PAM²L BIOTECHNOLOGIES

BT-IT Powered Technology Platform for Innovation of Biomaterials

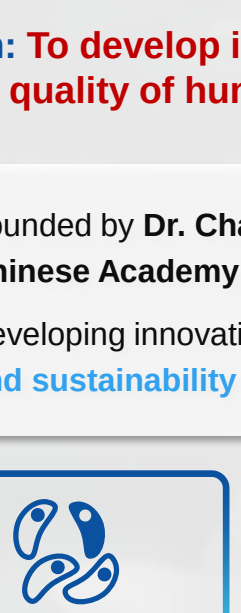
Driving Beauty Market Growth by Ground-Breaking Biomaterial Innovations

Jan. 2025

PAM²L Biotechnologies: Global Leader in Synbio Innovation for Biomaterials

Vision: To develop innovative and sustainable biomaterials to improve the quality of human life without sacrificing the benefits of earth.

- Founded by **Dr. Chao Zhong**, from Shenzhen Institutes of Advanced Technology, **Chinese Academy of Sciences**, with leading biomaterial innovation team in 2021
- Developing innovative biomaterials with **new functionality, cost-effectiveness and sustainability** by Synbio and AI (BT- IT) Powered Technology Platform



Biomaterial Innovation

BT- IT Powered Technology Platform

Application Solution

Synbio and AI (BT- IT) Powered Technology Platform

- Use of microorganisms as factories for material fabrication
- Customization of material's functionality via **strain, enzyme and fermentation engineering**, guided by **AI**

Innovative biomaterials and bioactive ingredients through innovations

- **Proteins**: **Mussel Adhesive Protein**, **Fibronectin**, Collagen (III, IV, XVII), Elastin, etc.
- **Polysaccharides**: **Colamin**, Bacterial Cellulose, etc.

Massachusetts Institute of Technology · 中国科学院深圳先进技术研究院 SHENZHEN INSTITUTES OF ADVANCED TECHNOLOGY CHINESE ACADEMY OF SCIENCES · 3M · ADISSEO A Bluestar Company · MicroPort 微创医疗

End-to-End Biomaterials Innovation: Design-Biosynthesis-Application-Product (D-B-A-P)

Application Development

From Raw Materials to Products

- Material Development
- Process Development
- Function Development
- Product Development

Technology Platform

From Design to Biosynthesis


High-throughput Automation


Molecular Design


Enzyme Engineering


Artificial Intelligence


Strain Engineering


Performance Evaluation

Underlying Technology

Based on DBTL

Synthetic Biology and Artificial Intelligence

Design
Intelligent design of component systems

Build
Scale-up construction of synthetic organisms

BT- IT Driven

Learn
Standardized database and knowledge base accumulation

Test
High-throughput screening and testing

Design	Biosynthesis	Application	Product
Molecular Discovery			Tissue Adhesive
Sequence Database	Component Library		Medical Filler
Protein Structure	Enzyme Engineering		Injectable Grade Material / Medical Grade Material
Microbial Engineering Component Library	Gene Editing	Industrial Fermentation / Industrial Purification / Function Exploration / Efficacy Evaluation	Skincare Grade Material / Liquid Dressing
Bioinformatics Mining	Sequence Design	Pilot-scale Fermentation / Pilot-scale Purification / Method Validation / Method Development	Medical Spray / Medical Gel
High-throughput Automation	Host Library	High-throughput Fermentation / High-throughput Purification / Compatibility Research / Formulation Development	Protein Raw Material / Polysaccharide Raw Material

Leading Innovative Biomaterials and Products Powered by D-B-A-P Platform

D-B-A-P End-to-End Platform

Design

Biosynthesis

Addressing unmet cosmetics, aesthetic and medical needs

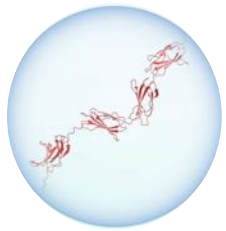
Product

Application

Innovative Biomaterials

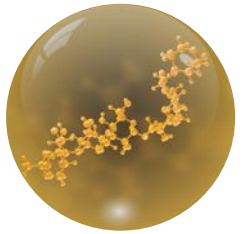
Mussel Adhesive Protein (MAP)

Repair, Anti-inflammatory



Fibronectin

Anti-wrinkle, Repair



Colamin

Anti-aging, Firming, Repair, Moisturizing

Innovative Medical Aesthetics/Devices

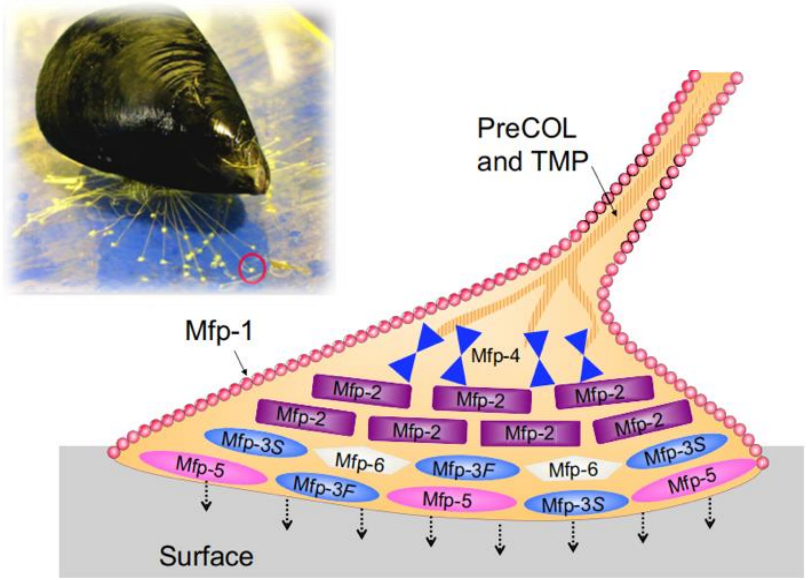
MAP-based Class II or III Medical Aesthetics/Devices

PAM²L owns comprehensive D-B-A-P capacities, thus can transform cutting-edge technologies to innovative ingredients and products with faster pace!

Mussel Adhesive Proteins: the “Marine Soft Gold” Offered by Nature

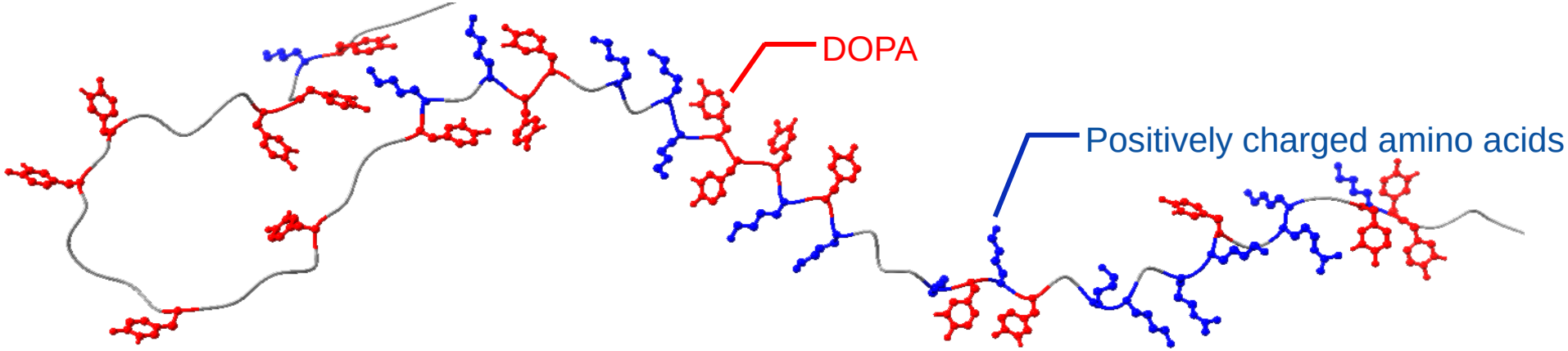
- Mussel Adhesive Proteins (MAPs), known as “Marine Soft Gold”, are a series of polyphenol proteins extracted and purified from the foot silk gland of mussels.
- MAPs is the only known type of proteins enriched in high contents of **L-3,4-dihydroxyphenylalanine (DOPA)**, which exhibits significant **anti-inflammatory, antioxidant, antimicrobial, analgesic, and anti-itch activities**.
- PAM^{2}L achieved the biomanufacturing of MAPs: the amount of MAP produced **per liter of fermentation broth is equivalent to that obtained from extracting tens of millions of mussels**, addressing the challenges of low yield, complex composition, and risks of virus transmission and immunogenicity associated with traditional animal extraction methods.

In 1980, American scientists made the initial discovery of mussel adhesive protein (MAP). Northwestern University subsequently identified its bio-adhesive properties. Since then, researchers have uncovered the protein's roles in wound healing and protection, which include the formation of nanofilms, antibacterial activity, and anti-inflammatory effects.



- A variety of mussel adhesive proteins have been identified along the mussel thread.
- Mfp-5 has been found to contain the highest concentration of DOPA residues and is recognized for its superior performance in anti-inflammatory and wound-healing capabilities.

MAP: A Medical Biomaterial with Wound-repairing & Anti-inflammatory Properties

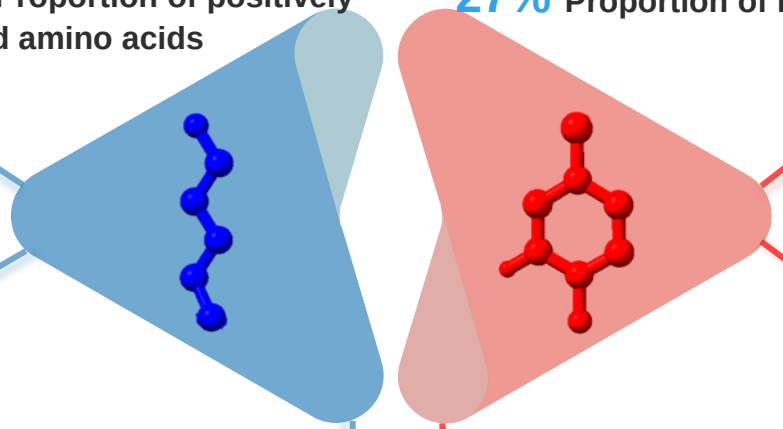


Antibacterial[1]:
Promotes the adhesion of cells, accelerates the migration of cells, and speeds up the healing of ulcerated wounds by electrostatic interactions

Wound-healing [2]:
Its inherent positive charge attracts negatively charged cells, promoting their rapid adhesion, migration, and growth

23% **Proportion of positively charged amino acids**

27% **Proportion of DOPA groups**



Anti-inflammatory and Anti-oxidant[3, 4]:
Dopamine groups effectively bind to the skin surface or incoming free radicals, preventing oxidative damage to epidermal cells

Melanin Inhibition[5]:
Oxidized and unoxidized dopamine form crosslinks, competitively binding and preventing the conversion of dopamine into melanin

Anti-allergy and Anti-itch[3]:
L-DOPA binds to receptors on epidermal nerve endings, blocking cortical nerve endings. Its abundant positive charge improves the potential balance of healthy and pathological cells, facilitating the timely restoration of damaged cells

1. Fichman G. *et al. Adv Mater*. **2021**. 33(40):e2103677.
2. Richeng Dong *et al. J Cosmet dermatol-US*. **2023**. 22(6).
3. Liu Z. *et al. Arch Dermatol Res*. **2020**; 312(9).
4. Pegah Kord Forooshani et al. *Polym Chem*. **2016**. 55(1).

Mussel Adhesive Proteins: Applications Across Skin Care & Medical Aesthetics

Skin Care

1. Sensitive Skin Repair

- Repair skin barrier
- Suppress inflammation
- Lock in moisture and hydrate

2. Acne Treatment

- Suppress inflammation
- Antibacterial
- Oil control

3. Atopic Dermatitis

- Suppress inflammation
- Relieve itching
- Lock in moisture and hydrate

4. Scalp Care

- Oil control
- Prevent hair loss
- Relieve itching

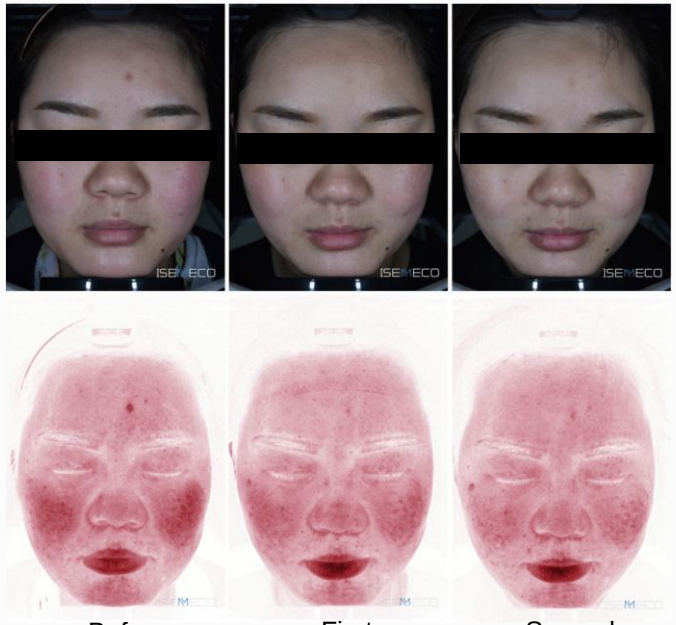
Medical Aesthetics

Product Example	Indication
MAP Hydro Shine Injection	Skin Anti-inflammatory
MAP Repair Dressing Patch	Post-cosmetic Surgery Repair
MAP Scar Repair Gel	Scar Repair

Highlight: MAP Hydro Shine Injection for Anti-inflammatory and Skin Rejuvenation

MAP Hydro Shine Injection

Micro-needle delivery of MAP shows significant efficacy in treating sensitive skin*



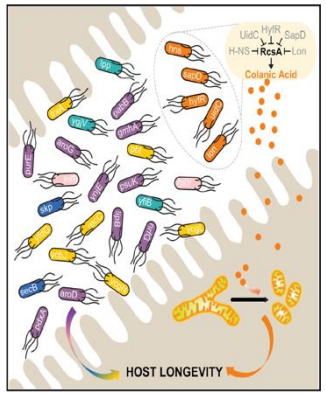
Before treatment | First treatment | Second treatment

- Out of 23 patients, 20 saw symptoms improve by over 20% after one treatment, reaching an 87% efficacy rate. After three treatments, all patients experienced over 20% improvement, achieving 100% efficacy.
- Dryness, tightness, desquamation, flushing, burning, itching, and stinging sensations improved.
- Clinical assessments showed significant reduction in facial erythema and severity index scores post-treatment, with visible improvement in clinical photos.

**Mussel adhesive protein treatment delivered by microneedling for sensitive skin: A clinical study, J Cosmet Dermatol. 2023*

Colamin: Next-Generation Longevity Ingredient Powered by Mitochondrial Revitalization

Microbial Genetic Composition Tunes Host Longevity*

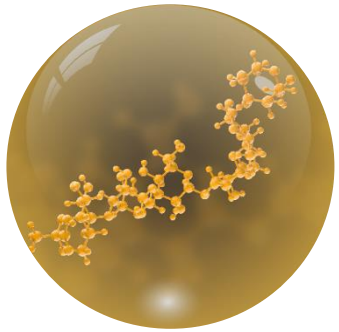


Bing et al., *Cell 2017.*

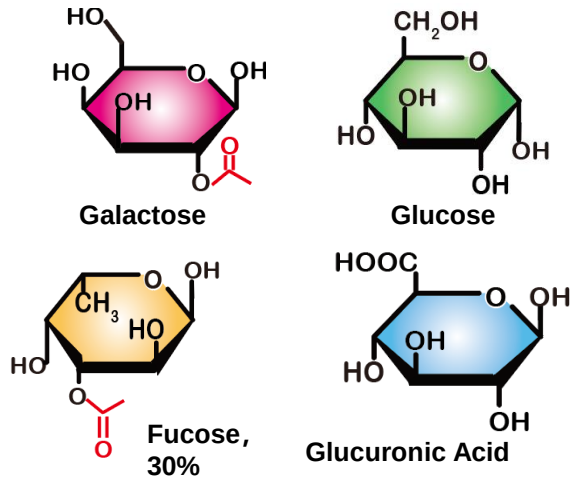
3,983 gut microbial genes

35 genes extend lifespan by 10+%

2 genes identified for longevity



Colamin



- **Colamin (Sodium Colanate)**: An extracellular polysaccharide originally synthesized by probiotics, composed of D-Glucose, **L-Fucose (30%)**, D-Galactose, and D-Glucuronic Acid.
- **Longevity Molecule**: Initially discovered by Baylor College of Medicine, Colamin extends the host's lifespan by 20% through the regulation of **mitochondrial dynamics** in host cells.
- **First in the World**: First to produce Colamin via synthetic biology and achieve full-spectrum molecular weight through proprietary enzyme.
- **Injectable Gel Materials:** High-molecular-weight Colamin chemically crosslinked to create injectable gel formulations.

"Colamin" is abbreviated as "CA" for simplification.

Colamin Promotes Healthy and More Youthful-looking Skin (Across All Skin Layers)

Wrinkles
reduced by **36%**

Collagen content
increased by **22%**

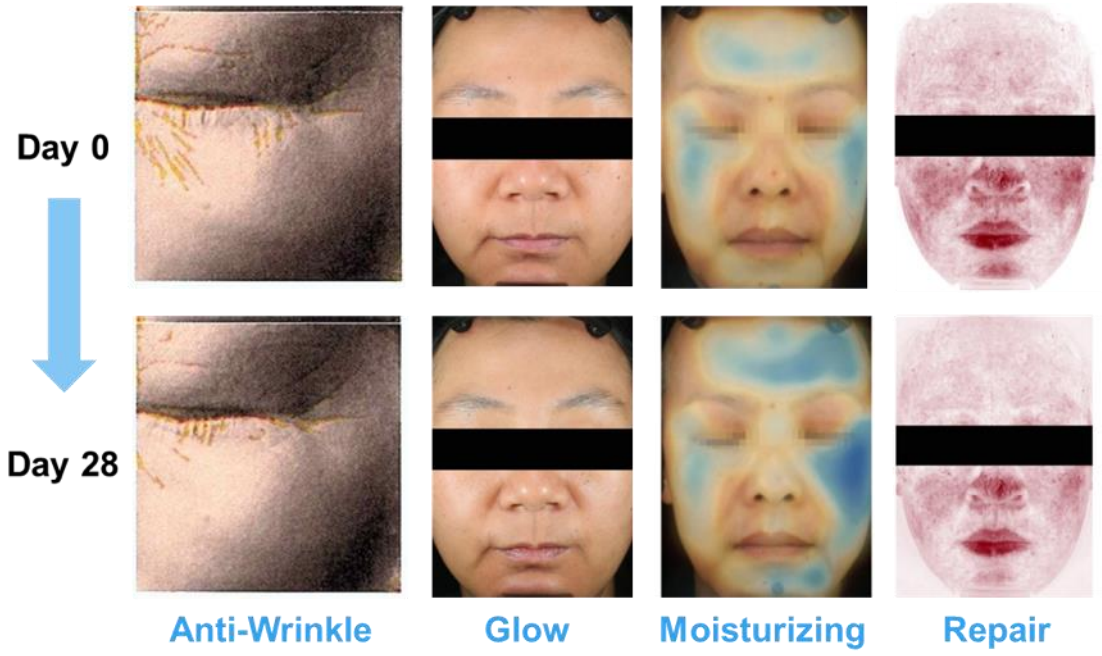
Radiance
increased by **44%**

Anti-aging SAAID
increased by **111%**

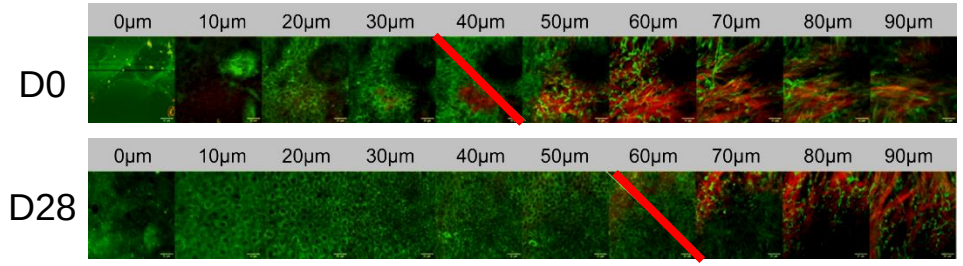
Hydration
increased by **64%**

Red area
reduced by **10%**

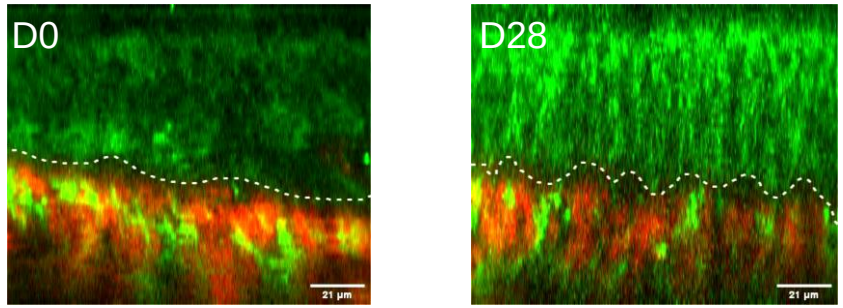
Human Skin Test*



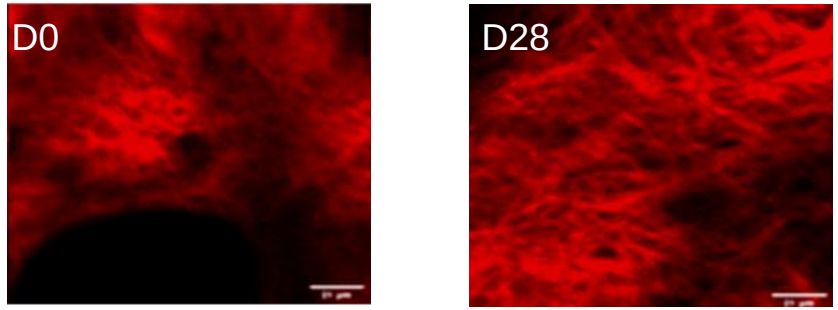
Epidermal Thickness increased by **27%**



Dermal-Epidermal Junction increased by **36%**



Collagen Content in Dermis increased by **22%**

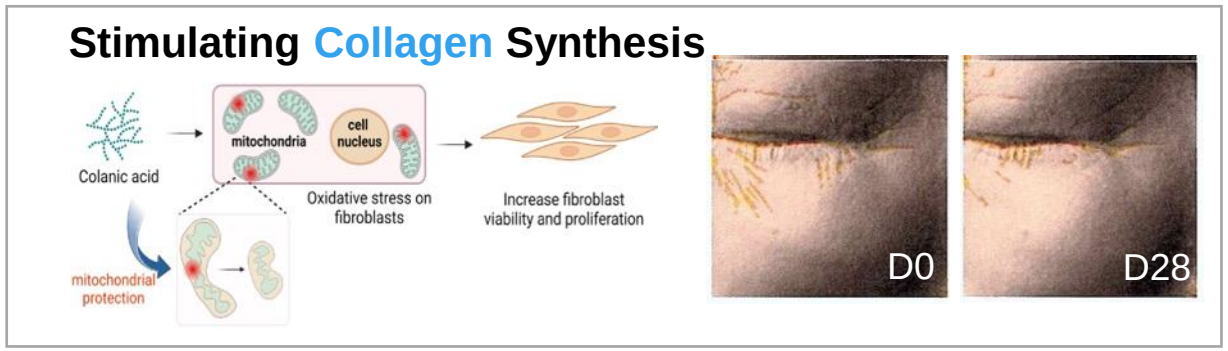


***Participants:** 62 healthy women aged 30 to 60 years; **Protocol:** 0.5% Colamin, topically applied for 28 days; **Third-party efficacy evaluation organization:** Shanghai Weipu

Colamin: Comprehensive Anti-aging Benefits in Skin Care and Medical Aesthetics

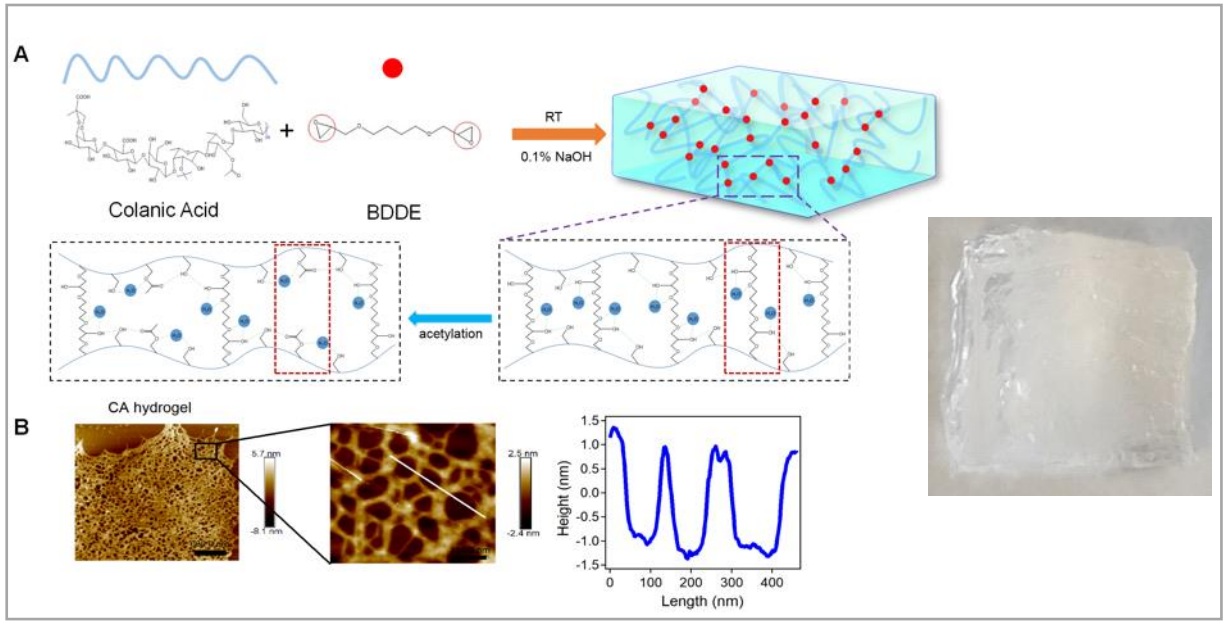
Skin Care

Anti-aging



Dermal Filler

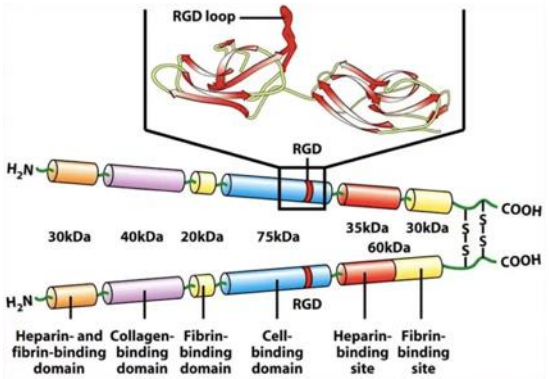
Support for collapsed skin with anti-aging benefits

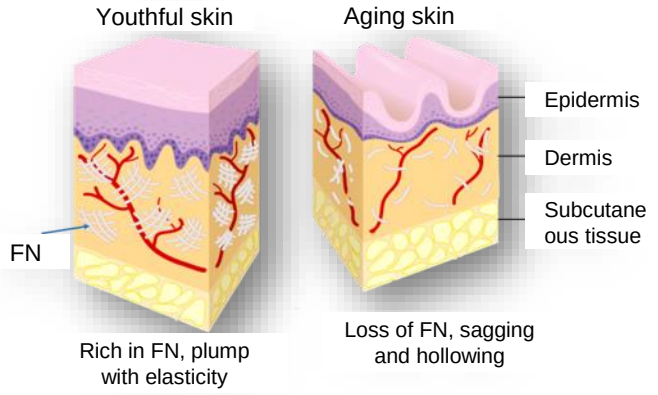


Fibronectin: Active Ingredient for Skin Repair and Anti-aging Solutions

Fibronectin is a structural protein and an important extracellular matrix protein that forms fibrous network structures in the extracellular space, supporting and maintaining tissue integrity and elasticity

- **Skin-repair**: Regulate cell migration, extensively involved in skin cell adhesion, proliferation, hemostasis, and tissue repair
- **Anti-wrinkle**: Stimulate cell proliferation of collagen protein, improve skin roughness, making the skin plump and elastic





Poor transdermal absorption ability

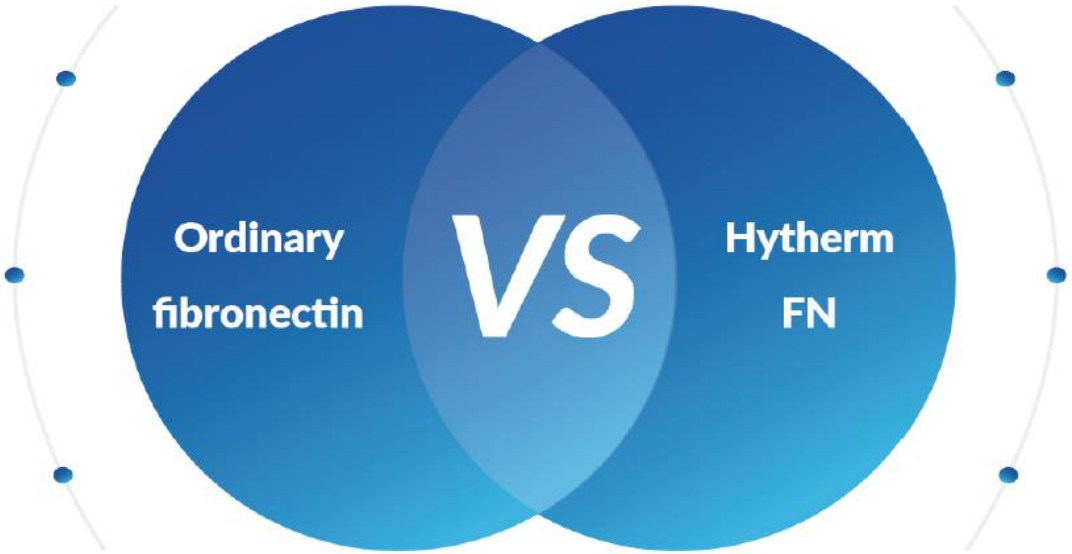
Difficult to penetrate the skin barrier and reach the target area, making it difficult for the skin to absorb

Low stability

Prone to precipitation when placed or transported at room temperature; denatures and completely deactivates at temperatures of 40~50℃

Low biological activity

Limited biological activity and efficacy without sequence screening



Excellent biological activity

providing good skin repair and anti-aging benefits.

High stability

High-throughput screening technology to enhance protein thermal stability

High transdermal efficacy

Exclusive transdermal peptide design, AI-assisted structural sequence design, increase transdermal efficacy by more than 10 times

Fibronectin Promotes Skin Repair and Tightening

TWEL
reduced by **5.4%**

Dermal density
increased by **47.8%**

Skin moisture
increased by **9.8%**

Nasolabial folds
reduced by **47.1%**

Redness area
reduced by **4.2%**

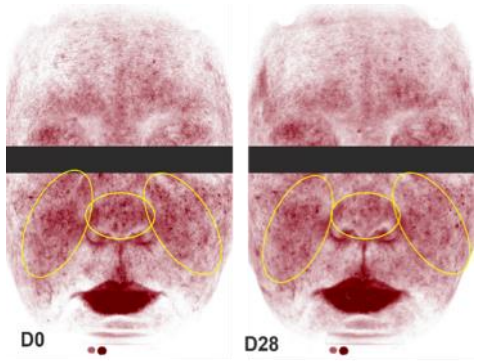
Ceramide
increased by **15.1%**

Day0 → **Day28**

Subjects: A cohort of 32 volunteers, clinically diagnosed with sensitive skin by a dermatologist, were recruited for this study.

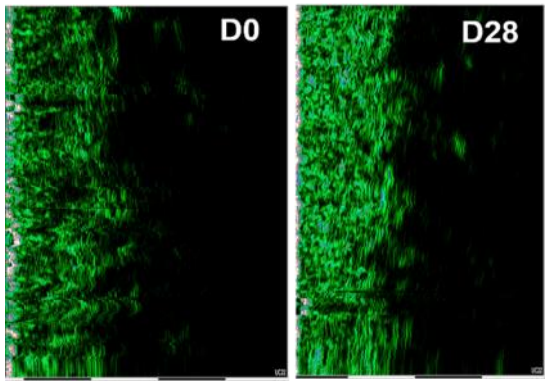
Study Protocol: The participants were instructed to apply a 50 PPM concentration of HythermFN topically over a 28-day period.

Efficacy Assessment: The efficacy of the treatment was independently evaluated by a third-party organization specializing in dermatological efficacy assessments, Shanghai Weipu.

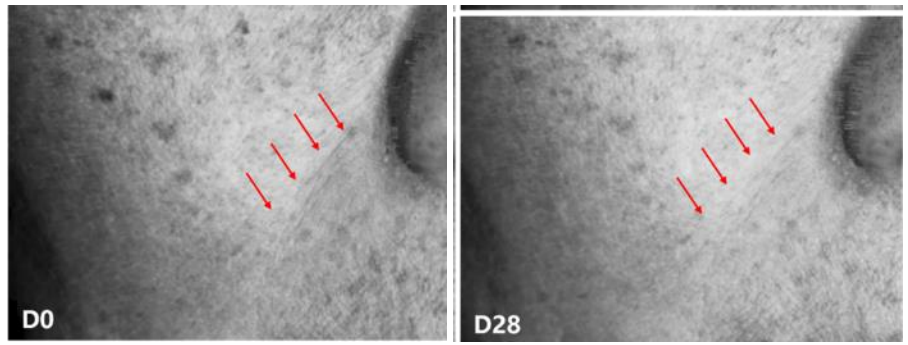


Redness area

Skin moisture



Dermal density



Nasolabial folds

Thanks

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