Jellyfish as source of bioactive compounds with nutraceutical value

Stefania De Domenico

CNR-ISPA, ITALY

2 DIC 2021

Stefania De Domenico, Gianluca De Rinaldis , Tonia Gallo & Antonella Leone

Bioactive compounds from jellyfish

Traditional Chinese medicine utilized jellyfish as a treatment for bronchitis, high blood pressure, tracheitis, asthma, and gastric ulcers.

Scientific literature:

Collagen, hydrolysed collagen and low molecular weight compounds

- Antioxidant activity
- Protective effects on skin UV damage
- Immuno-stimulatory effects

Anti-cancer activity

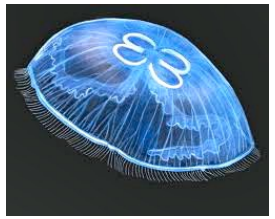
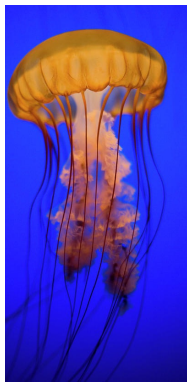
- Venoms from several jellyfish

Antimicrobial activity

- Jellyfish peptides





Bioactive compounds from Jellyfish

Apulia, Italy

Rhizostoma pulmo

Endemic to the Mediterranean Sea

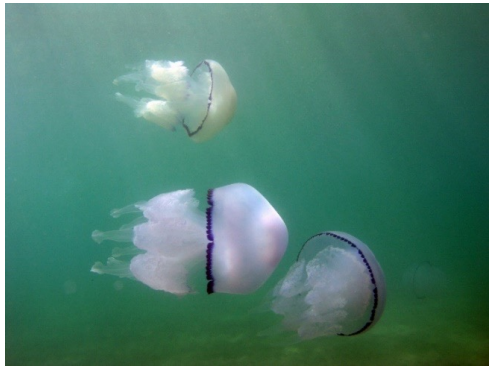
Cassiopea andromeda

Sicily, Italy

Alien species in Mediterranean Sea

Jellyfish sampling

R. pulmo



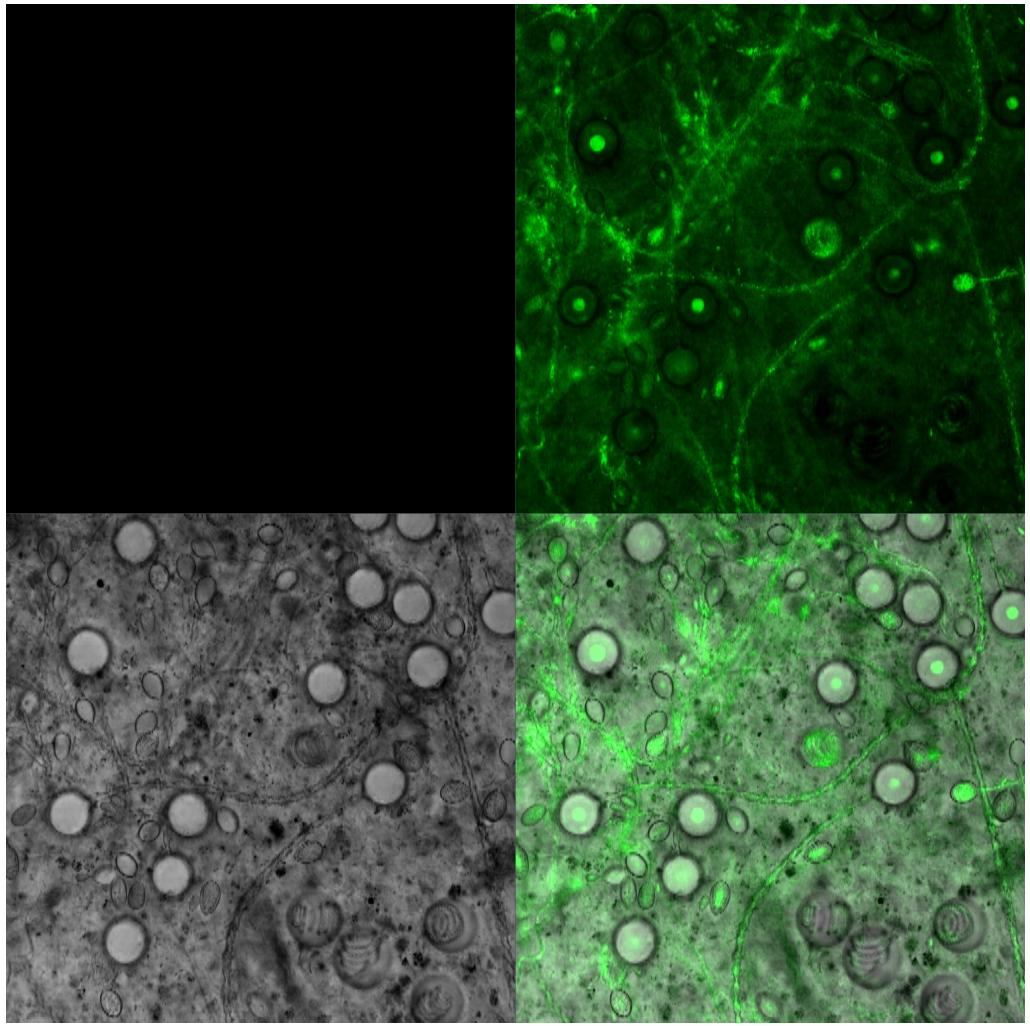
Gulf of Taranto (Apulia, Italy)

Jellyfish are caught by nylon net and stored in barrels in refrigerated seawater

Rhizostoma pulmo

R. pulmo

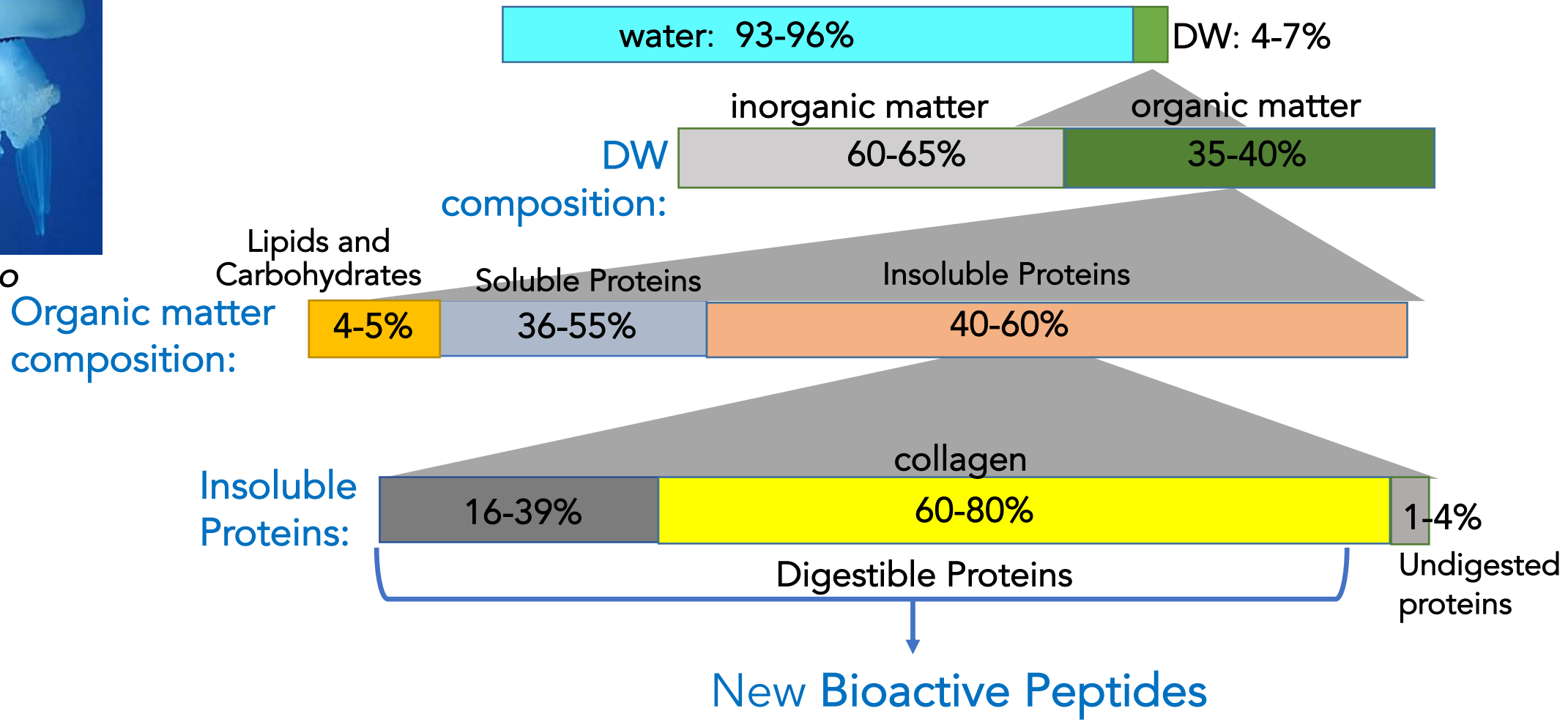
Not very stinging



Cnidocystis **in mucus** observed at laser scanning confocal microscopy

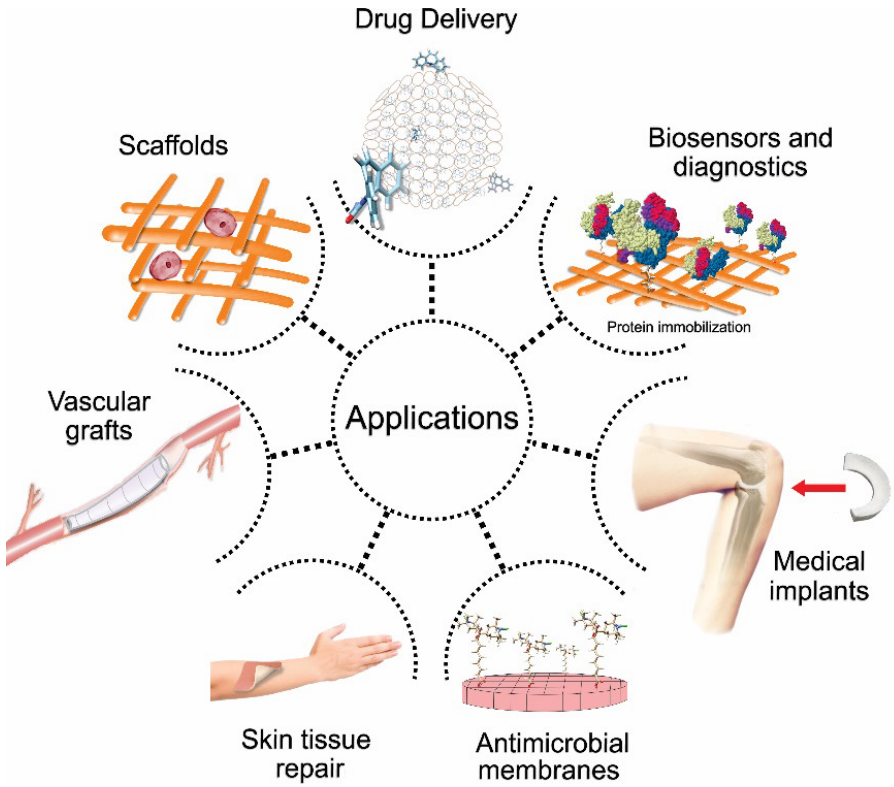
Nutritional value of *Rhizostoma pulmo*

R. pulmo



Leone et al. Mar. Drugs 2015, 13: 4654-4681

Collagen biotechnological uses



Collagen from **jellyfish** is similar to mammalian collagen type I

Collagen uses	
Medical uses	Immune-stimulatory - Rheumatoid arthritis and osteoarthritis therapy - Cosmetic surgery - Bone grafts - Tissue regeneration - Reconstructive surgery - Wound care - Drug delivery - Biodegradable hydrogels
Food / Food Industry uses	Gelatine – Thickeners - Dietary supplements - Functional food
Cosmetics	Active ingredient
Other uses	Biomaterials (soil improver in agriculture, construction) -Glue for musical instruments

Amino Acid profiles of the *R. pulmo* total proteins

R. pulmo

	R. pulmo mg/100 g ± SD	*R. pulmo* %
Alanine (Ala)	3.5 ± 0.2	3.9
→ Arginine (Arg)	1.8 ± 0.0	2.0
Aspartic acid + Asparagine (Asx) *	2.9 ± 0.6	3.2
→ Cysteine (Cys)	1.2 ± 0.0	1.3
→ Glutamic acid + Glutamine (Glx) **	13.7 ± 0.2	15.2
→ Glycine (Gly)	4.8 ± 0.5	5.3
→ Histidine (His) [e]	5.0 ± 0.4	5.6
Isoleucine (Ile) [e]	4.9 ± 0.7	5.5
Leucine (Leu) [e]	8.2 ± 0.4	9.1
Lysine (Lys) [e]	6.2 ± 0.4	6.9
Methionine (Met) [e]	4.1 ± 0.7	4.6
→ Phenylalanine (Phe) [e]	8.4 ± 0.8	9.3
→ Proline (Pro)	3.5 ± 0.2	3.9
→ Serine (Ser)	6.0 ± 0.8	6.7
Threonine (Thr) [e]	4.5 ± 0.1	5.0
→ → Tyrosine (Tyr)	6.8 ± 0.6	7.6
→ Tryptophan (Try) [e]	n.d.	-
Valine (Val) [e]	4.4 ± 0.4	4.9
$\sum_{AA}$	89.9 ± 7.0	100
$\sum_{EAA}$	45.7 ± 3.9	50.8
$\sum_{CAA}$	36.6 ± 2.3	40.7
$\sum_{AAA}$	20.2 ± 1.8	22.5

EAA=Essential Amino Acids

CAA=Conditionally Essential Amino Acids

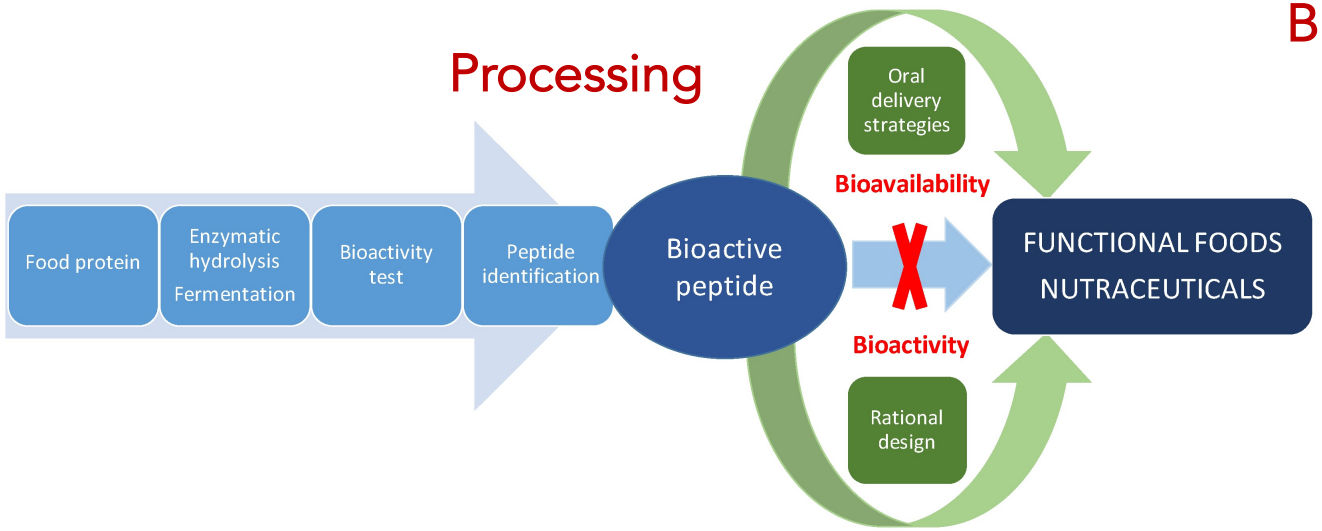
AAA=Aromatic Amino Acids

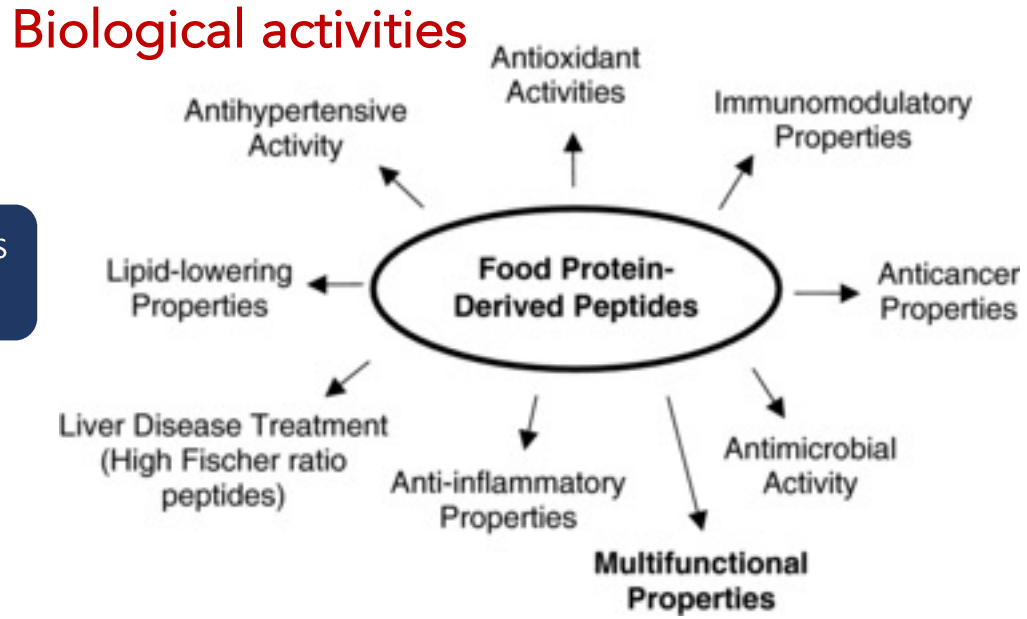
Food peptides with antioxidant activity

Leone et al. *Mar. Drugs* **2015** *13*:4654-4681

Bioactive peptides

- Small protein fragments providing several health benefits
- Short-chain protein molecules (usually 3-20 amino acid residues)
- Peptides are released during food processing or as result of enzymatic or chemical hydrolyses
- Their functions, MW and amino acid composition are largely influenced by the nature of proteins, hydrolytic enzymes, enzyme-substrate ratio, pH, temperature and time of reaction.





Antioxidant activity *in vitro*

R. pulmo

SOLUBLE PROTEIN SP

Insoluble proteins IP

SP>30

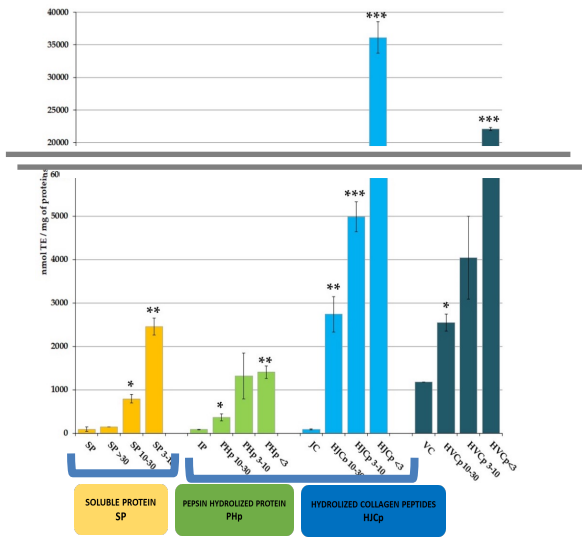
SP10-30

SP3-10

SP3<3

Enzymatic digestion

Jellyfish PEPTIDES



Small proteins and peptides have the highest Antioxidant activity

De Domenico et al. Mar. Drugs 2019 10.3390/md17020134

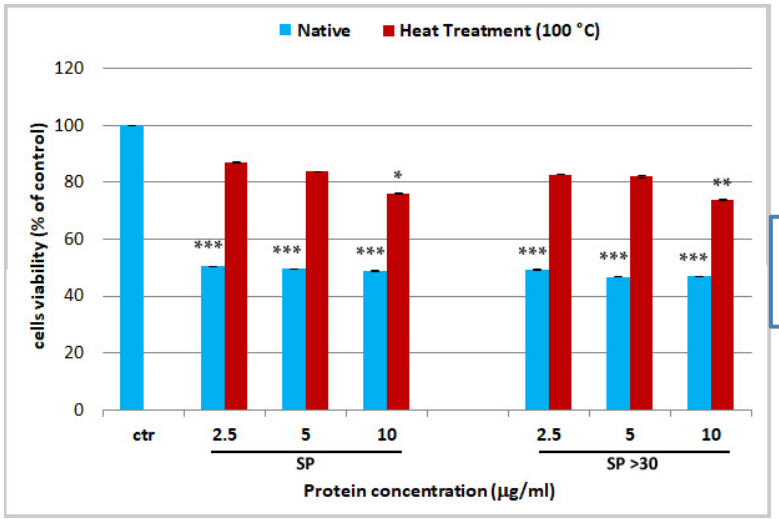
Effect on HEKa (human cell cultures)

R. pulmo

Human epidermal keratinocytes isolated from adult skin (HEKa)

Jellyfish **small soluble proteins** and **peptides** are **not cytotoxic.**

Cytotoxicity of larger soluble proteins decreased after **thermal treatment.**



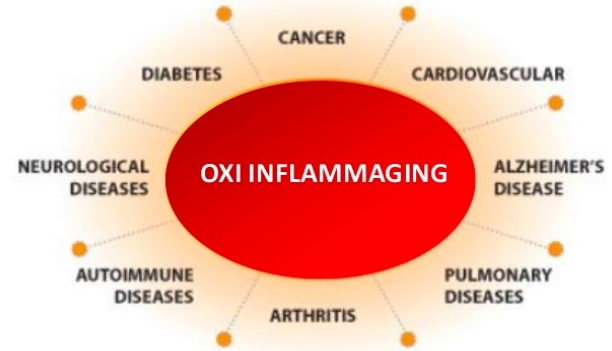
Effect of heat treatment on cytotoxic soluble proteins (SP)

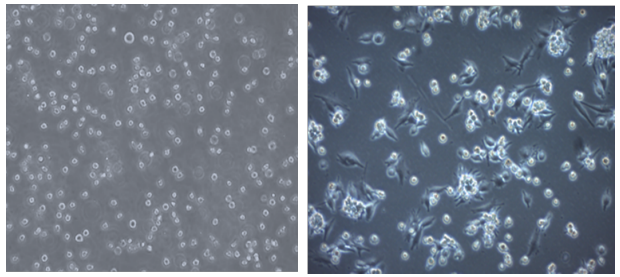
100°C/10 min

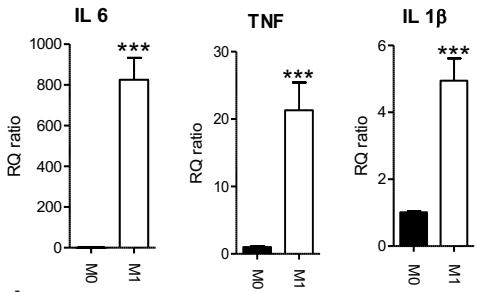
De Domenico et al. Mar. Drugs 2019 10.3390/md17020134

Immuno-modulatory effect of jellyfish peptides

R. pulmo







human monocyte and macrophages

Jellyfish peptides
have **immuno-modulatory effect:**

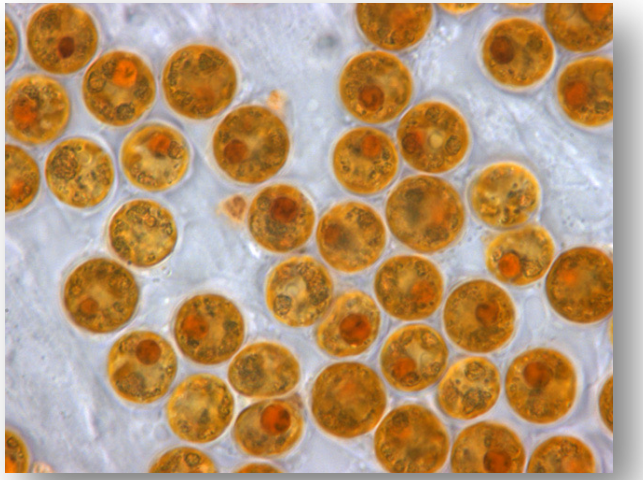
- **no pro-inflammatory** effect on human monocytes and macrophages in vitro.

- Some JF peptides shows **anti-inflammatory activity.**

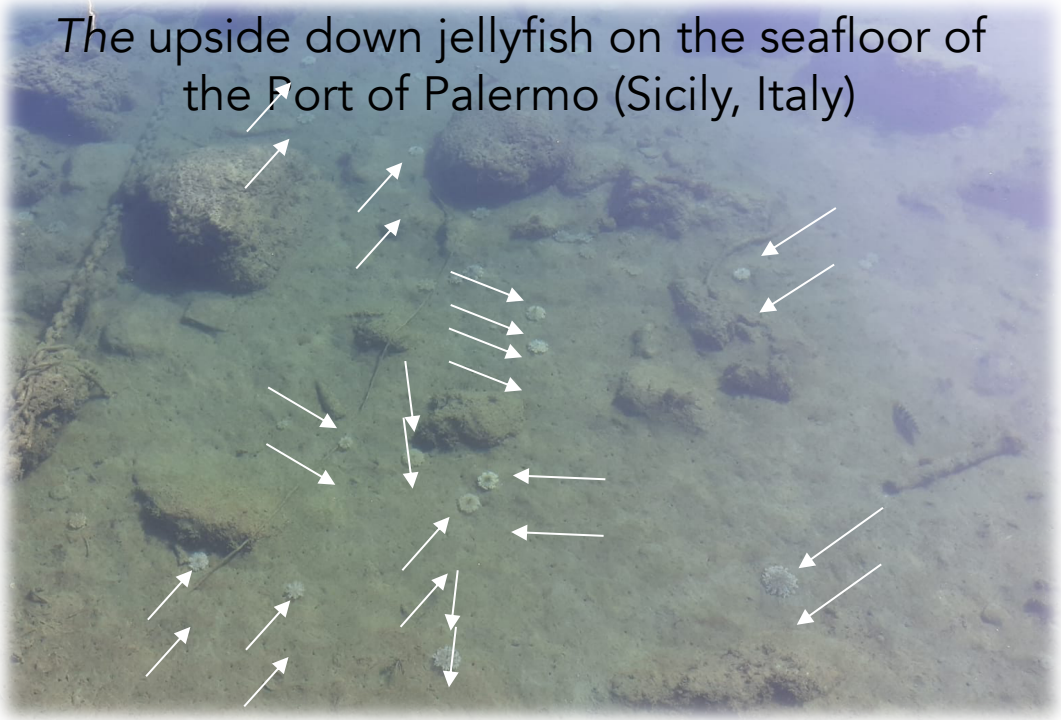
De Domenico et al., *in preparation*

The "upside-down" *Cassiopea andromeda* jellyfish

C. andromeda



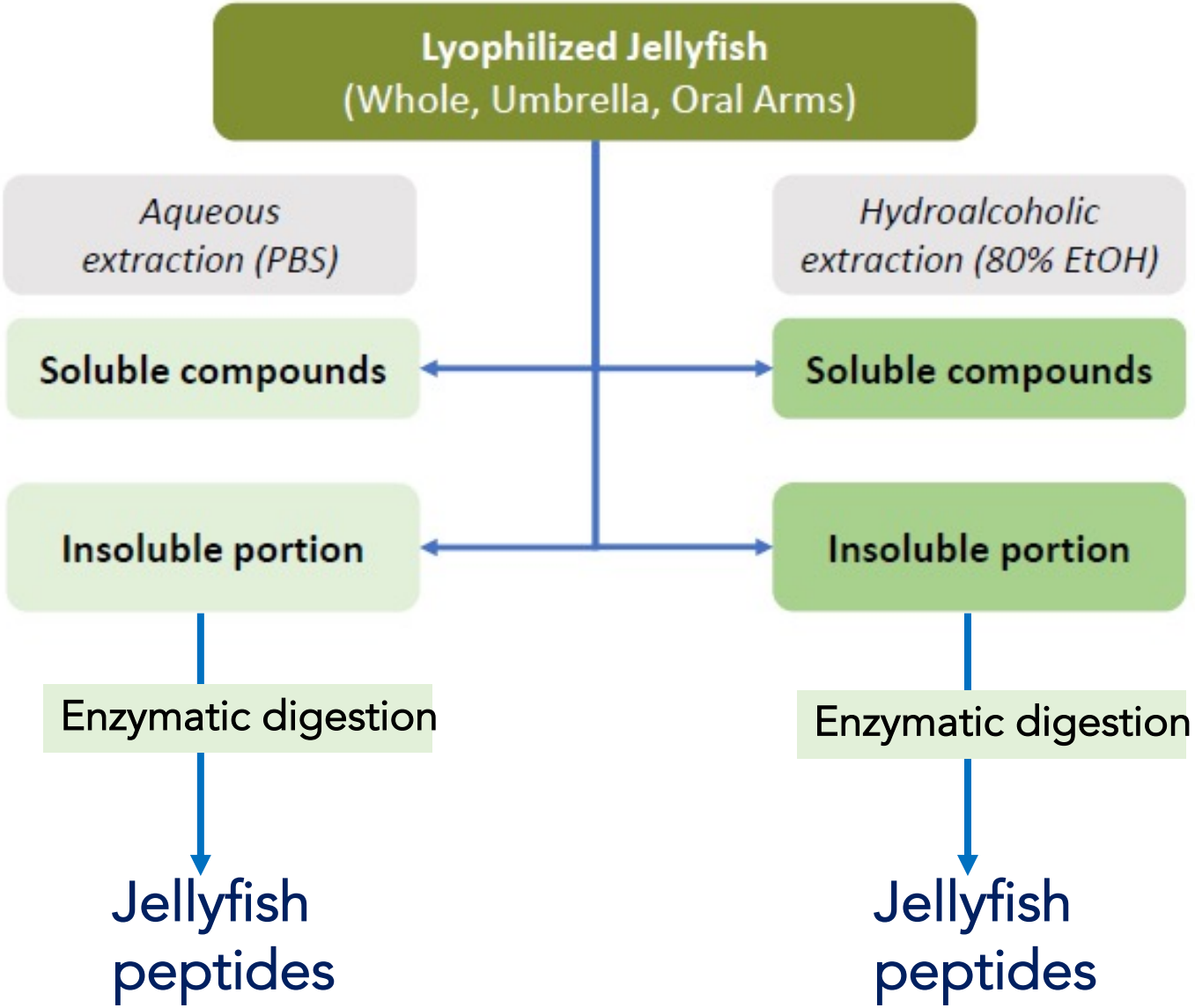
Photosynthetic microalgal endosymbionts (zooxanthellae)



De Rinaldis et al. Mar. Drugs 2021, 19, 498

Soluble and Insoluble compounds extraction from umbrella and oral arms

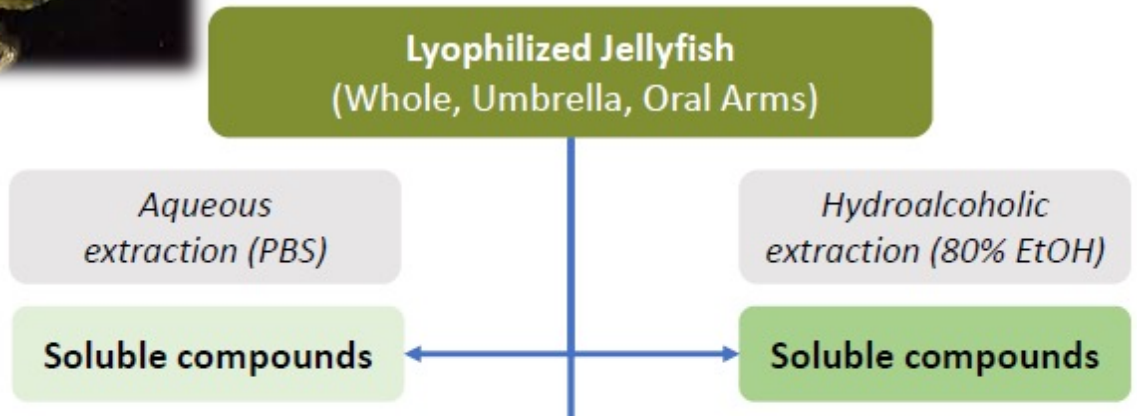
C. andromeda



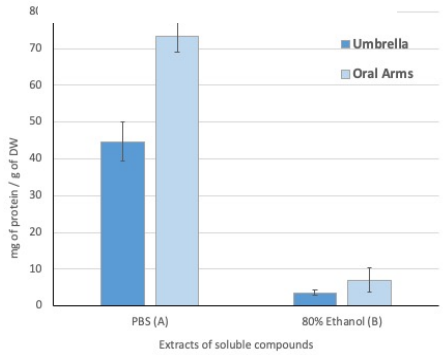
De Rinaldis et al. Mar. Drugs 2021, 19, 498

oluble Proteins, phenol content and antioxidant activity in extracts of *C. andromeda*

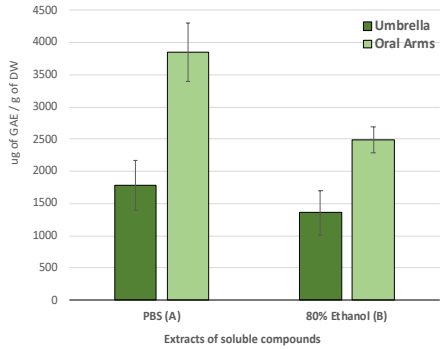
C. andromeda



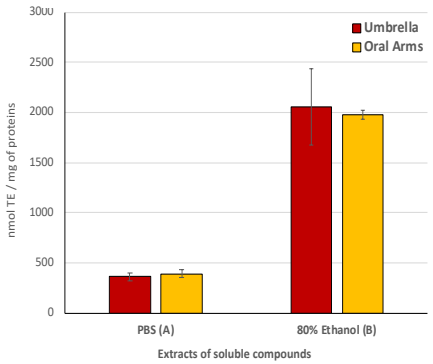
PROTEIN content



PHENOL content



ANTIOXIDANT activity



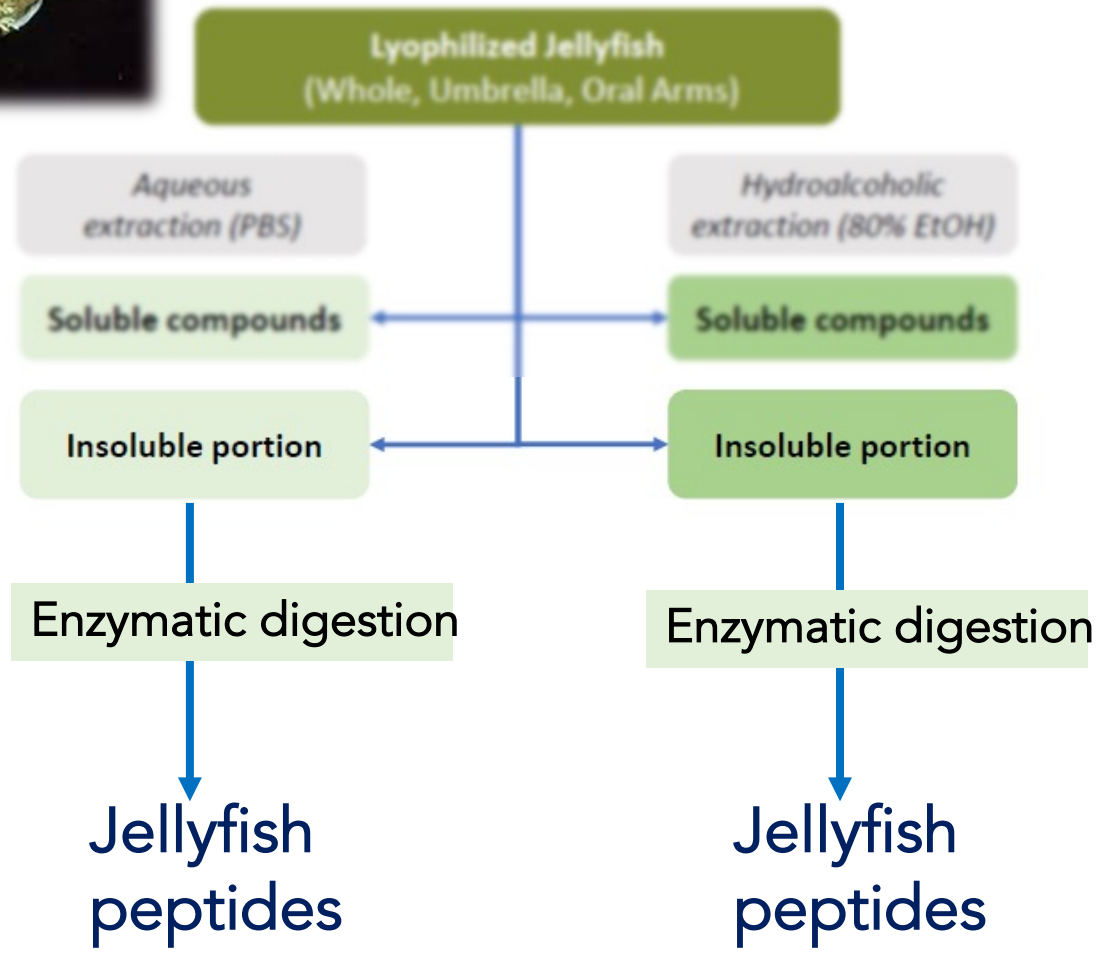
Jellyfish **oral arms** show a higher soluble **protein** content than umbrella.

Jellyfish hydroalcoholic extracts present high **antioxidant activity.**

De Rinaldis et al. Mar. Drugs 2021, 19, 498

Antioxidant activity in vitro

C. andromeda



Jellyfish peptides both from umbrella and oral arms present high **antioxidant activity**

De Rinaldis et al. Mar. Drugs 2021, 19, 498

General Conclusions

R. pulmo proteins and peptides	
	- Antioxidant activity
	- Not cytotoxic on human cells
	- Immuno-modulatory effect (anti-inflammatory effect) on human cells

C. andromeda extracts	
	- Antioxidant activity
	- Oral arms rich in proteins and phenols
	- Anti-proliferative activity on cancer cells

Jellyfish can be regarded as a **novel source of active natural compounds** for current and future applications in biomedical and nutraceutical studies.

Acknowledgements

These studies were developed at the Institute of Sciences of Food Production of the National Research Council, Unit of Lecce (CNR-ISPA) under the supervision of Dr. Antonella Leone.

Funded by the H2020 EU project "GoJelly – *A gelatinous solution to plastic pollution*" n.774499

Thank You

Antonella Leone

Stefania De Domenico

Antonia Gallo

Gianluca De Rinaldis

Gianluca Bleve

Clara Albano