

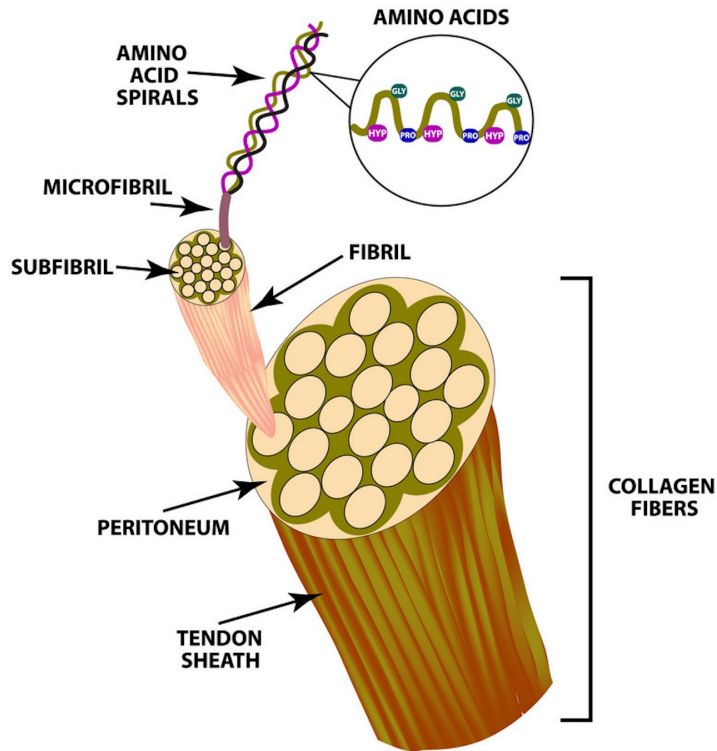
# EXTRACTION OF COLLAGEN BIOACTIVE INGREDIENTS FROM JELLYFISH FOR COSMECEUTICAL APPLICATION



Video on collagen for skin



# Collagen Supplement for **Skin**

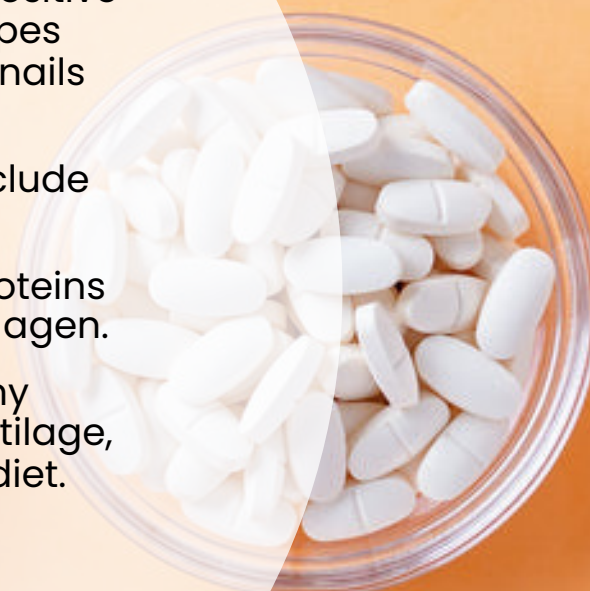
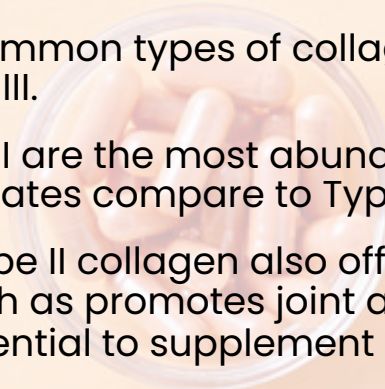


## WHAT IS COLLAGEN?

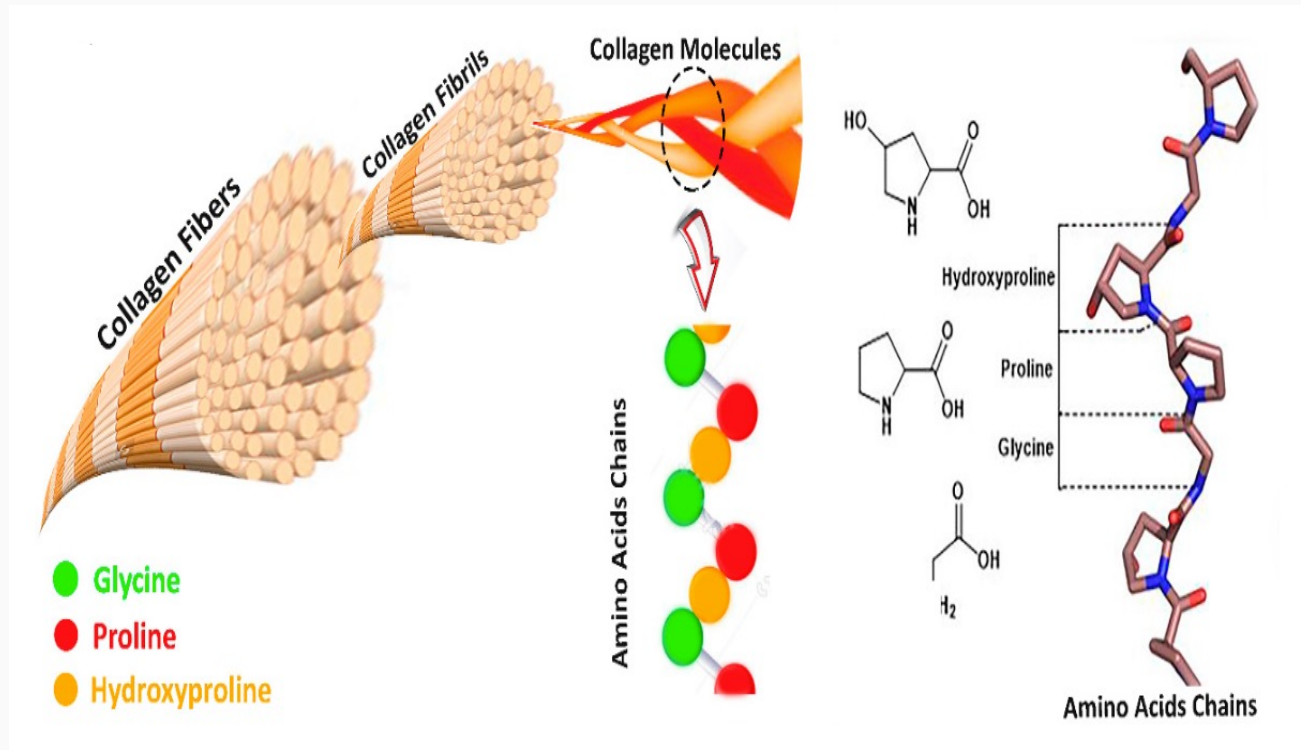
- Collagen is the most abundant component of the extracellular matrix.
- Collagen consists of three  $\alpha$ -chains that wind each other forming a collagen triple helix.
- These building blocks combine to form collagen fibrils.
- The amino acid sequence shows every third residue is glycine (Gly), which results in a Gly-X-Y repeating sequence where X is often proline (Pro) and Y is often hydroxyproline (Hyp)

# COLLAGEN

- Collagen is a protein that offers many positive benefits to our bodies. It has different types and each of those benefit our hair, skin, nails and bone.
- The most common types of collagen include type I, II and III.
- Types I and II are the most abundant proteins in all vertebrates compare to Type II collagen.
- However, Type II collagen also offer many benefits such as promotes joint and cartilage, and it is essential to supplement in our diet.



# TYPES OF COLLAGEN



There are 28 types of collagen

Variation may be occurred due to :

1. Differences in the assembly of basic polypeptide chains
2. Different lengths of the helix
3. Various interruptions in the helix
4. Differences in the terminations of the helical domains

# THE MOST COMMON TYPES OF COLLAGEN ARE :

Types of Collagen	Source	Major Roles/Functions
I	<ul style="list-style-type: none"><li>• Fish</li><li>• Bovine,</li><li>• Egg</li><li>• Bone broth</li></ul>	<ul style="list-style-type: none"><li>• Supports youthful looking skin</li></ul>
II	<ul style="list-style-type: none"><li>• Bone broth</li><li>• Chicken</li></ul>	<ul style="list-style-type: none"><li>• Helps builds &amp; maintain gut lining.</li><li>• Supports joints &amp; digestive health.</li><li>• Promotes immune function</li></ul>
III	<ul style="list-style-type: none"><li>• Fish</li><li>• Bovine</li><li>• Egg</li></ul>	<ul style="list-style-type: none"><li>• Supports skin &amp; bone health</li><li>• Part of arterial walls &amp; important for heart health</li></ul>



# The benefits of different type of collagen

I

## TYPE I COLLAGEN

Up to 90% of your body's collagen is type I collagen. (1) Type I collagen fibers can be found in the skin, bones, blood vessel walls, connective tissue and cartilage.

### BENEFITS

- May aid in wound healing and blood clotting. (2)
- Reduces the prevalence of cellulite, especially in women. (3)
- Helps minimize wrinkles and improve skin quality. (4)

### BEST SOURCES

- Fish collagen (or marine collagen in general)
- Egg whites (5)
- Bovine collagen peptides
- Protein-rich foods, like fish and beef
- Bone broth

II

## TYPE II COLLAGEN

Found in more elastic cartilage than type I, type II is known for promoting joint health. Type II also has the most efficient absorption after oral ingestion. (6)

### BENEFITS

- Promotes joint health and possible relieves symptoms of arthritis. (7, 8)

### BEST SOURCES

- Bone broth
- Chicken cartilage
- Protein-rich foods, like chicken
- Multi-collagen foods, protein powder

# The benefits of different type of collagen

III

## TYPE III COLLAGEN

Type III collagen provides and improves the structure of muscles, as well as organs and blood vessels.

### BENEFITS

- May aid in intestinal health (9)
- May support healthy blood clotting (10, 11)
- Aids muscle growth (12)

### BEST SOURCES

- Bovine collagen peptides
- Protein-rich foods, like beef and fish
- Bone broth
- Collagen protein powder

IV

## TYPE IV COLLAGEN

This less common type of collagen aids in filtration of the kidneys and other organs.

### BENEFITS

- Supports multiple layers of skin health
- May also aid in wound healing and digestion (13)

### BEST SOURCES

- Egg whites
- Other protein-rich foods
- Type IV is very difficult to find in supplement form



# Main collagen source in nature



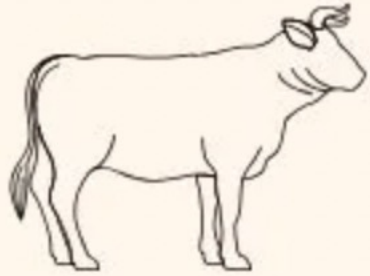


# **The shift towards marine sources**

# SOURCE OF COLLAGEN

- Over the years, bovine and porcine have been used as common source of collagen
- However, bovine and porcine collagen poses the risk of **transmitting disease** such as spongiform encephalopathy (BSE), transmissible spongiform encephalopathy (TSE) and food and mouth disease (FMD) which limited their use.
- Besides, the usage of bovine and porcine collagen is related with **cultural and religious considerations** (for Muslims, Jews and Hindus)





# BOVINE

VERSUS



# MARINE COLLAGEN

---

WHICH SHOULD YOU CHOOSE?

---

# BOVINE

# MARINE

## WHAT IT IS

Bovine collagen is a flavorless powder made from cow hides. It contains mostly Type I and III collagen and is a rich source of amino acids.

Marine collagen is a flavorless powder made from fish skin and scales. It contains mostly Type I collagen and due to its smaller size, is slightly more bioavailable.

# BENEFITS



Supports Joint  
Health



Enhances  
Exercise Recovery



Fewer Wrinkles



Reduces Signs  
of Aging



Promotes  
Gut Health



Boosts Hair  
and Nails



Moisturizes  
Skin

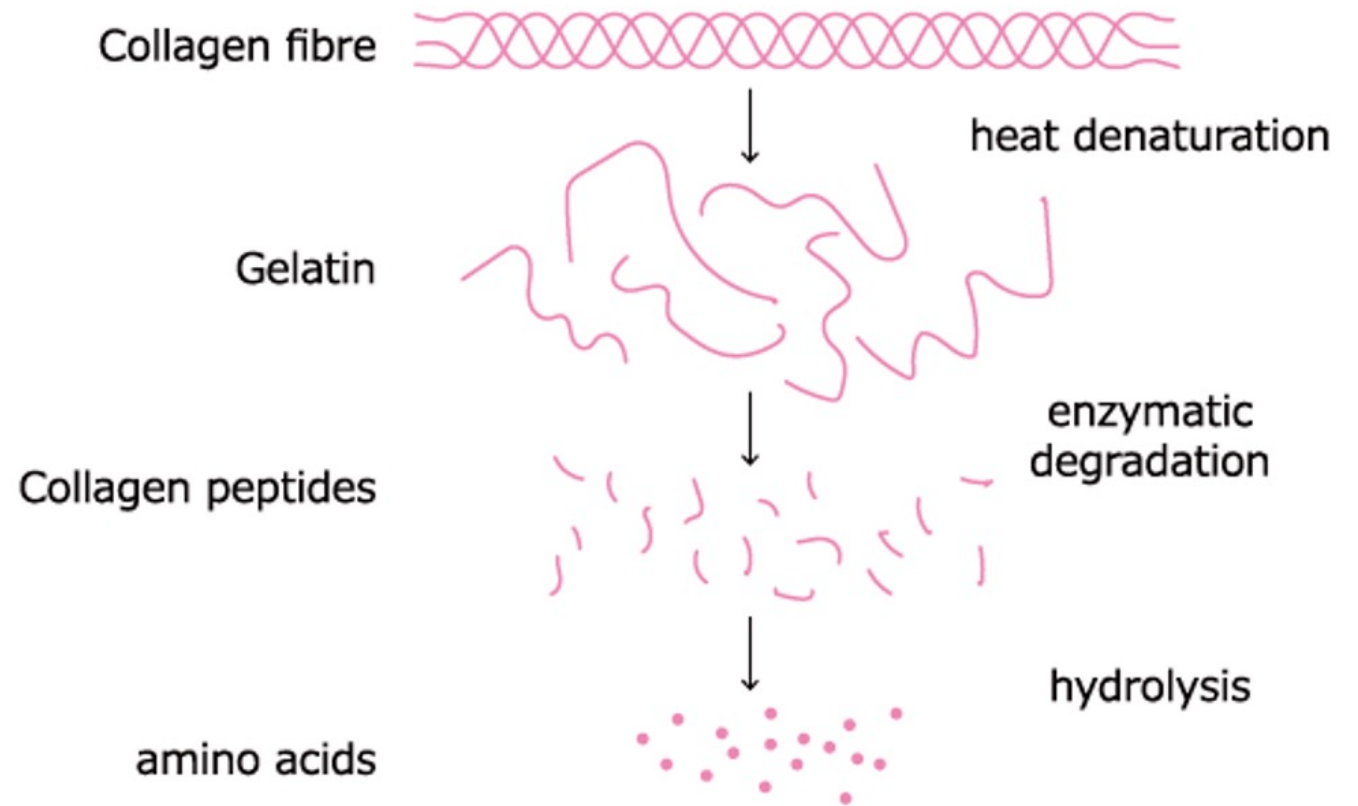


Boosts Hair  
and Nails

# Jellyfish for Cosmetics

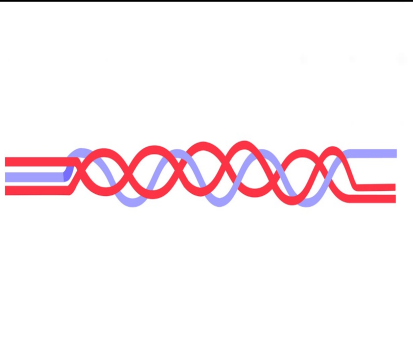
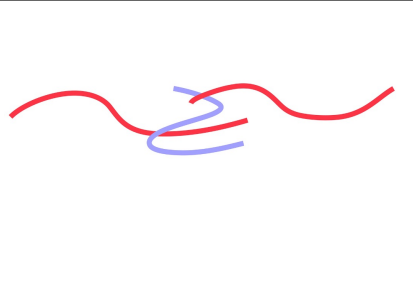
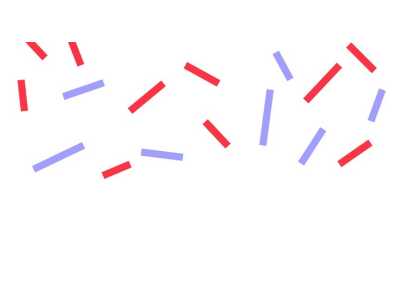
Industry	Advantages	Bioactive compound	Jellyfish	Reference
Cosmeceutical	-antioxidants	high content of hydrophobic amino acids	Ribbon Jellyfish ( <i>Chrysaora</i> sp.)	(Barzideh, Latiff, Gan, Abedin, & Alias, 2014)
	-antioxidants	Gelatin Polypeptides	<i>Rhopilema esculentum</i>	(Yongliang Zhuang, Sun, Zhao, Hou, & Li, 2010)
	-antioxidants	collagen peptide	<i>Rhopilema esculentum</i>	(Yongliang Zhuang et al., 2009)
	skin photo-protection from Ultraviolet radiation (protect skin lipid and collagen from the UV radiation damages)	Collagen & collagen hydrolysate	<i>Rhopilema esculentum</i>	(Fan, Zhuang, & Li, 2013; Y. Zhuang, Hou, Zhao, Zhang, & Li, 2009)
	-	collagen	<i>Rhopilema asamushi</i>	(Nagai et al., 2000)
	-	acid-soluble and pepsin-solubilised collagen	<i>Cyanea nozakii</i> <i>Kishinouye</i>	(Zhang, Duan, Huang, Song, & Regenstein, 2014)
	-antioxidant	Collagen, $\omega$ -3 and $\omega$ -6 polyunsaturated fatty acids (PUFAs)	<i>Aurelia</i> sp.1, <i>Cotylorhiza tuberculata</i> and <i>Rhizostoma pulmo</i>	(Leone, Lecci, Durante, Meli, & Piraino, 2015)
	-moisturizing	filaggrin, hyaluronan synthase-3 (HAS-3), aquaporin-3 (AQP-3) and desmocollin (DSC)	<i>Nemopilema nomurai</i>	(Kim, Baek, Kim, Choi, & Lee, 2016)
	-for burn wound dressing -would not require introduction of cross-linking agents.	Colloidal collagen	-	US Patent 2014

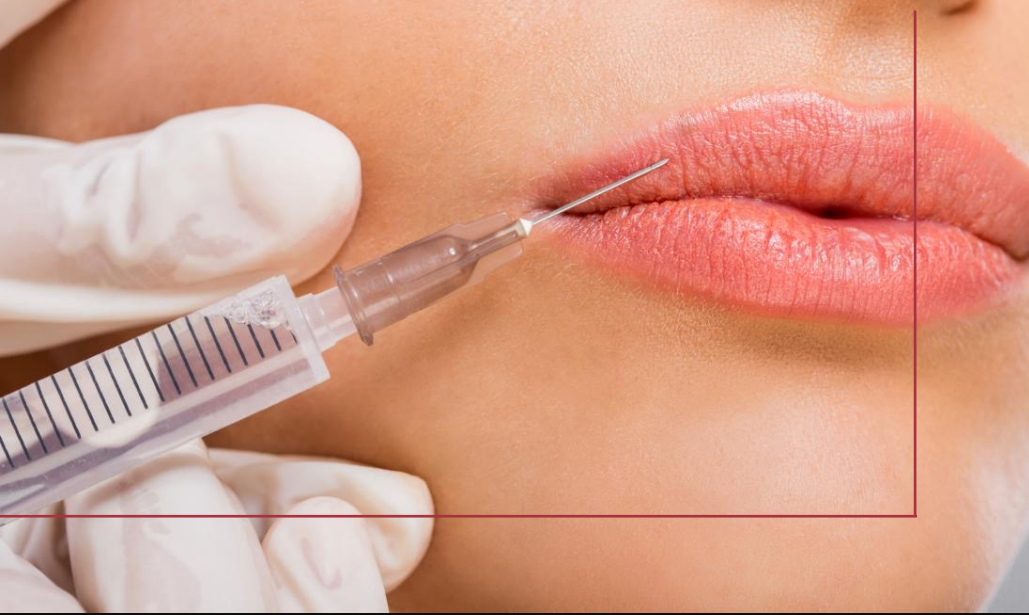
# COLLAGEN, GELATIN AND COLLAGEN PEPTIDE





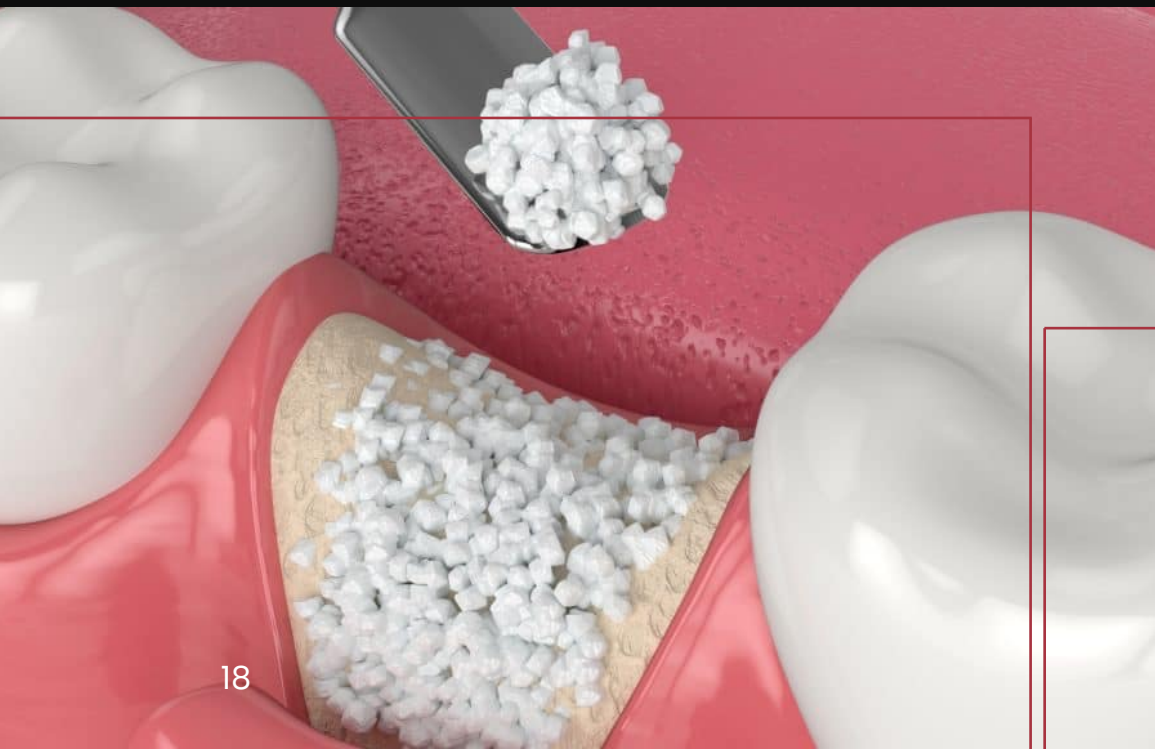
# DIFFERENCE BETWEEN COLLAGEN, GELATIN, AND COLLAGEN PEPTIDE

GRADE	FORM	SOLUBILITY	ABSORPTION & DIGESTIBILITY	APPLICATION SAMPLE	MOLECULAR WEIGHT
Collagen		Insoluble	None	Medical materials, collagen casing, nutritional supplements	> 300, 000 Da
Gelatin		Medium	Medium	Gelatin desserts, confectionery	2, 000 – 200, 000 Da
Collagen Peptide		High	High	Dietary supplements, functional foods	300 – 8, 000 Da



# Use of Collagen

- Bone grafts
- Tissue regeneration
- Cosmetic
- Wound care
- Reconstructive surgical uses

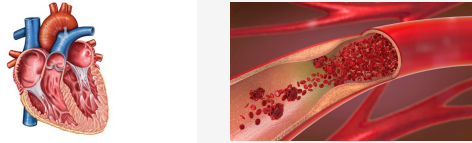




## HEALTHY AND FUNCTIONAL OF GELATIN

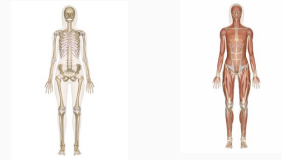
- Provides unique texture and mouthfeel in food products and can help to reduce fat and sugar
- Widely used in pharmaceutical products such as capsules, gelatins helps to protect the ingredient of the product
- Melts at body temperature and is fully digestible
- Extend the self life of products
- It has ability to gel, thicken, bind, foam and form layers

### Cardiovascular system



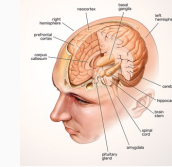
- Reduces vascular pressure
- Reduces blood glucose, triglyceride and cholesterol
- Regulate insulin secretion and antioxidant enzyme activity
- Promote fat metabolism and reduce fat tissue inflammation

### Skeletal and muscular system



- Relieves osteoporosis, increase bone density and bone strength
- Improve osteoarthritis, alleviate joint inflammation
- Improve body composition and local muscle strength

### Nervous system



- Relieve age-related learning and memory deficits
- Change brain structure and antidepressant
- Prevent cognitive function, anxiety-like behavior and stress response defects

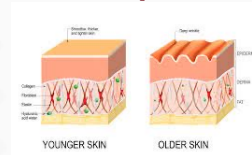
# THE POTENTIAL BENEFITS OF COLLAGEN PEPTIDE

### Immune system



- Inhibits tumor cell migration and proliferation
- Enhance cellular immunity and humoral immunity
- Suppresses allergic reactions
- Improve immune system antioxidant capacity

### Skin system



- Alleviate skin aging
- Increase skin properties (elasticity, hydration, and dermal collagen density)
- Inhibit wound inflammation
- Promote epithelial cells formation, tissue regeneration, angiogenesis, growth factor expression, and collagen deposition

### Gastrointestinal system



- Protects intestinal epithelial function
- Affects nutrient metabolism
- Change intestinal flora

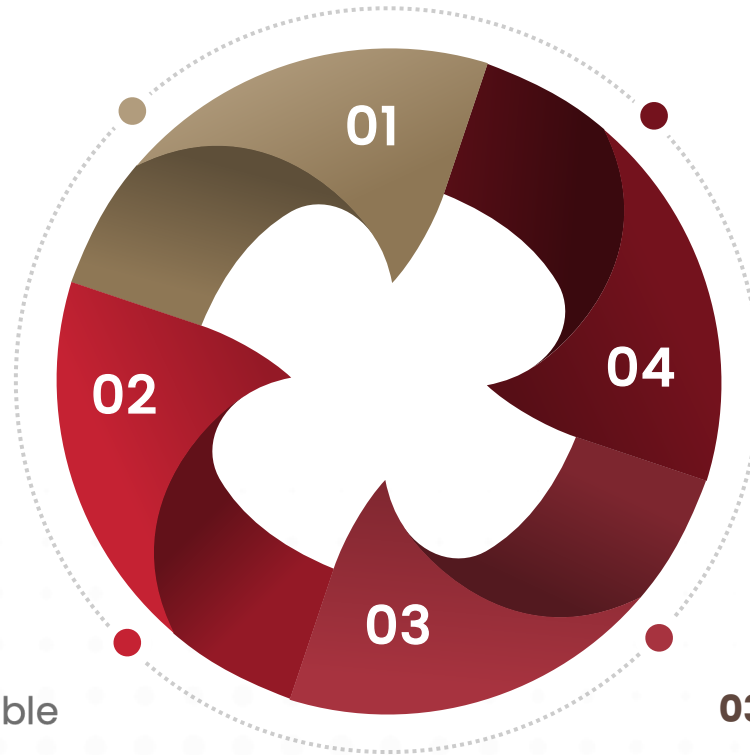


**Jellyfish: The  
future source  
of sustainable  
collagen**

# RESEARCH OBJECTIVES

**01.** To collect and study the literature on the extraction method of collagen bioactive ingredient from jellyfish.

**02.** To screen the best and suitable extraction method of collagen bioactive ingredient from jellyfish.



**04.** To characterize the collagen bioactive ingredient from jellyfish

**03.** To optimize the extraction method of collagen bioactive ingredient from jellyfish

# NOVELTY OF THE STUDY

1

Development of  
extraction process of  
collagen bioactive  
ingredient from local  
jellyfish



2

Development of extract  
containing high collagen  
bioactive ingredient  
content from local  
jellyfish

# COLLAGEN PRESERVING METHOD



10ml low pH preservatives





# STRUCTURAL ANALYSIS

- There are five important bands observed in collagen spectra which are Amide A, Amide B, Amide I, Amide II and Amide III.
- Based on the spectra, it was confirmed the structural of collagen from jellyfish

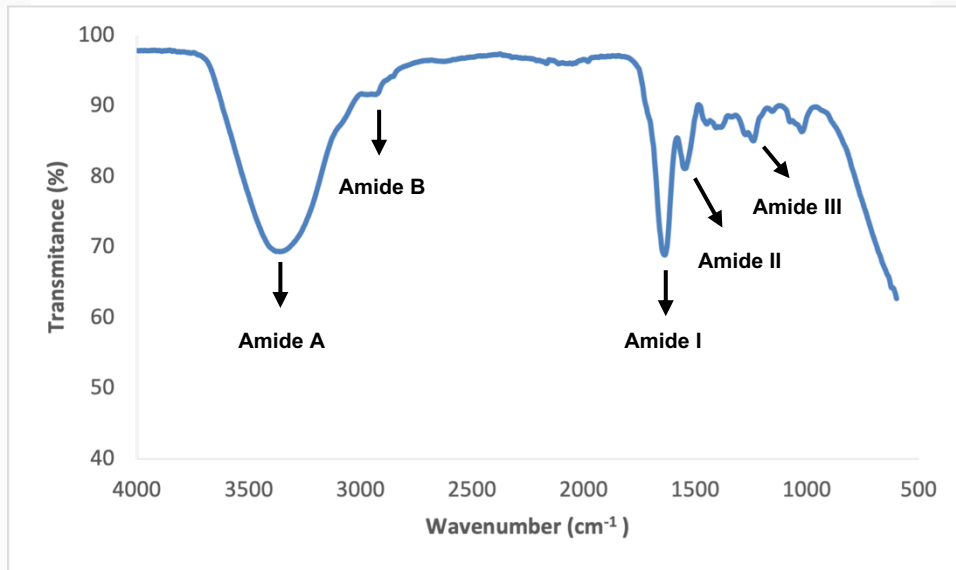


Figure 1 The FTIR spectra of collagen jellyfish

	Wavenumber (cm <sup>-1</sup> )	Assignments
Amide A	3375	N-H stretching
Amide B	2951	CH <sub>2</sub> and NH <sub>3</sub> <sup>+</sup>
Amide I	1647	C=O stretching , N=H bending
Amide II	1557	N-H bending , C-N stretching
Amide III	1251	C-N stretching , N-H deformation

# FTIR SPECTRUM OF COLLAGEN FROM JELLYFISH *RHOPILEMA ESCULENTUM*

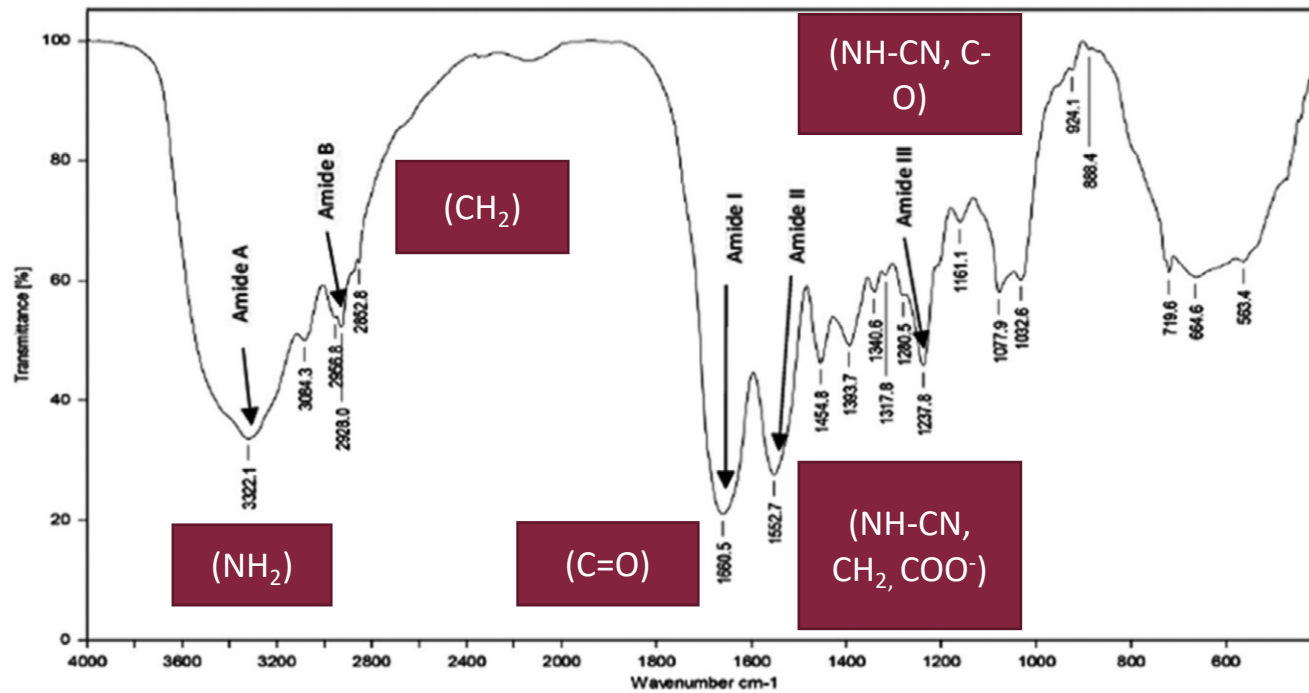
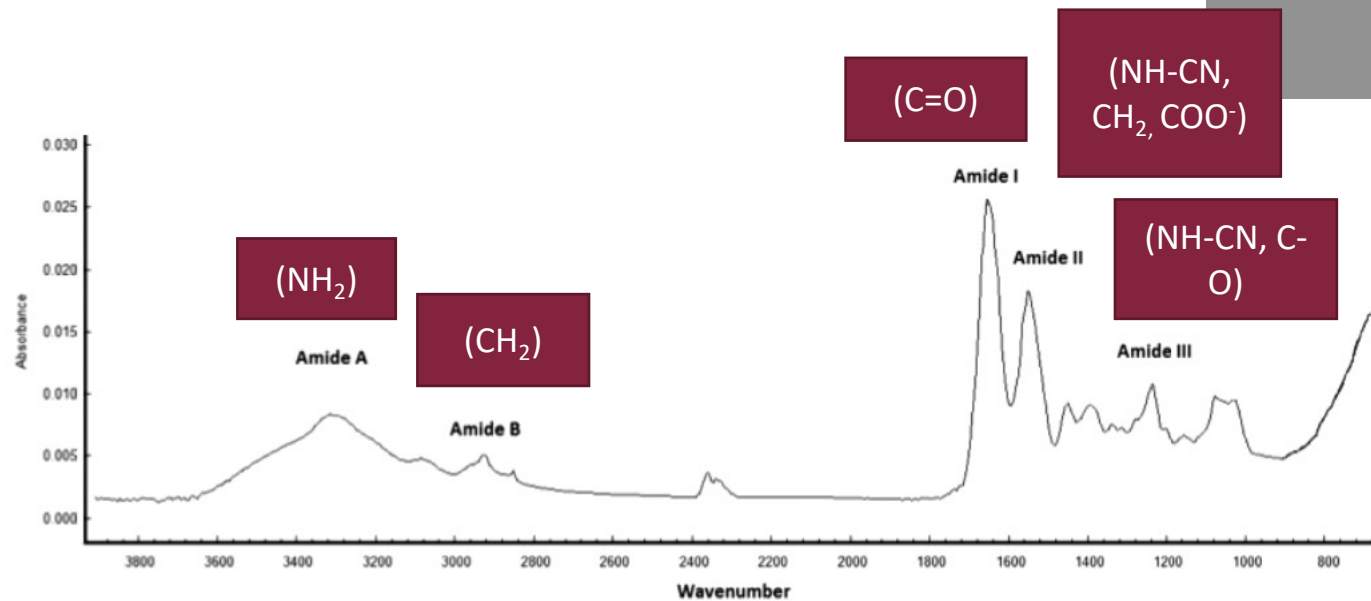


Fig. 4. Fourier transform infrared spectrum of collagen from the jellyfish *Rhopilema esculentum*.

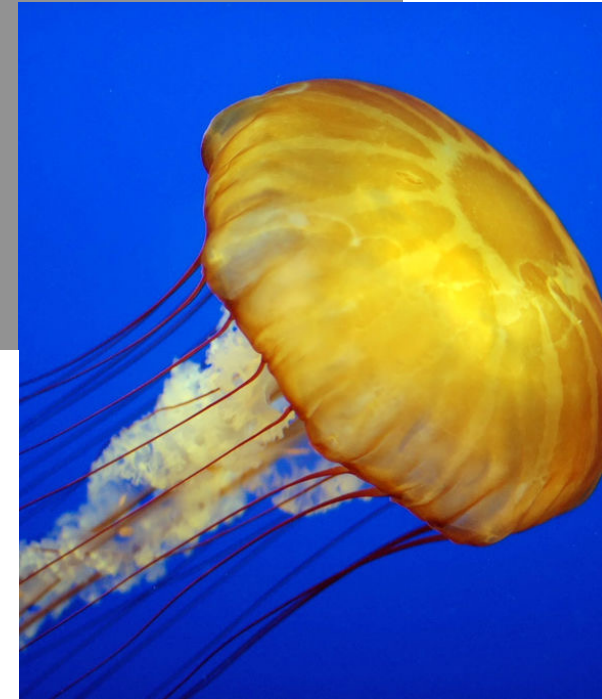


Barzideh, Z., Latiff, A. A., Gan, C-Y., Benjakul, S. and Karim, A. A. Isolation and Characterization of collagen from the ribbon jellyfish (*Crysaora* sp.). International Journal of Food Science & Technology, 2013.

# FTIR SPECTRUM OF COLLAGEN FROM JELLYFISH *chrysaora*

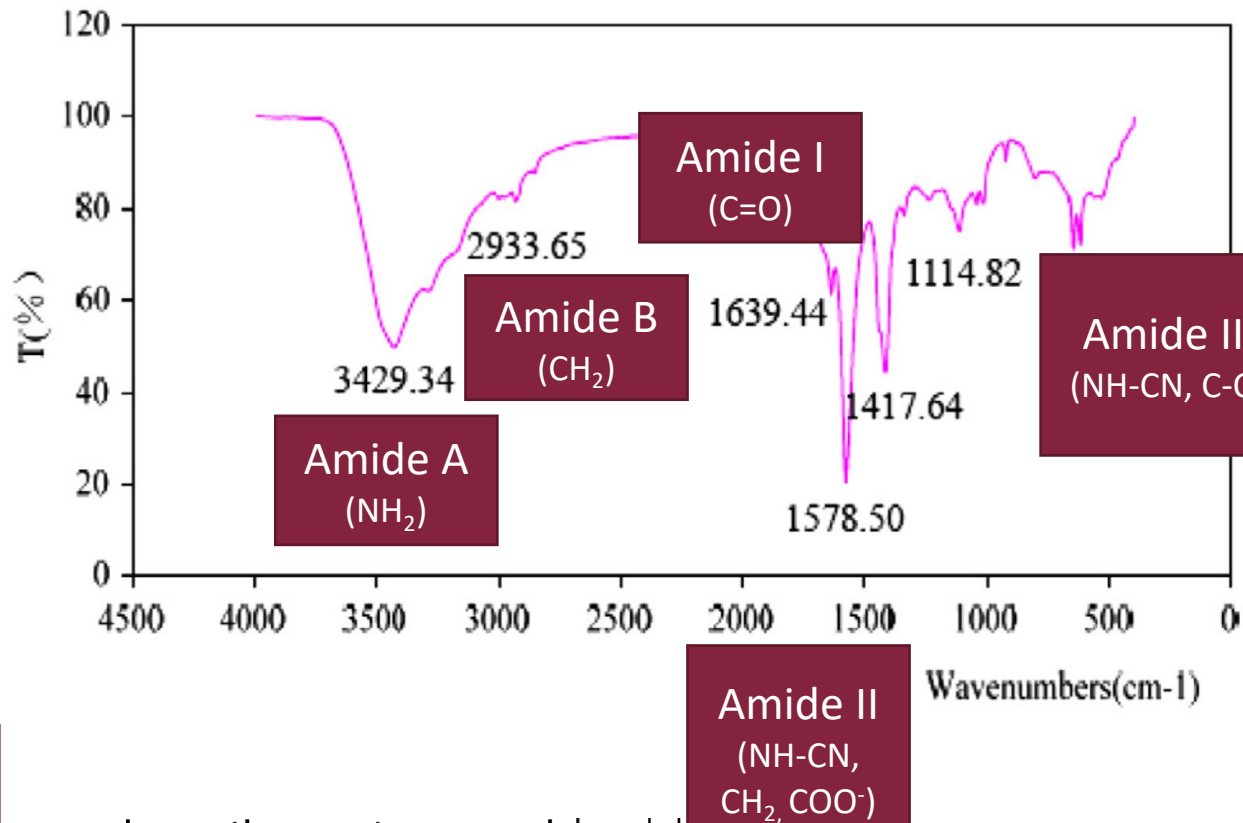


**Figure 3** Fourier transform infrared (FTIR) spectra of jellyfish collagen (the unit of abscissa is  $\text{cm}^{-1}$ ).



Felican, F. F., Yu, R-H., Li, M-Z., Li, C-J., Chen, H-Q., Jiang, Y., Tang, T., Qi, W-Y. and Xu, H-M. The Wound Healing Potential of Collagen Peptides Derived From The Jellyfish *Rhopilema esculentum*. Chinese Journal of Traumatology, 22, 12-20.

# FTIR SPECTRUM OF COLLAGEN FROM JELLYFISH *CYANEA NOZAKII* KISHINOUE

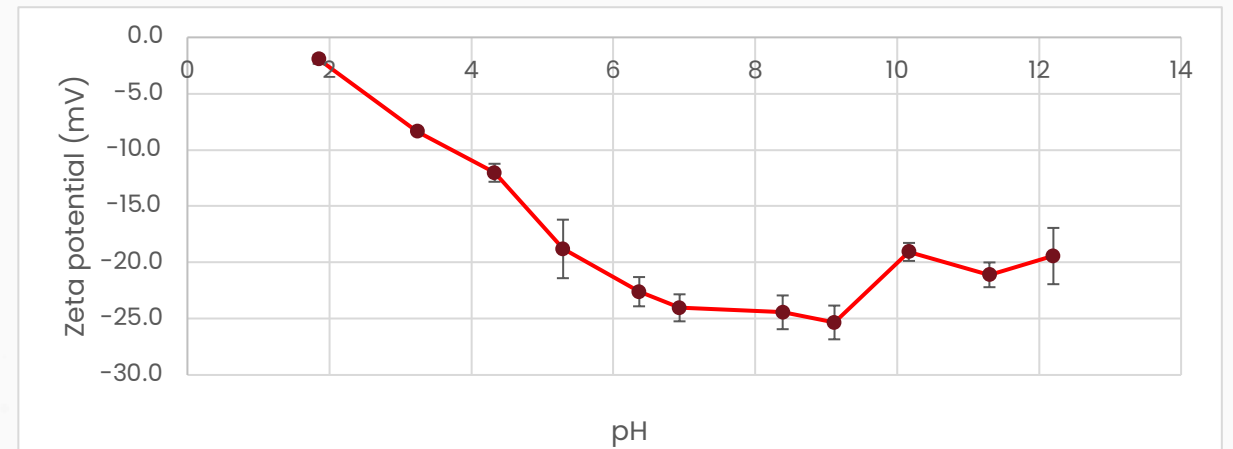


Zhang, J., Duan, R., Huang, L., Song, Y. and Regenstein, J. M. Characterization of Acid-soluble and Pepsin Solubilised Collagen From Jellyfish (*Cyanea Nozakii* Kishinouye). Food Chemistry, 150, 22-26.

• • • •

# ZETA POTENTIAL

- A sharp decreased of zeta potential of collagen was observed from pH 2 until it reached at pH 9
- This suggested that collagen jellyfish is not stable in alkaline solution.

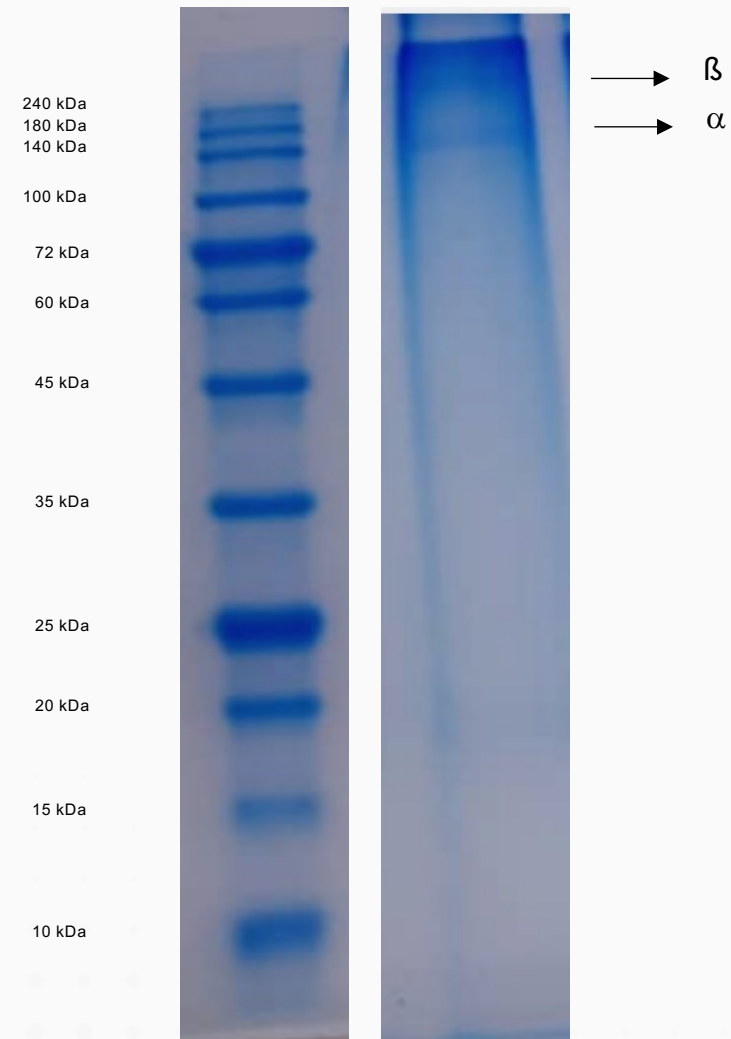


**Figure 2** The Zeta potential of collagen jellyfish

• • • •

# SDS-PAGE ANALYSIS

- Collagen jellyfish consisted of  $\alpha$  chain (a1) and  $\beta$  chains (with molecular mass values of >240 and ~140 kDa, respectively, which referred to type II collagen



**Figure 3** The SDS-PAGE analysis of collagen jellyfish



# THERMAL STABILITY

- The thermal stability of jellyfish collagen,  
 $T_{max} = 32.11\text{ °C}$  ,  $\Delta H = 34.25\text{ J/g}$

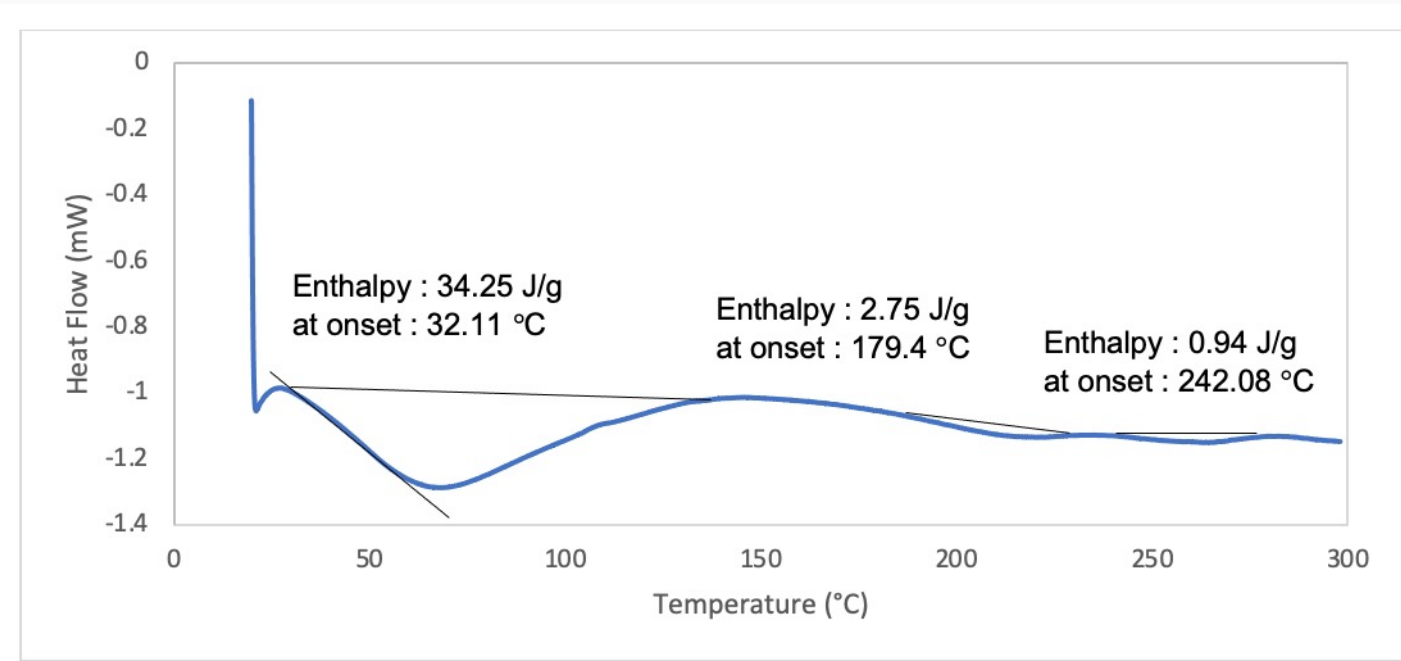


Figure 4 DSC thermogram of collagen jellyfish



# AMINO ACID PROFILING

- Glycine (Gly) was the major amino acid in jellyfish collagen with 15/100 residues. This result is in the good agreement with the basic structure of collagen which consists of Gly-X-Y amino acid model in which Gly is the highest content of amino acid in collagen jellyfish

Amino Acid Compound	Compound content (%)
Hydroxyproline	5.966
Aspartic Acid	9.989
Serine	3.473
Glutamic Acid	13.787
Glycine	15.940
Histidine	0.956
Arginine	7.794
Threonine	3.430
Alanine	7.627
Proline	7.337
Cysteine	2.199
Tyrosine	1.688
Valine	3.814
Methionine	1.657
Lysine	5.409
Isoleucine	3.035
Leucine	4.077
Phenylalanine	1.820
Total Amount Amino Acid	100.000

Table 1 Amino acid analysis of collagen jellyfish



# CONCLUSIONS

- Acid soluble collagen was successfully extracted from the commercial jellyfish with a **maximum yield of 20%** (wet weight).
- The structure of the jellyfish collagen shows five important band of collagen which are **Amide A, Amide B, Amide I, Amide II and Amide III.**
- The zeta potential of the jellyfish collagen was **stable up to pH 9**, after pH 9 the collagen starts to decompose.
- The amino acid composition of the jellyfish collagen shows the similar pattern with the standard **type II collagen** from chicken feet.
- The thermal stability of the jellyfish collagen ( **$T_{max} = 32.11\text{ }^{\circ}\text{C}$** ) was in range of other marine sources of collagen
- The findings indicted that this jellyfish species may be a valuable source of type II collagen that can be used as an **alternative to land-based sources.**



Marine collagen:  
A promising source for safer  
and sustainable cosmetic  
ingredients

# The Team Members



**Dr Nur Izyan Wan Azelee**  
**PROJECT LEADER**  
(Downstream process: Extraction & Optimization)



**Dr Norhayati Mohamed Noor**  
**RESEARCH OFFICER**  
(Downstream process: Extraction & Formulation)



**Assoc Prof Dr BA Venmathi Maran**  
**COLLABORATOR (UMS)**  
(Upstream process: Jellyfish preparation & toxicity analysis) (Downstream process: Extraction)



**Dr Siti Zulaiha Hanapi**  
**RESEARCH ASSOCIATE**



**Dr Siti Maryam Jasman**  
**RESEARCH ASSISTANT**  
(Upstream & Downstream process: Extraction & Characterization)



**Prof. Dr Hesham Al-Enshasy**  
**PROJECT MEMBER**  
(Downstream process: Extraction)



**Ms Zaitul Iffa Abd Rasit**  
**RESEARCH OFFICER**  
(Downstream process: Extraction)



**Dr Nor Hasmaliana Abdul Manas**  
**PROJECT MEMBER**  
(Upstream process: Analysis & Characterization)



**Ms Azizah Ishak**  
**LAB ASSISTANT**  
(Downstream process: Formulation)