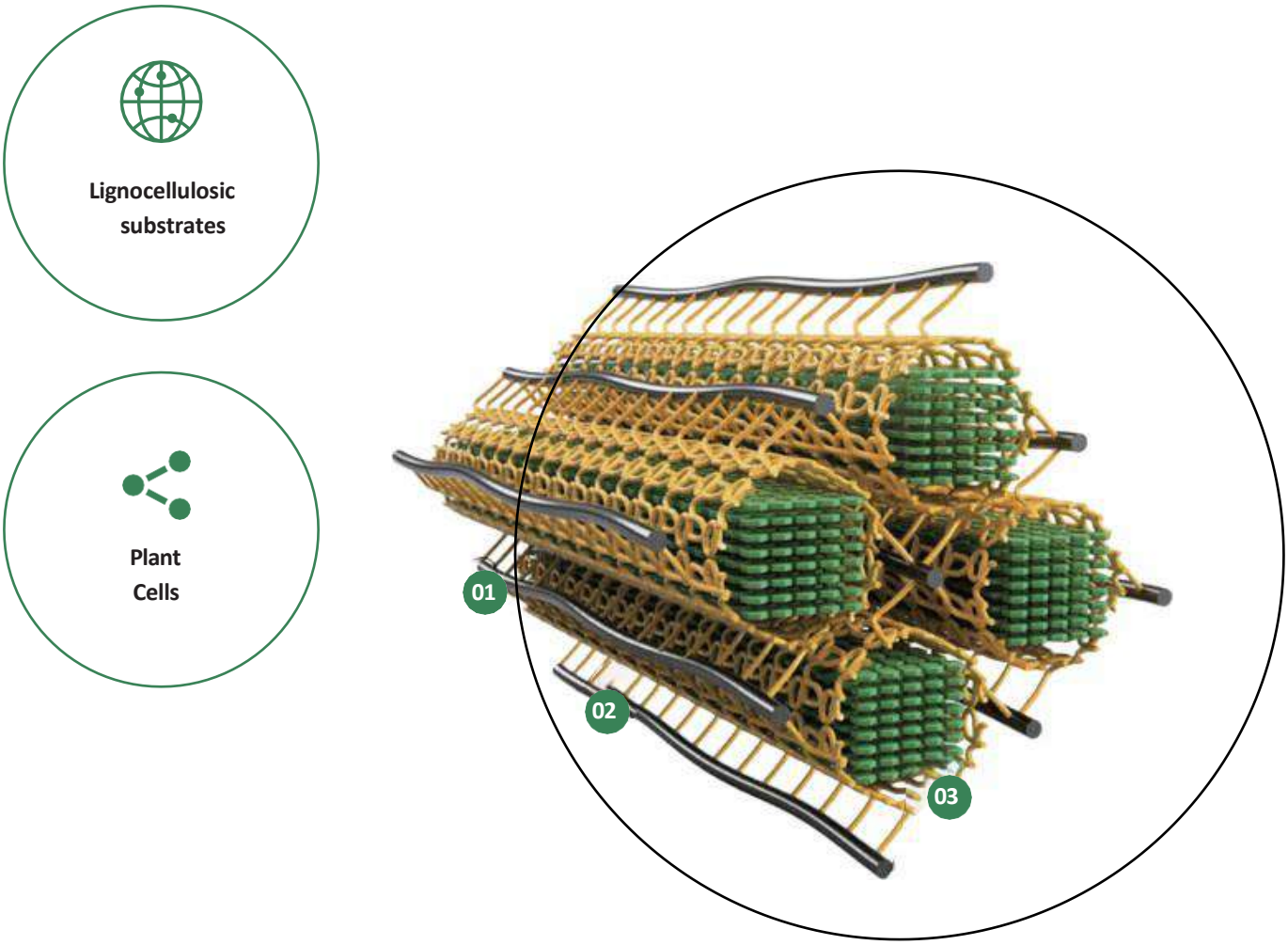
ECOSOLUTION

- No organic solvents used
- High content of natural active ingredients
- Effectively decomposes structural barriers
- Perfect preservation of internal active ingredients Improved extraction efficiency
- Significantly improved delivery effect Improved exosome stability

Plant Softening Principle

Plant Matrix

Plant cell wall structure and microfibril cross-section



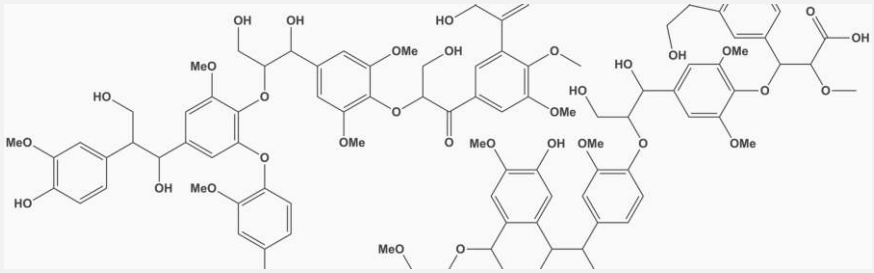
Unlike animal cells, which are relatively flexible, plant cells possess rigid cell walls that help them maintain their structural stability. These cell walls are primarily composed of cellulose, hemicellulose, and pectin, and the strong hydrogen bonds formed between these components greatly enhance the strength and durability of plant tissues. Within the cell wall matrix, various bioactive compounds such as polyphenols, flavonoids, dietary fibers, and natural anthocyanins—are present, contributing to the nutritional and functional value of plant-based materials.

However, because the plant cell wall is highly robust, multiple processing and pretreatment methods are required to efficiently extract these valuable components. Techniques such as grinding, thermal treatment, enzymatic hydrolysis, fermentation, ultrasonic extraction, and high-pressure processing are commonly used.

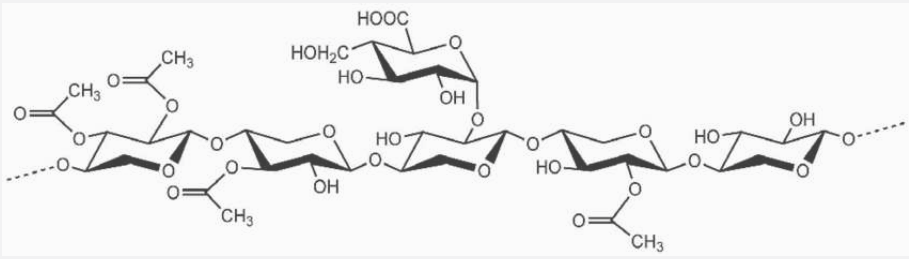
These processes help break down or loosen the rigid cell wall structure, enabling the release of beneficial compounds.

Therefore, understanding the structural characteristics of plant cell walls and selecting the optimal extraction method according to the target compounds are essential steps in obtaining high-quality functional ingredients from plants.

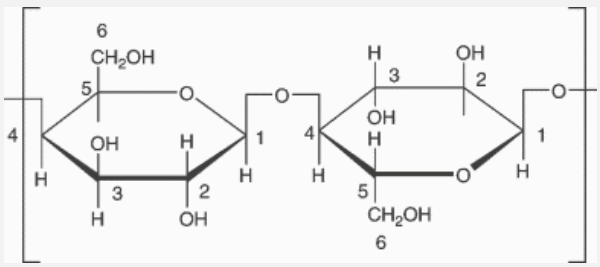
01 Lignin



02 Hemicellulose



03 Cellulose

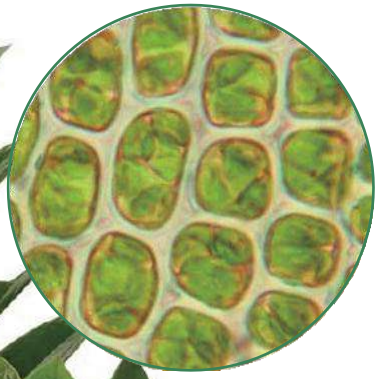


ECOSPHERE & ECOSOLUTION

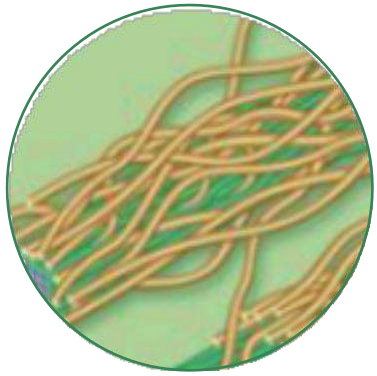
Plant Matrix

Plant cell wall structure and microfibril cross-section

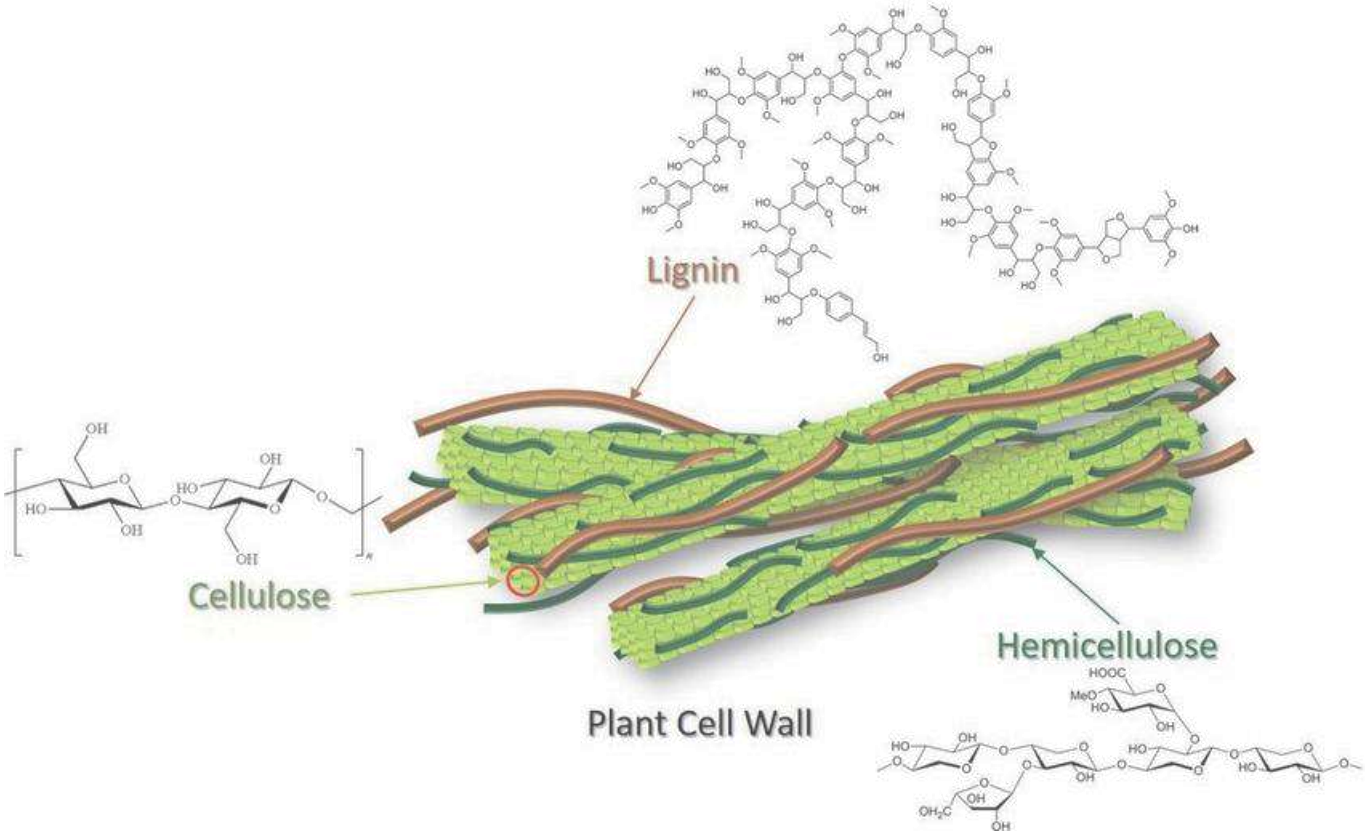
Plant Cells



Micro Fibril



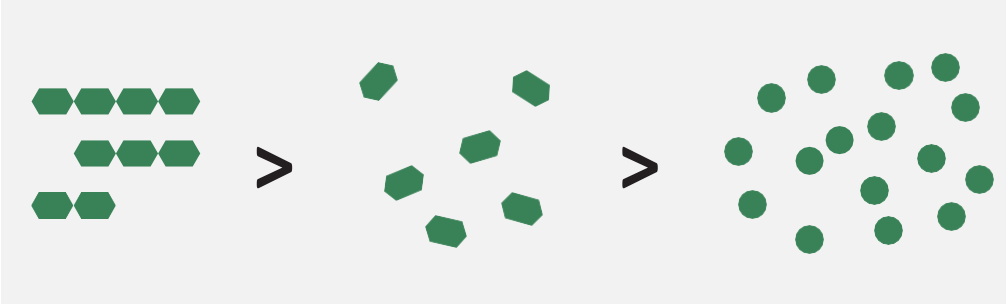
1. **Lignin separation and removal**
2. **Cellulose fragmentation**
   (conventional softening process)
3. **HME-DDS™ Softening**



Our HME-DDS

technology softens tough plant cell walls,

allowing a wide range of biologically active compounds to be safely and effectively utilized.



Manufacturing process

Natural product selection and characteristic analysis

Green

CENTELLA ASIATICA

- ASIATICOSIDE
- ASIATID ACID
- MADECASSIC ACID
- MADECASSOSIDE

HOUTTUYNIA CORDATA

- THIAMIN
- RIBOFLAVIN
- RUTIN
- QUERCETIN

CAMERLLA SINENSIS

- EPIGALLOCATECHIN GALLATE (EGCG)
- CHLOROPHYLL
- VITAMIN C

ARTEMISIA PRINCEPS

- APIGENIN
- LUTEOLIN
- RUTIN
- CAFFEIC ACID

Red

ROSA

- QUERCETIN
- RUTIN
- DELPHINIDIN
- VITAMIN C

Yellow

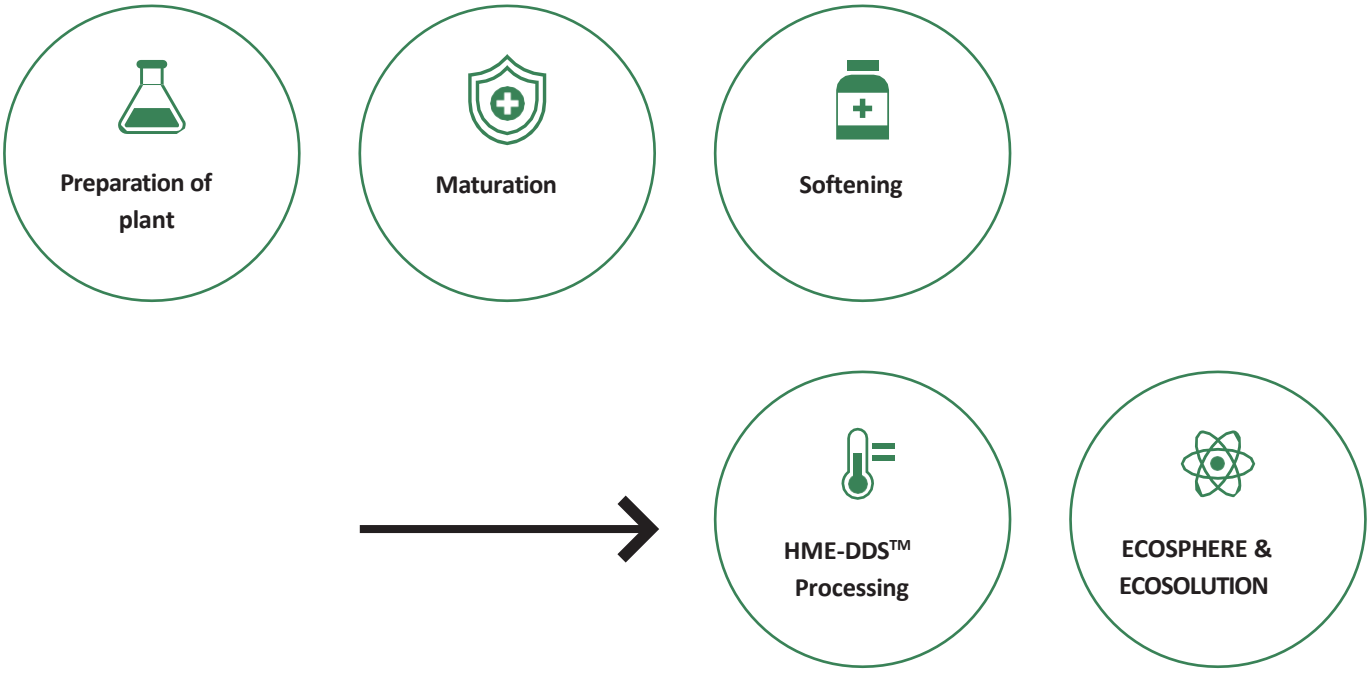
CALENDULA OFFICINALIS

- FARADIOL ESTERS
- ISORHAMNETIN
- LUTEIN
- QUERCETIN

HELIANTHUS ANNUUS

- QUERCETIN
- CHLOROGENIC ACID
- CAFFEIC ACID
- β-SITOSTEROL

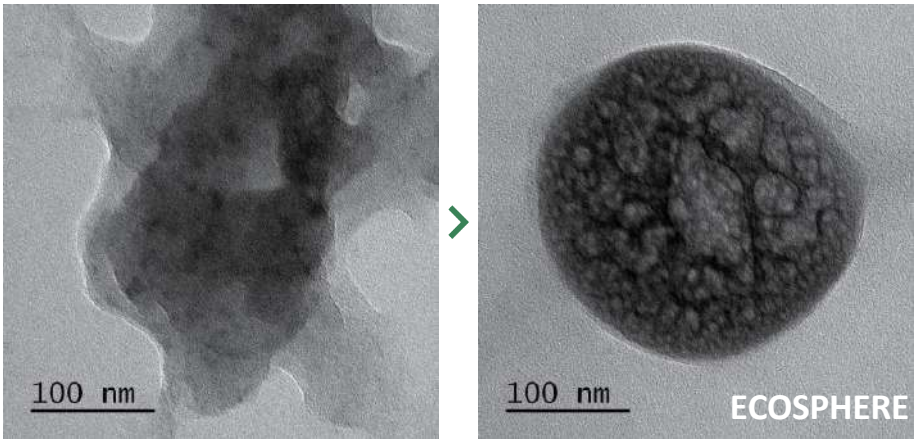
Optimizing the microencapsulation process

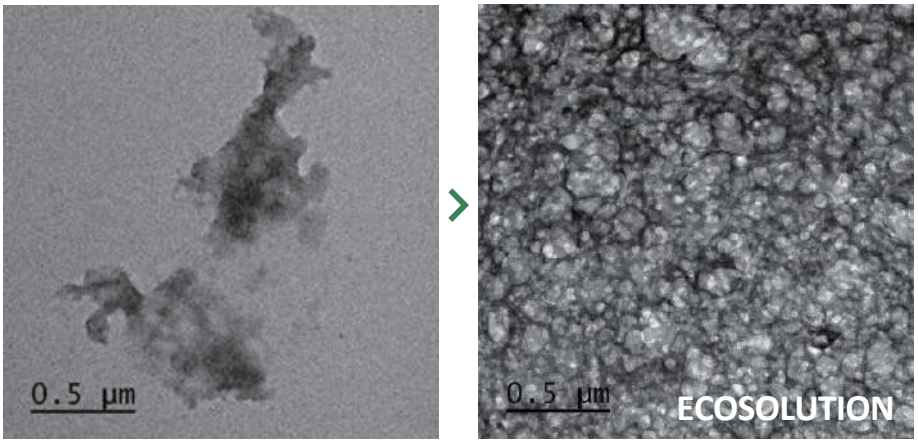


- Selected plant undergo maturation to prepare for softening.
- Materials are processed using HME-DDS technology.
- This produces ECOSOLUTION an aqueous phase rich in bioactives.
- The remaining solids are dried and milled into ECOSPHERE.

Previous Research 01

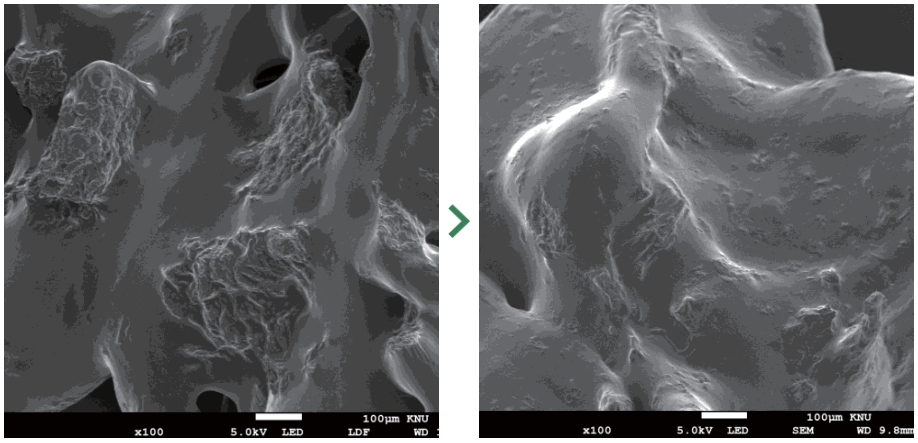
Centella asiatica





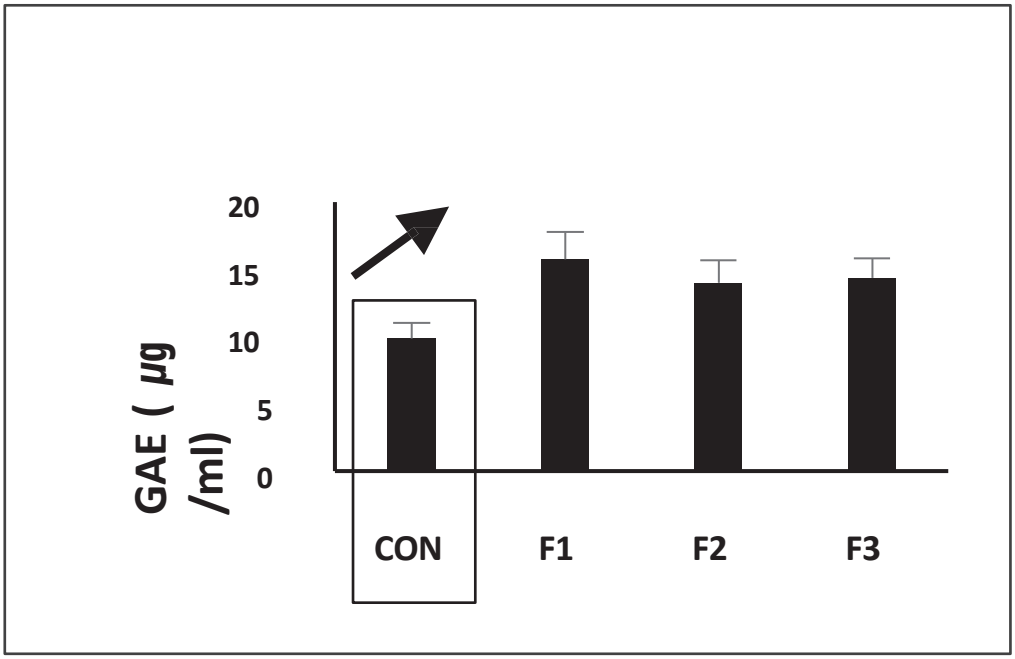
*Spherner shape and clearer structure in Ecosphere compared to Control

After rubbing the ECOSPHERE



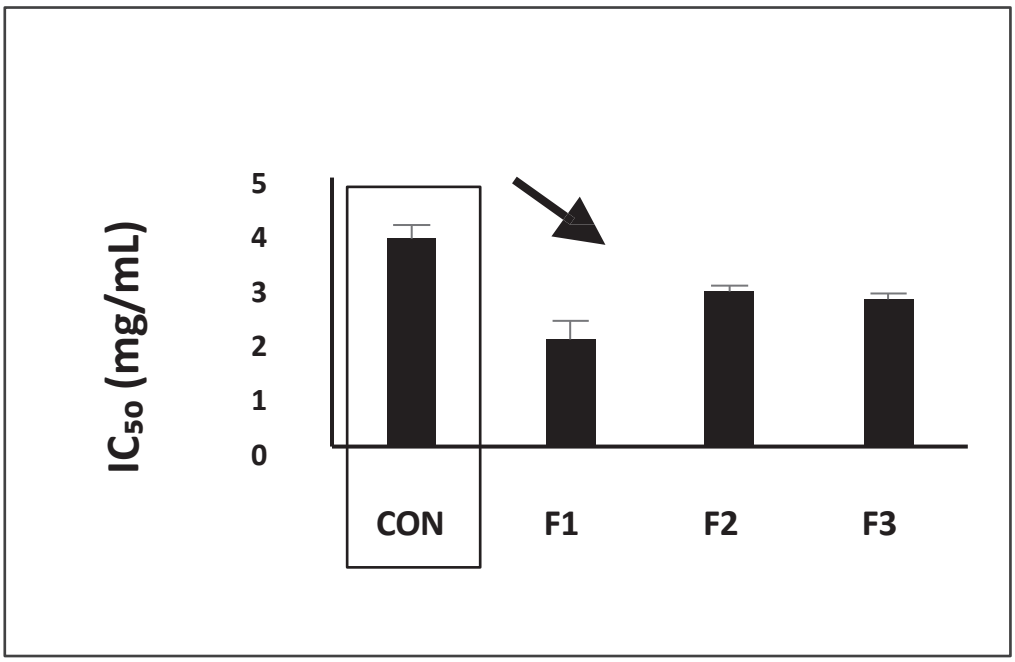
Innovatively advanced functional ingredients to increase stability and skin efficacy, and realize next-generation K-beauty competitiveness in the global market.

TFC



Compared to control, ECOSOLUTION (F1, F2, F3) showed increased total flavonoid content.

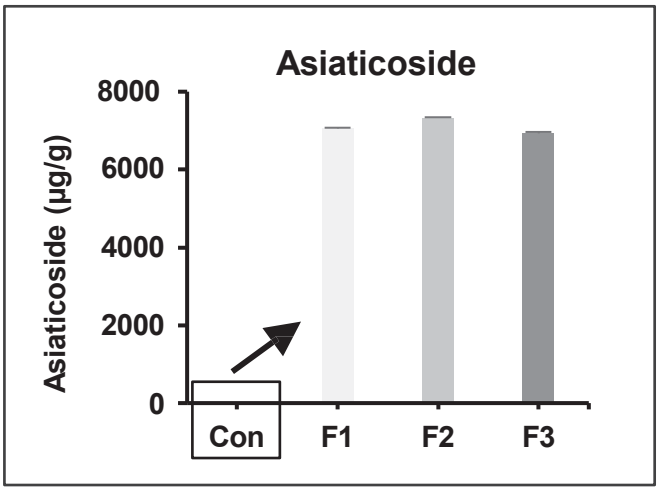
ABTS

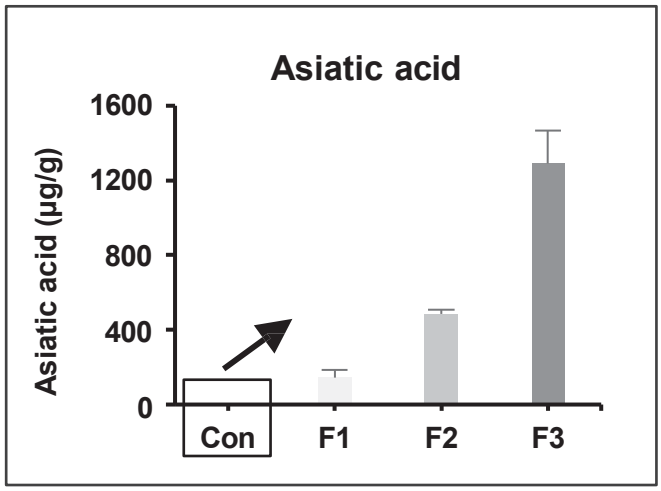


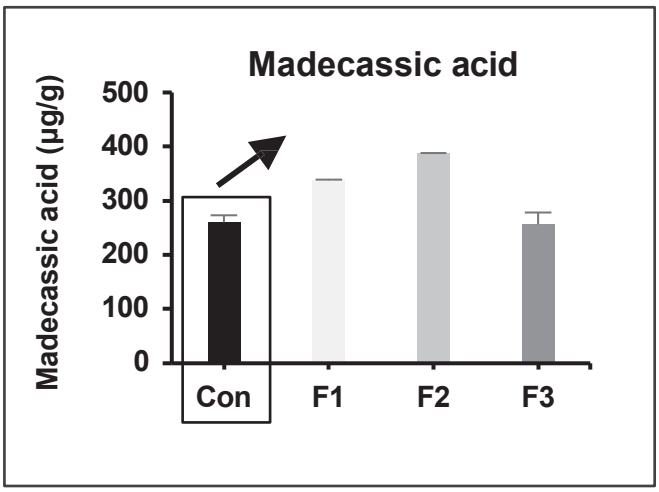
ECOSOLUTION (F1, F2, F3) showed improved antioxidant activity with lower IC50 values compared to the control.

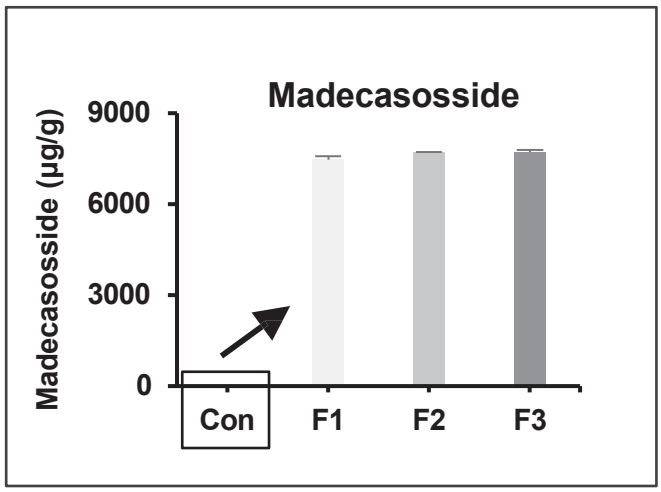
Previous Research 02

ECOSOLUTION

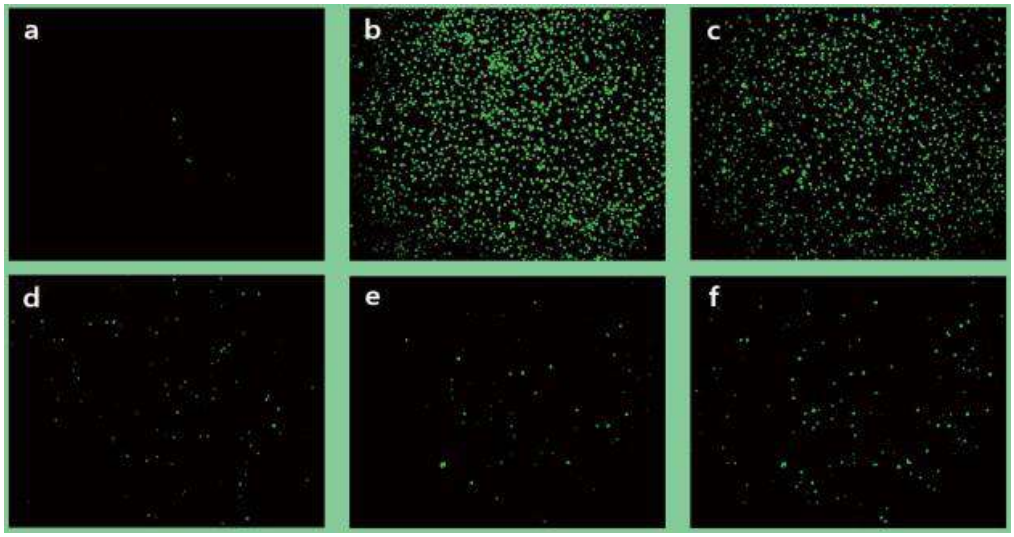








The contents of asiaticoside, asiatic acid, madecassic acid, and madecassoside increased overall in the ECOSOLUTION (F1, F2, F3) than in the control.



The F1, F2, and F3 treatment groups effectively inhibited H_2O_2-induced ROS expression compared to the control group, as confirmed by the decrease in fluorescence.

A. Control

B. H_2O_2 treatment group

C. H_2O_2 + Con (Controltreatment)

D. H_2O_2 + F1

E. H_2O_2 + F2

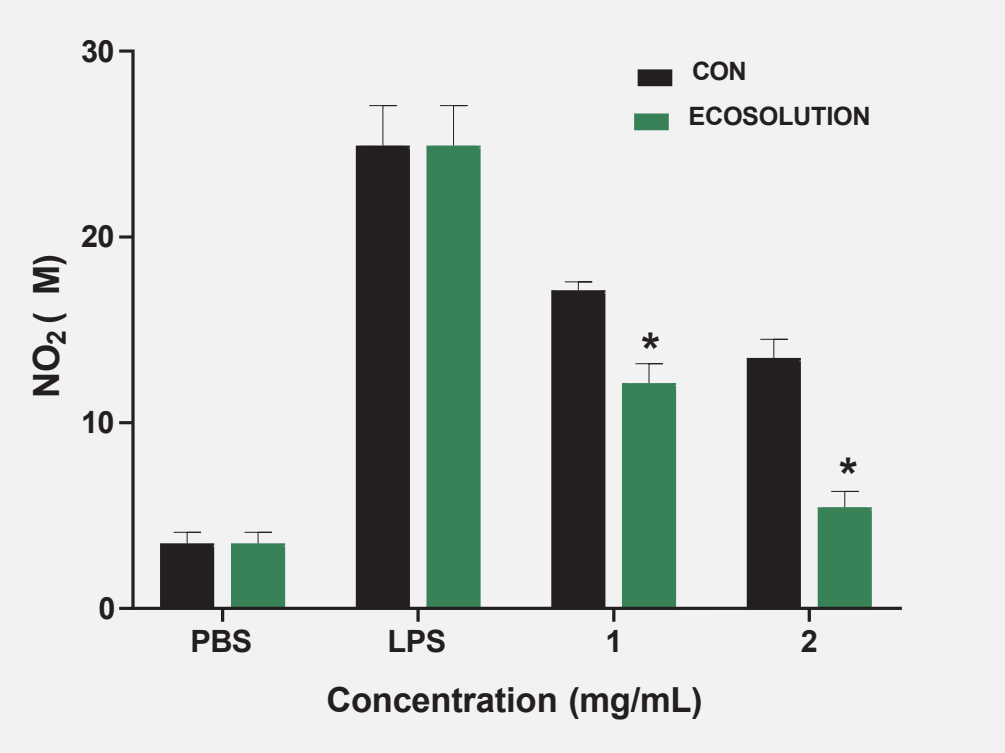
F. H_2O_2 + F3

The F1, F2, and F3 treatment groups demonstrated a pronounced ability to suppress H_2O_2-induced reactive oxygen species (ROS) production when compared with the untreated control group. This protective effect was clearly evidenced by the marked reduction in fluorescence intensity observed during analysis, indicating that the treatments effectively mitigated oxidative stress.

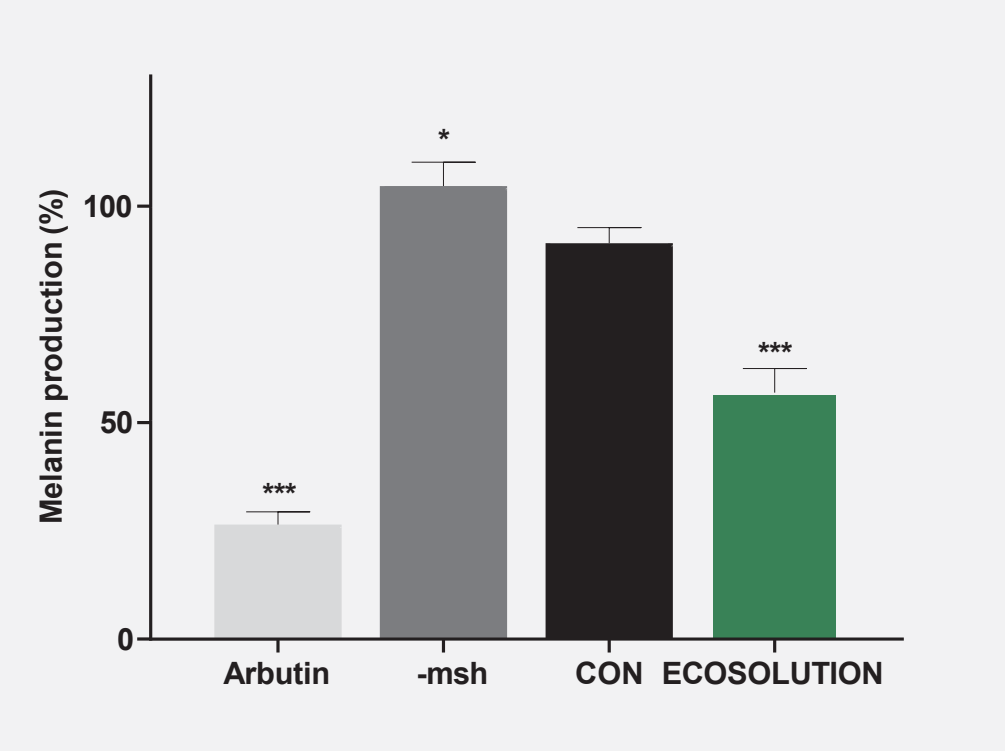
The diminished fluorescence signals suggest that each formulation contributed to lowering intracellular ROS levels, thereby helping maintain cellular integrity and preventing oxidative damage triggered by hydrogen peroxide exposure.

Previous Research 03

anti inflammatory experiment

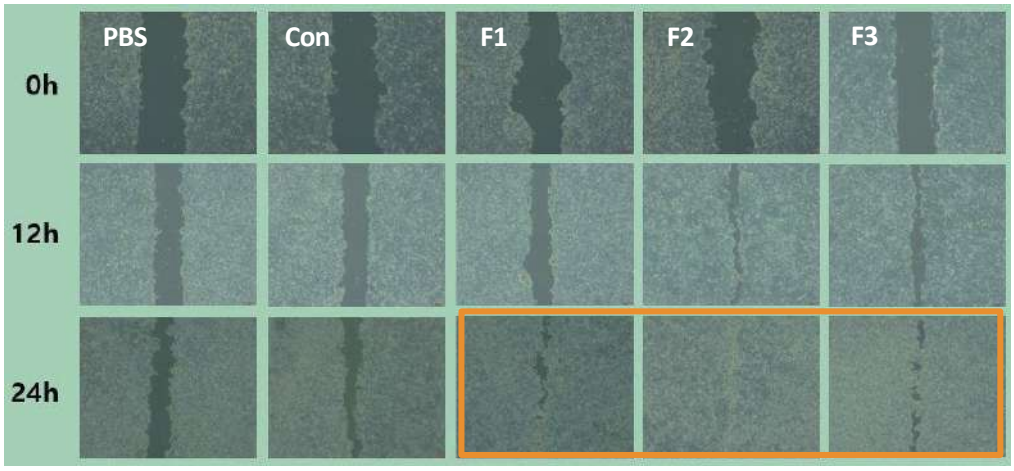


Effectively inhibits H_2O_2-induced ROS expression compared to CON



In B16F10 cells, ECOSOLUTION inhibited melanin production compared to the control (CON).

BOOSTING SKIN REGENERATION WITH ECOSOLUTION



ECOSOLUTION Formulations Enhance Wound Healing by Promoting HaCaT Keratinocyte Migrationarrier function following cellular injury.

In HaCaT keratinocyte cells, treatment with the ECOSOLUTION formulations (F1, F2, and F3) exhibited a notable ability to enhance wound healing processes, particularly by promoting cellular migration, when compared to the untreated control group. After 24 hours of incubation, cells exposed to each of the ECOSOLUTION variants showed a visibly accelerated closure of the artificially created scratch area, indicating that the formulations effectively stimulated cell motility and contributed to the regeneration of the disrupted monolayer.

This enhanced migration activity suggests that ECOSOLUTION may support the early phases of wound repair by facilitating re-epithelialization, a critical step in the healing cascade. The improved movement of HaCaT cells toward the wound gap implies that the active components within F1, F2, and F3 may influence cytoskeletal dynamics, intercellular signaling pathways, or extracellular matrix interactions that are essential for coordinated cell migration. Moreover, the consistent performance across all three formulations highlights the potential of ECOSOLUTION as a promising candidate for promoting skin recovery, improving tissue repair efficiency, and restoring barrier function following cellular injury.

Previous Research 04

Human Clinical Test Results- Korea Institute of Dermatological Sciences

Skin Soothing Improvement Effect

그림 7. a* value 변화 및 개선율(%).

After 4 weeks of use, the *a value decreased significantly (p < 0.01)** compared to before application on both test areas, confirming a skin soothing improvement effect.

Suitability Evaluation for Acne-Prone Skin

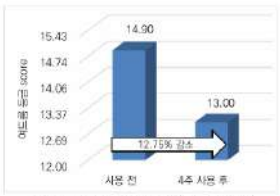


그림 8. 여드름 등급 score 변화 및 개선율(%).

After 4 weeks of use, the **acne severity index significantly decreased (p < 0.01)**, confirming **suitability for acne-prone** skin. Inter-rater reliability was also secured **(ICC ≥ 0.75)**.

Sebum Secretion Control Effect

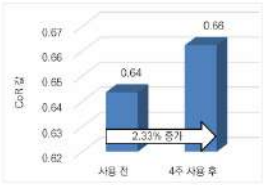


그림 10. CoR 값 변화 및 개선율(%).

After 4 weeks of use, a **significant sebum regulation effect was confirmed (p < 0.001).**

Skin Moisturization Improvement Effect

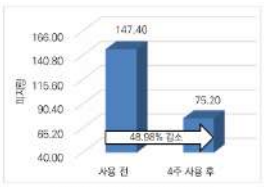


그림 8. 피지량 변화 및 개선율(%).

Immediately after a single application, **skin hydration and barrier indicators showed significant improvement (p < 0.001).**

Skin Elasticity Improvement Effect

그림 9. 피부 수분 변화 및 개선율(%).

After 4 weeks of use, **skin elasticity indicators showed significant improvement (p < 0.001).**

Skin Adverse Reaction Evaluation

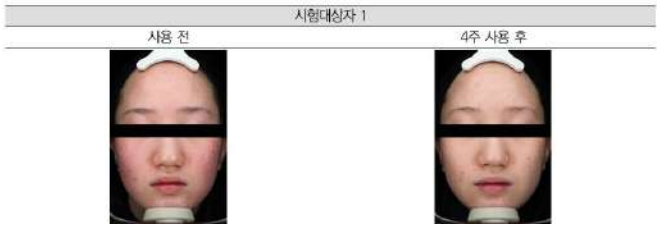
0: 없음, 1: 약한 정도, 2: 중간 정도, 3: 심한 정도
-부작용 등 발생시에 : 0
-부작용 발생에 따른 치료 및 보상 조치 내역 : 0

표 21. 시험대상자가 보고한 피부이상반응 (N=20)

이상반응	1회 사용 직후	4주 사용 후	이상반응	1회 사용 직후	4주 사용 후
1. 홍반(붉어짐)	0	0	5. 자통(통증)	0	0
2. 부종(부어오름)	0	0	6. 작열감	0	0
3. 인설(각질)	0	0	7. 뻣뻣함	0	0
4. 가려움	0	0	8. 따끔거림	0	0

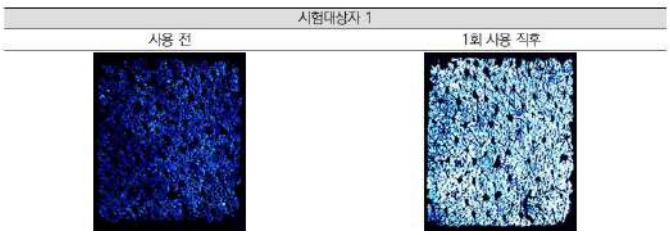
According to dermatological expert evaluations and subject questionnaires, **no allergic or irritation-related skin adverse reactions were observed.**

Skin Soothing Analysis Images



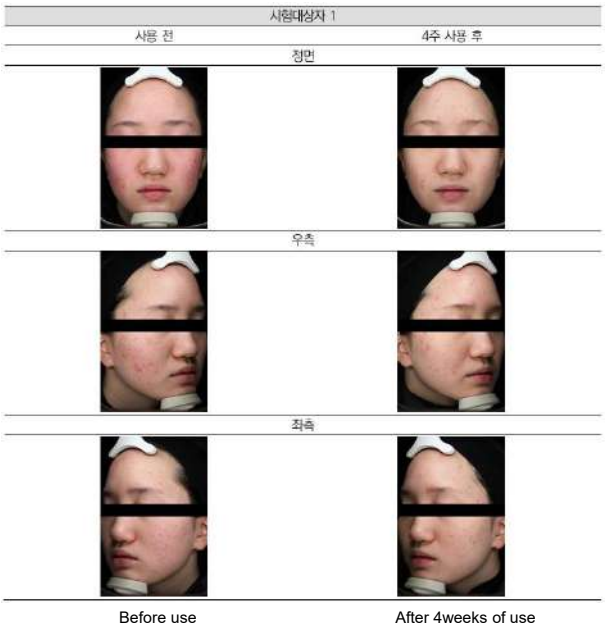
Before use — After 4weeks of use

Skin Hydration Analysis Images



Before use — Immediately after one application

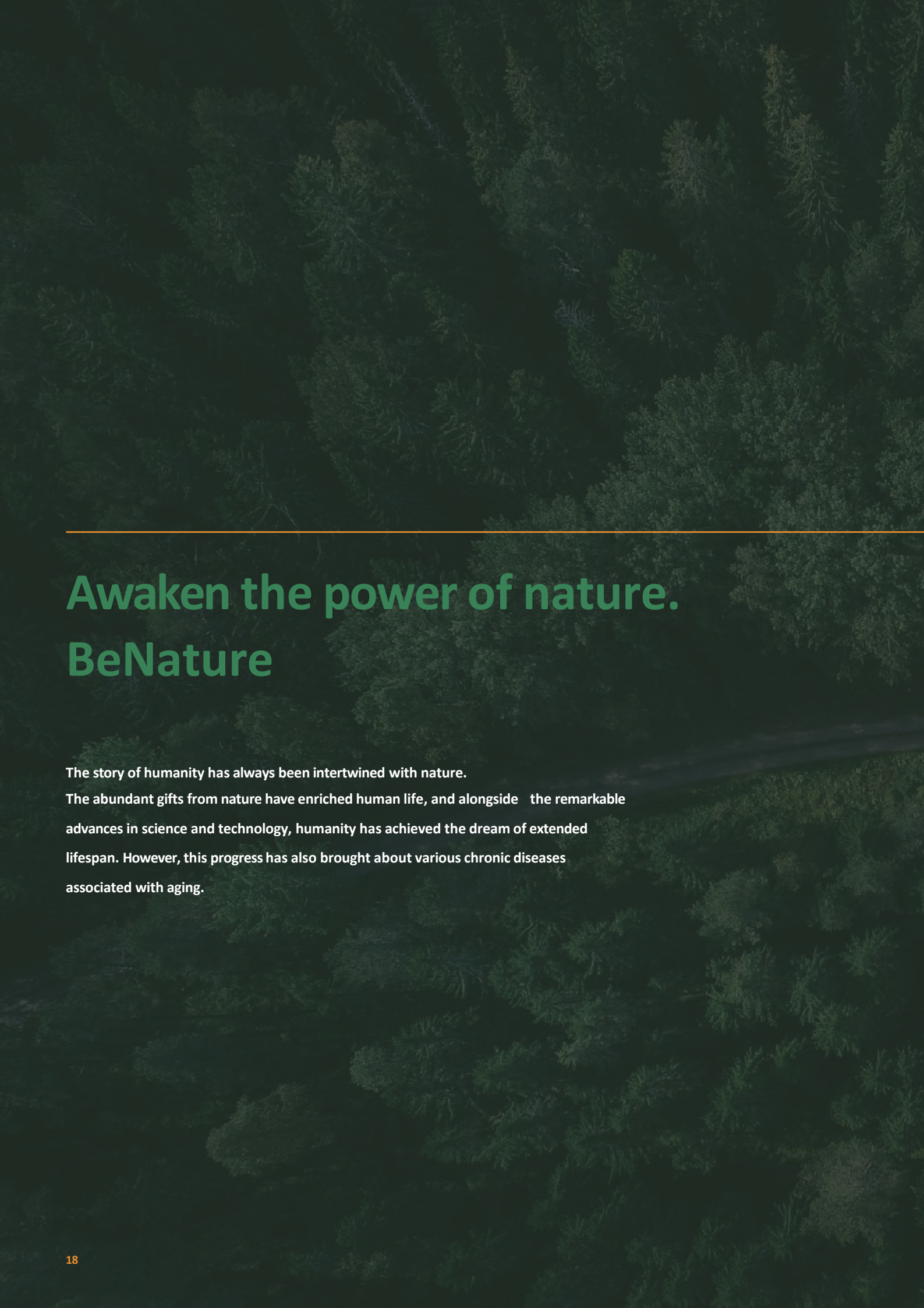
Suitability Analysis Images for Acne-Prone Skin



Before use — After 4weeks of use

Nature, not just applied, but deeply absorbed

The plant is reconstituted while maintaining its physiological activity and is manufactured in a safe and ECOSPHERE or ECOSOLUTION.



Awaken the power of nature. BeNature

The story of humanity has always been intertwined with nature.
The abundant gifts from nature have enriched human life, and alongside the remarkable advances in science and technology, humanity has achieved the dream of extended lifespan. However, this progress has also brought about various chronic diseases associated with aging.


BeNature
BioLab

BeNatureBioLab Inc.

Business registration number 457-88-01770

Headquarters: Room 1001 of Bodumgwan (Hanbitgwan), 1, Daehak-gil, Gangwon-do, Chuncheon-si, Gangwon-do

Research Institute/Factory: 61-14, Sinbuk-ro, Sinbuk-eup, Chuncheon-si, Gangwon-do, Gangwon Techno Park 2nd Plant 101

+82-33-257-5908

bnbiolab@benaturebiolab.com