Plant proteins for nutraceutical and food applications

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Plant Protein and Cellulose Research

Mission

To create and develop competitive advantages for western Canadian crop and forestry resources in value-added product development with an emphasis on plant proteins and wood cellulose.

Plant Protein and Cellulose Research

Vision

- Components from Alberta crops and forestry resources will be profitable and competitive in world markets that are dominated by soy, whey, corn, alginates and synthetics

- Alberta crops will be natural and sustainable alternatives to replace synthetic ingredients

- Develops fractionation processes that can produce pure ingredients, extracts, and isolates from a wide range of Alberta based crops

- An expert resource to industry partners and clients for analysis of crop and forestry components and assistance with innovative and value-added product development.

Research & Development Directions

Feedstock

- Characterize and understand feedstock attributes (different crops and varieties)
- Aligning crop component quality with product attributes demanded by market, identify and developing specialty crops for food and non-food applications

Crop & By-Product Processing

- Develop cost-effective processing to fractionate crop components.
- Advance technology to produce pure ingredients, extracts, and isolates from a wide range of Alberta based crops.
- Develop processing and utilization of by-product streams from primary processing and utilizing other supply sources: Distillers Grains, Brewing ingredients, barley leaves, straw, seed coats, hulls, etc.

Property Testing

- Evaluate unique properties and competitive advantages of crop extracts, isolates, and pure ingredients to predict their potential applications

Value-Added Applications

- Advancing technologies that convert crop components into value-added products for utilization within food, personal care, bioplastic, biomaterials, and other industrial applications
- Develop and customize the innovative technologies to meet specific industry requirements

Services

- Providing industry with access to expertise, unique analytical services, and problem solving capabilities

Business Development Directions

Commer-cialization Routes

- Establish commercialization routes of the fractionations and ingredients from Alberta crops within food, personal care and other industrial products

Supply Chain Develop-ment

- Developed supply and value chains where companies directly contract producers to ensure a stable and quality supplies of crops

Growing Enterprises

- Assisting local companies to grow or further innovate and develop
- Assisting local companies with building regional and international networks to access equipment, resources, and expertise

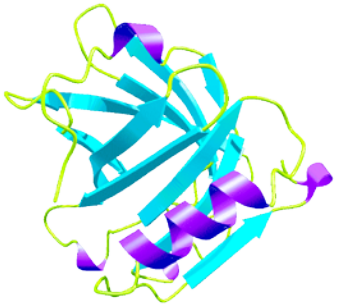
Alberta Brand

- To create and maintain an international recognized Alberta brand for crop based ingredients, fractions, isolates, etc.

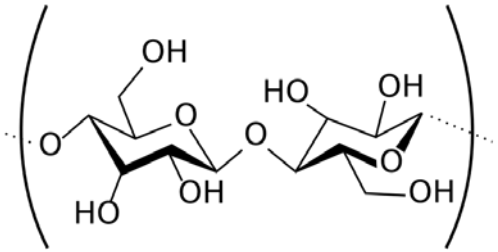
Collaboration and/or Investment

- Ongoing access to specialized expertise and skill sets
- Direct access to innovative and cutting edge research, and new intellectual property
- Direct access to state-of-the-art equipment and facilities
- Connections with ingredient suppliers and end users

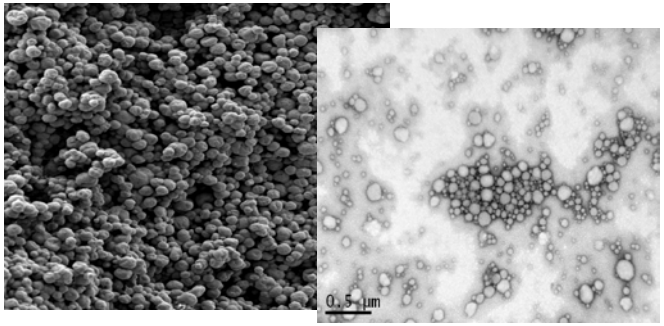
Plant Protein & Cellulose Research



Protein

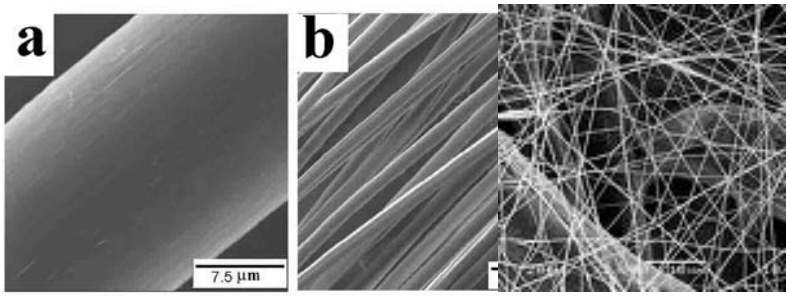


Cellulose

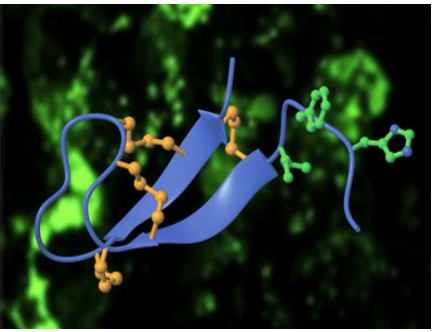


Nano/microparticles/emulsions

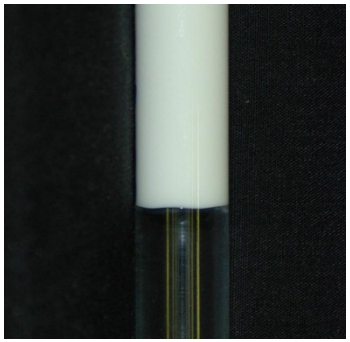
Polymer physics & chemistry

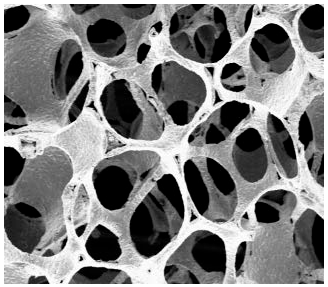


Fibre/non-woven tissue

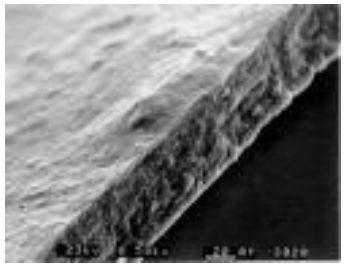


Bioactive peptides





Hydrogels/sponge/foam



Film/plastics

Plant Protein & Cellulose Research

Healthy foods

Personal care

Biomedical materials

Biodegradable natural polymer based bio-products…

Packaging

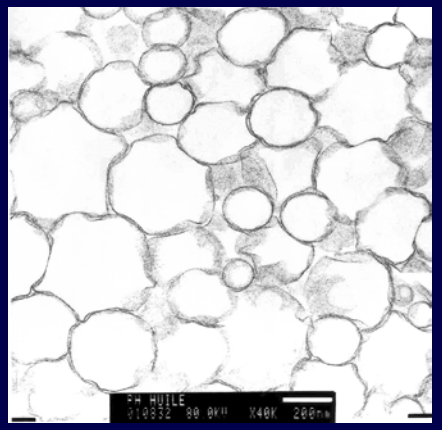
Filtration

Textiles

Challenges of food nano-/micro-encapsulations

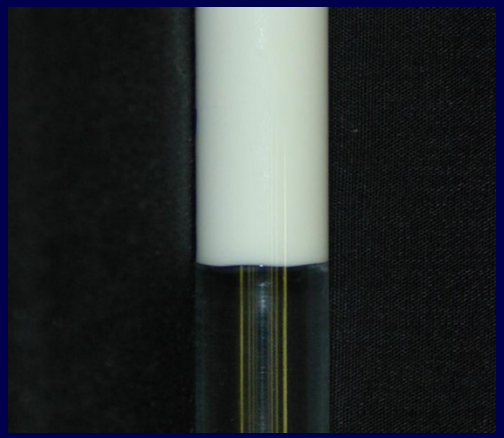
- GRAS status
- Safe processing
- no impact on food sensory
- Low-cost
- Degradable in gut
- Enhance the stability and bioavailability

Food protein



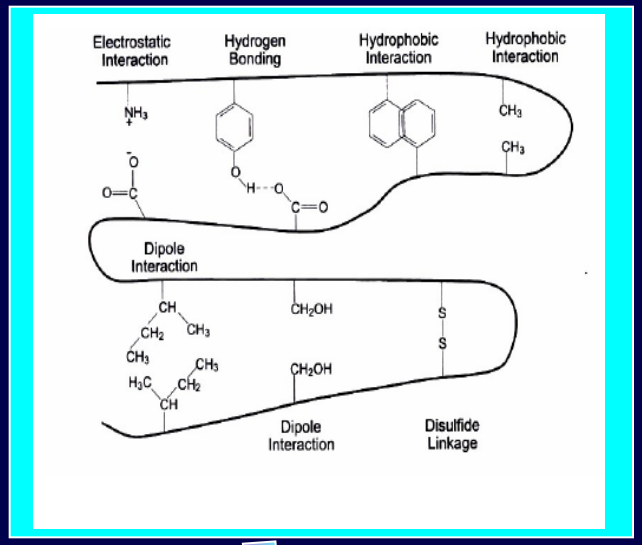
Emulsion gels

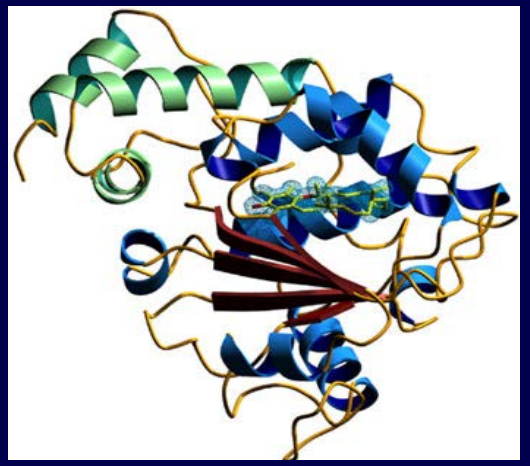
Film



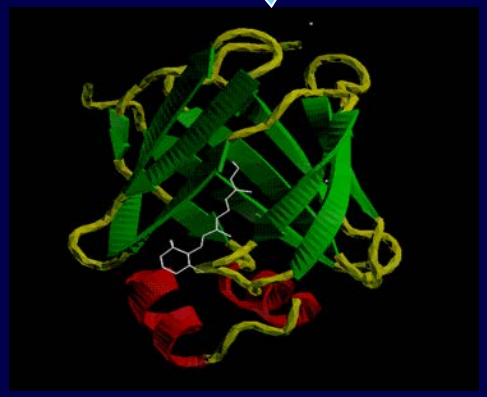
Gel

Food proteins

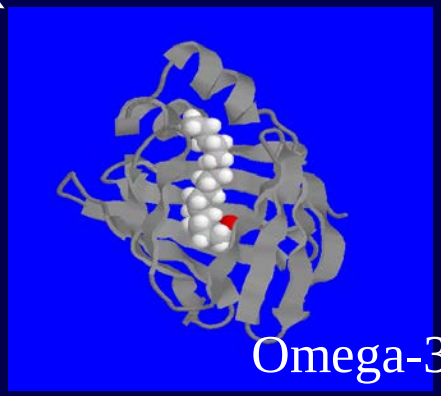




Tocopherol



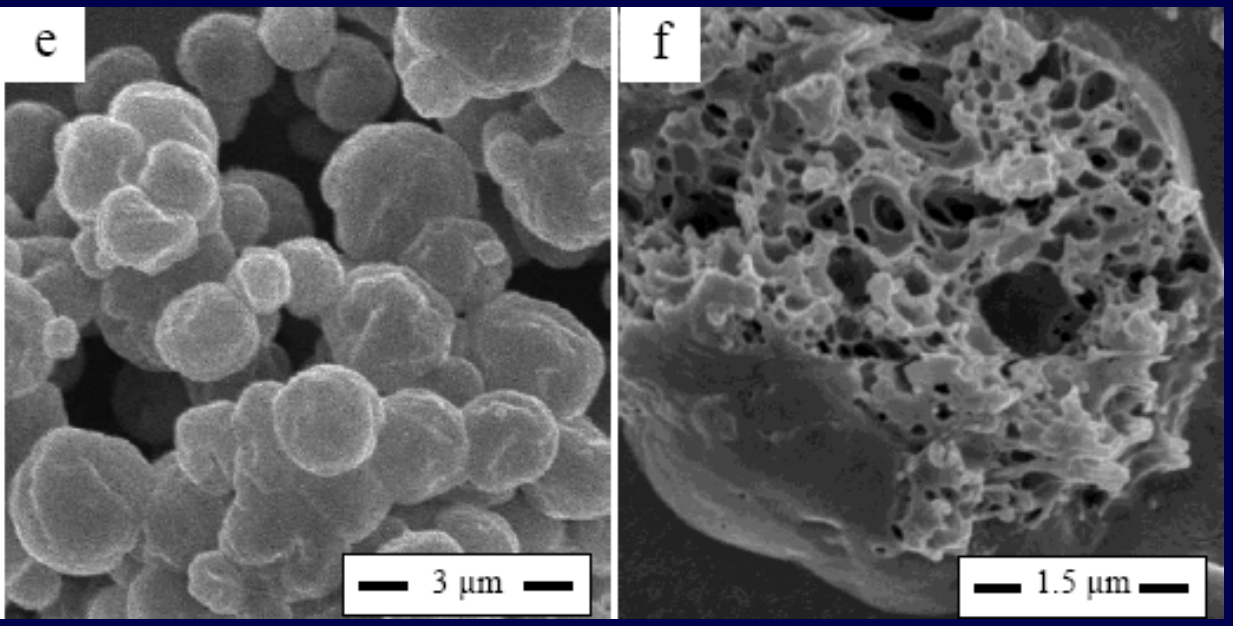
Retinol

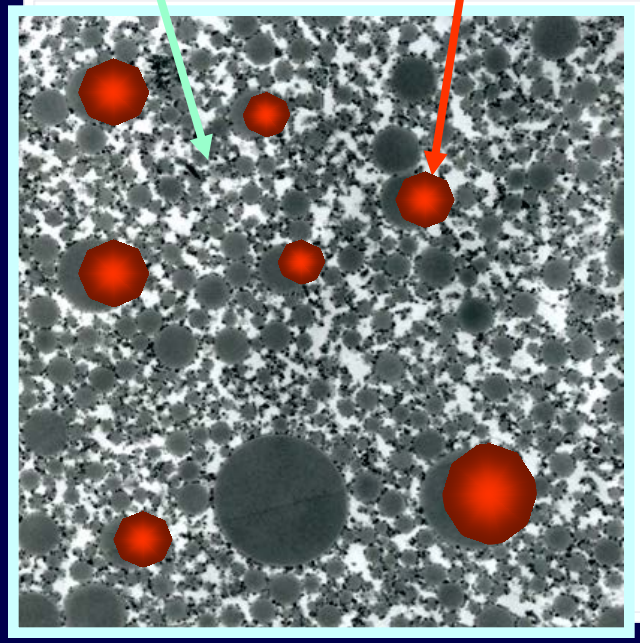


Omega-3

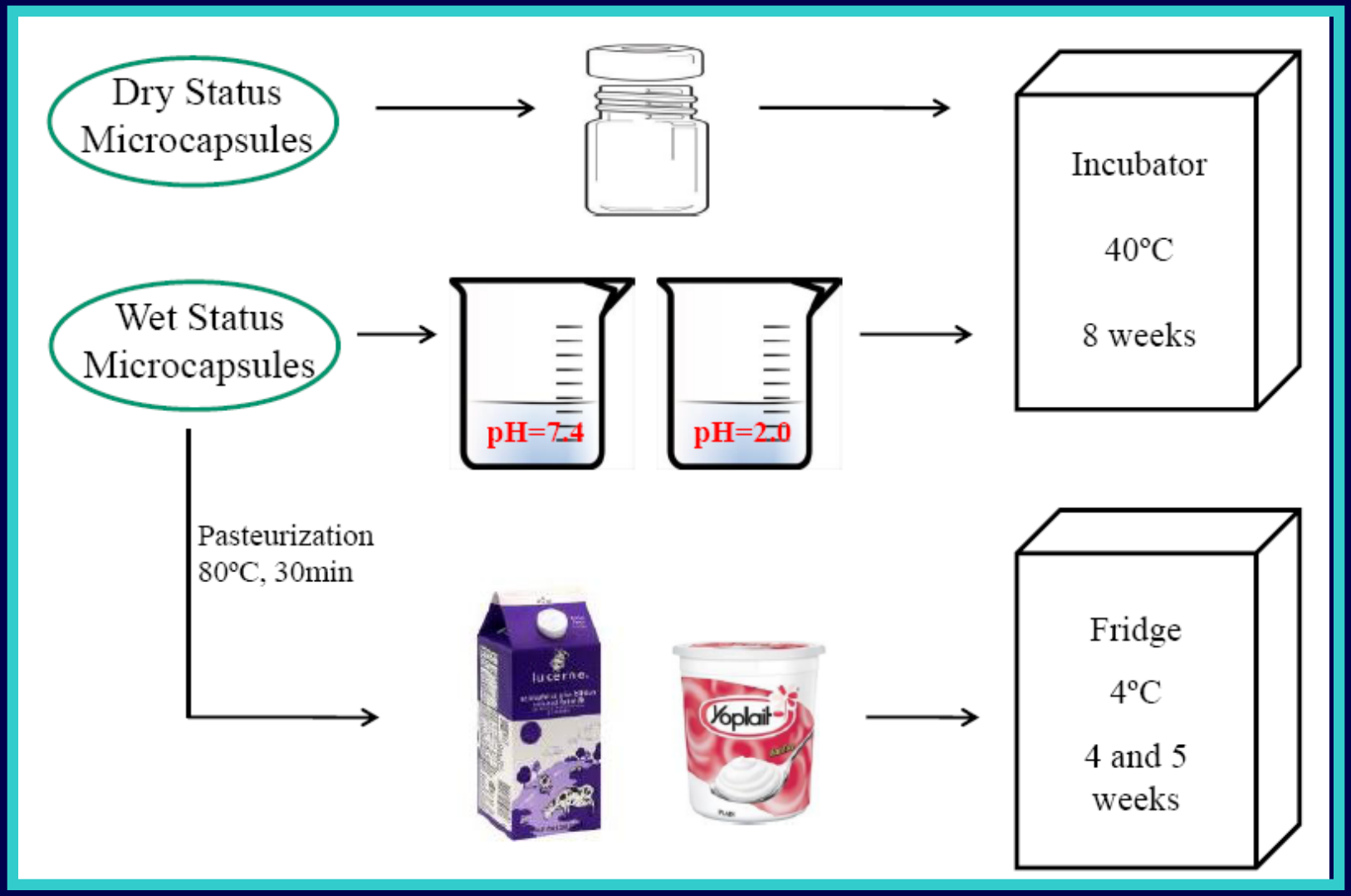
- Binding capacity

Barley protein microcapsules



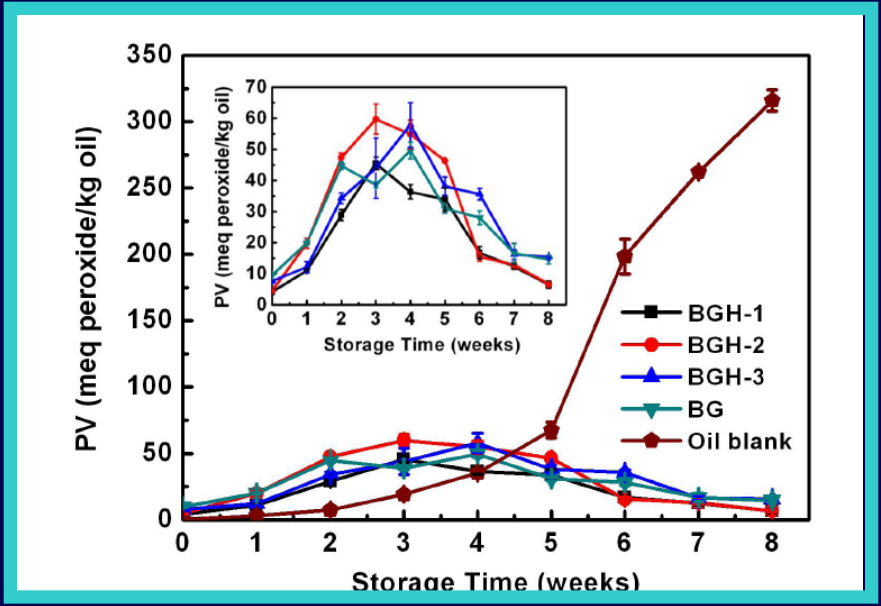


Oxidative stability test

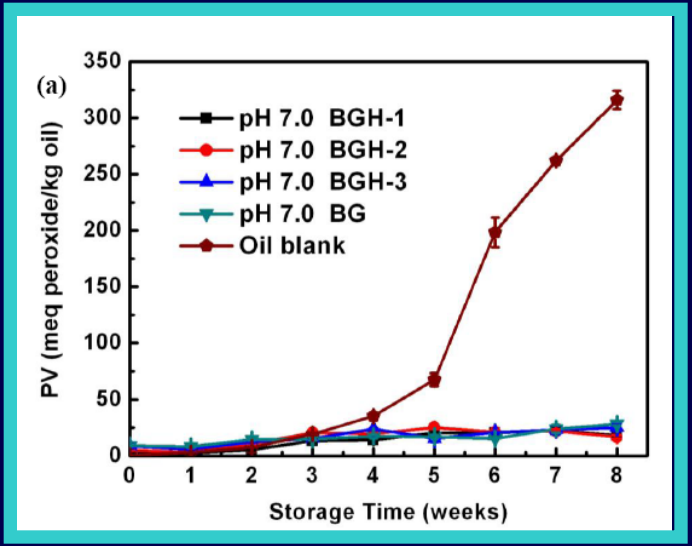


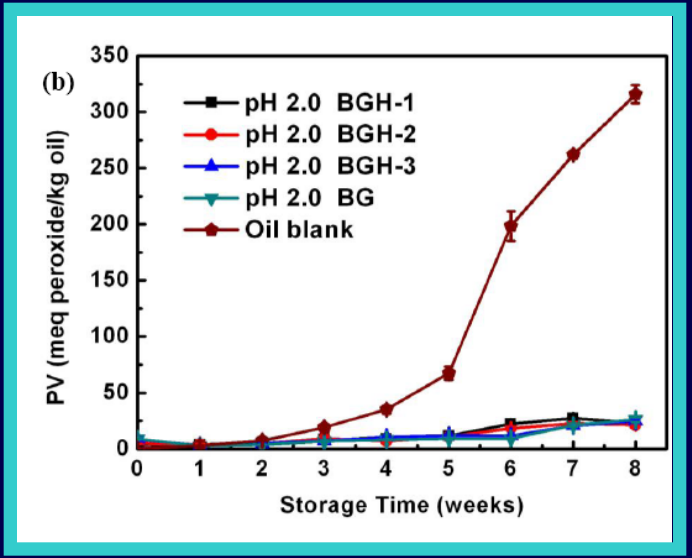
Oxidative stability of fish oil

Dry status



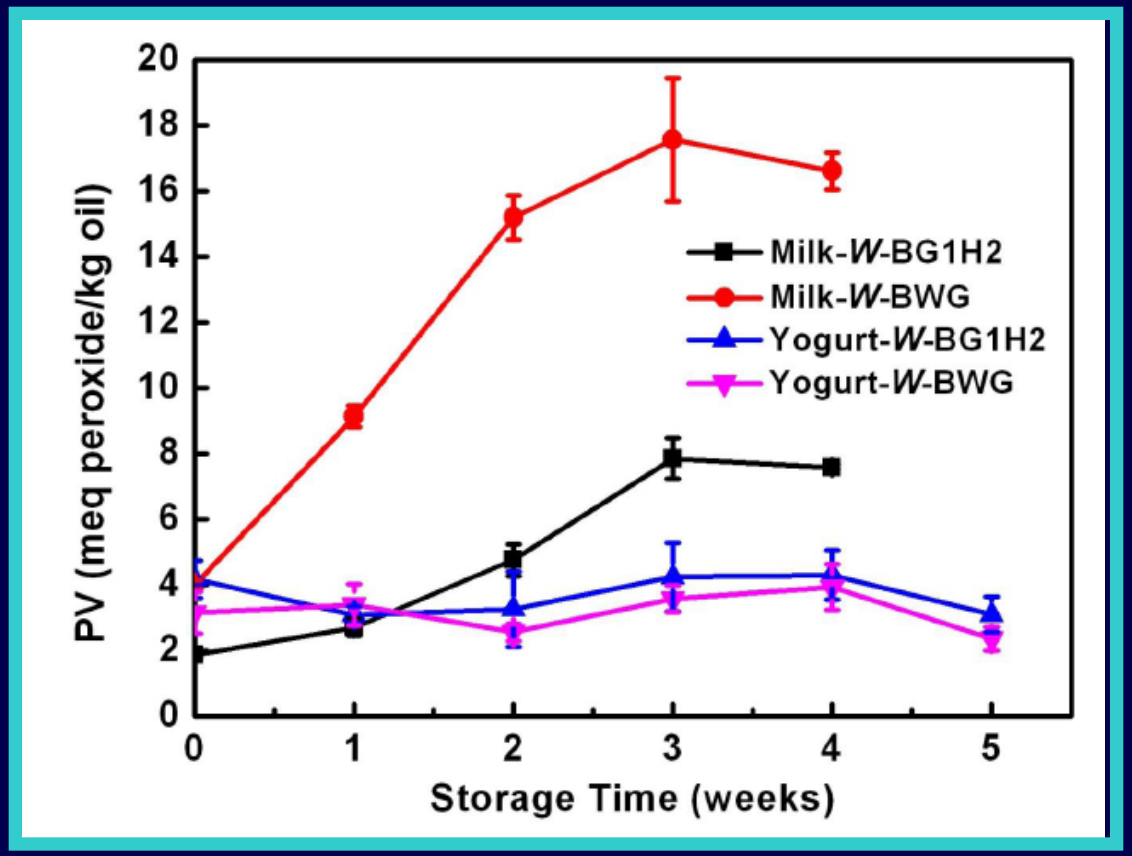
Wet status



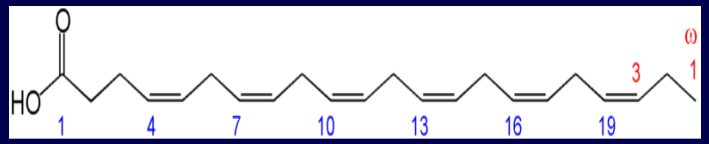


Oxidative stability of fish oil

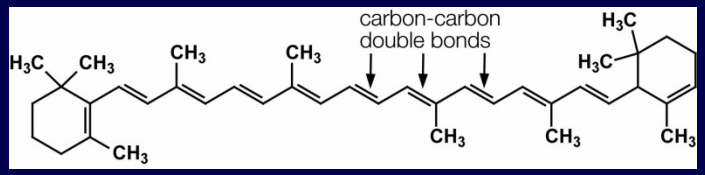
Food formulations



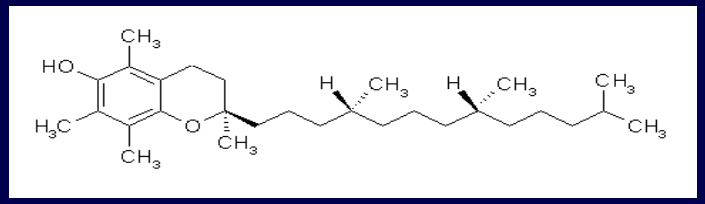
Release in the simulated GI tract



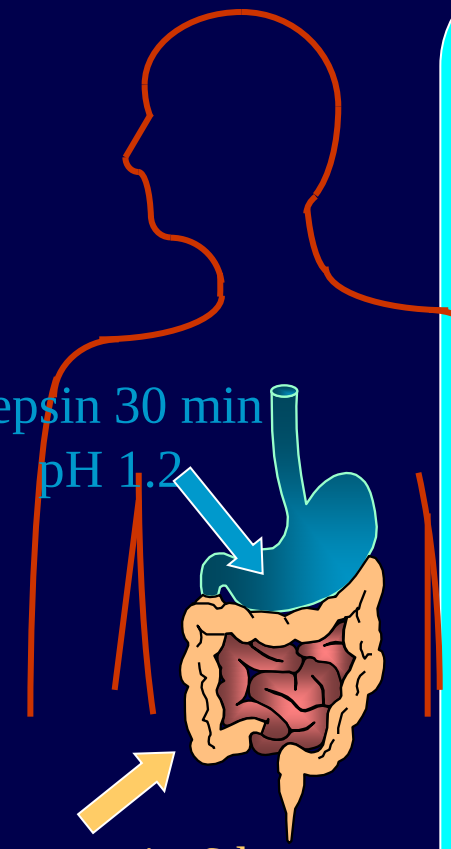
Omega-3 fatty acids



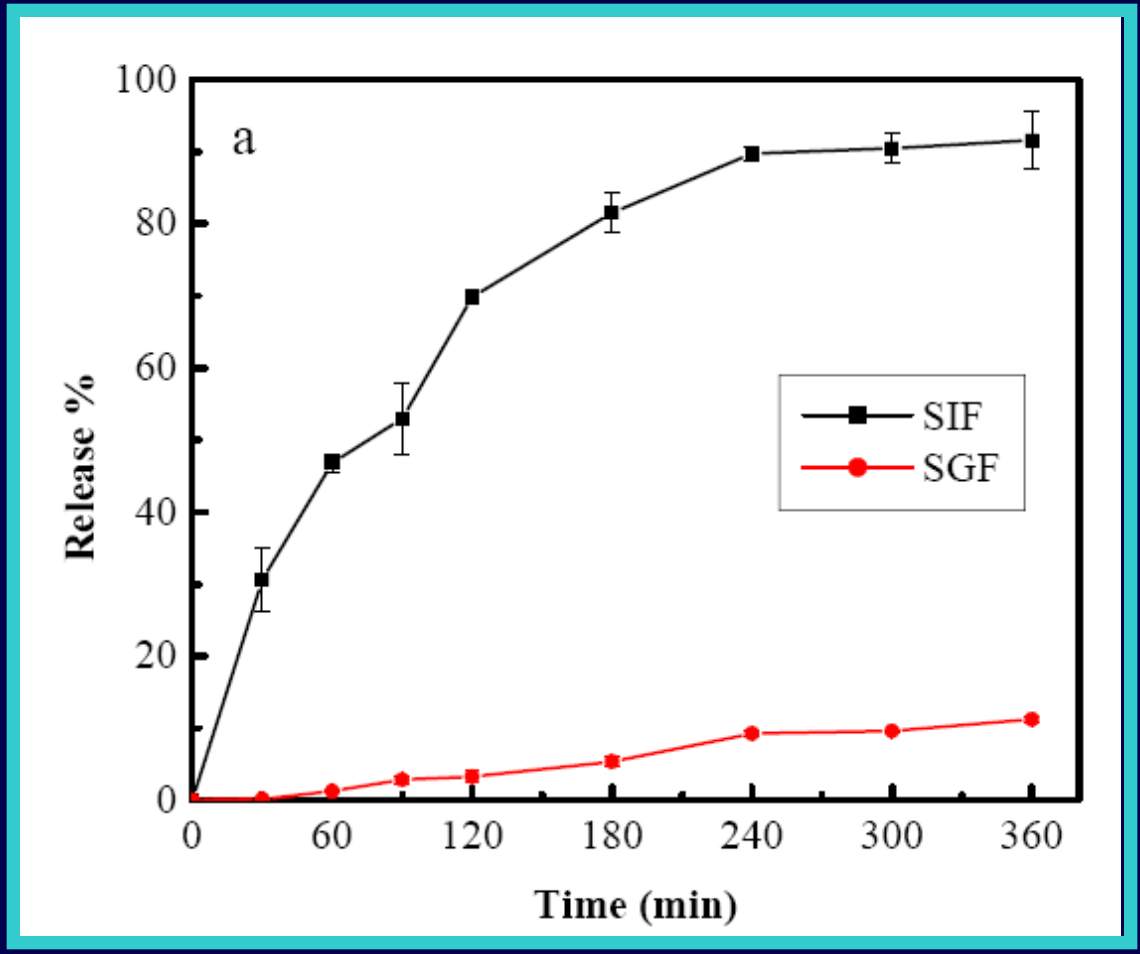
Beta-carotene



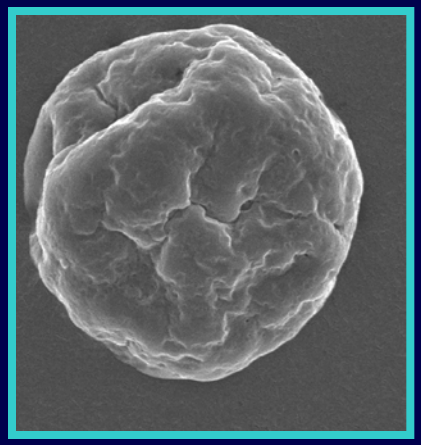
Alpha-tocopherol

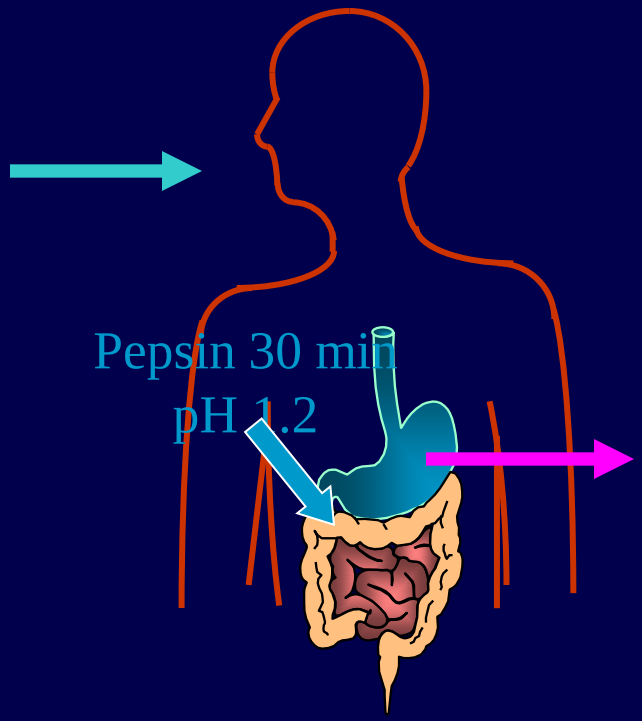


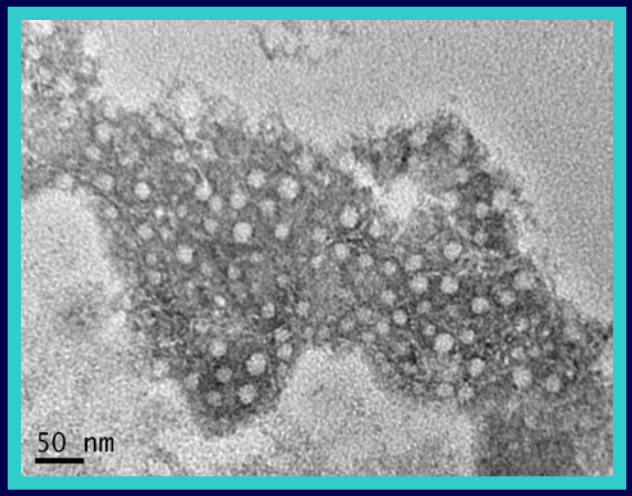
Release in the simulated GI tract

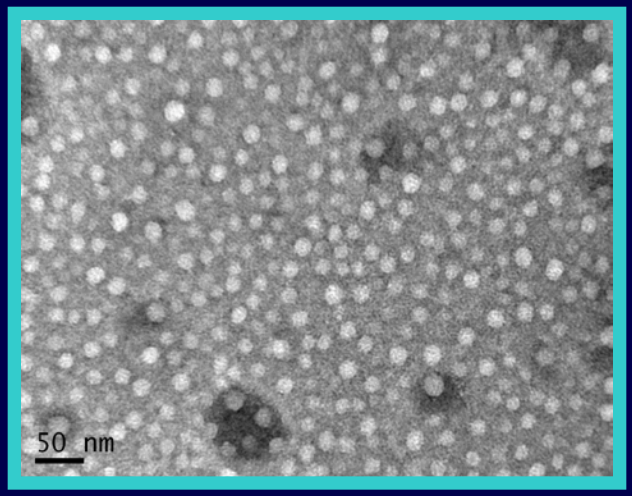


Particle degradation in the simulated GI tract

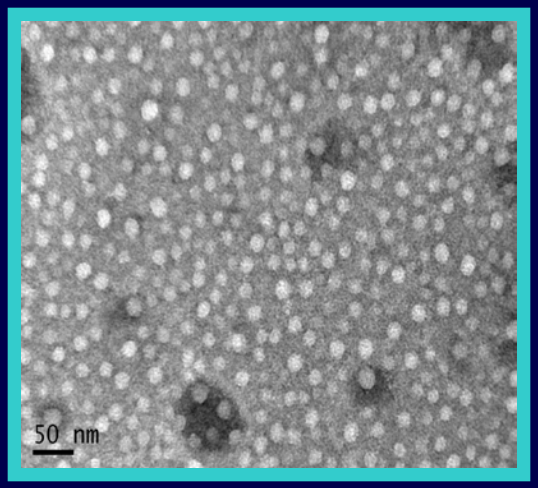




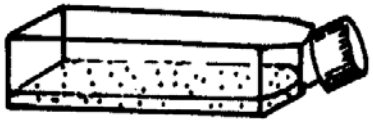


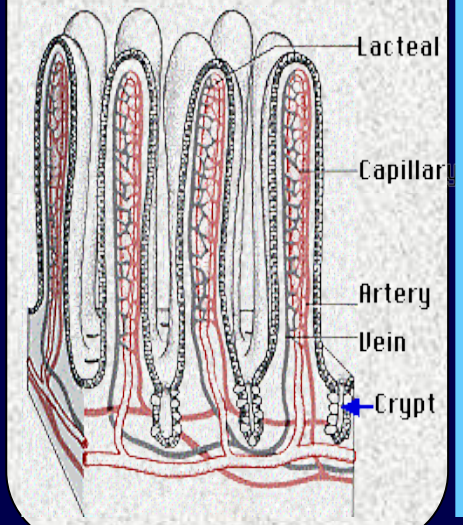


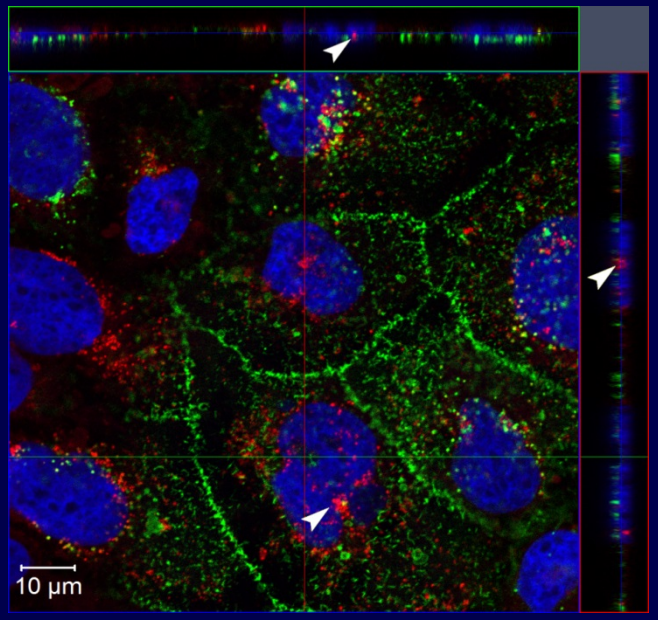
Cytoxicity and Uptake

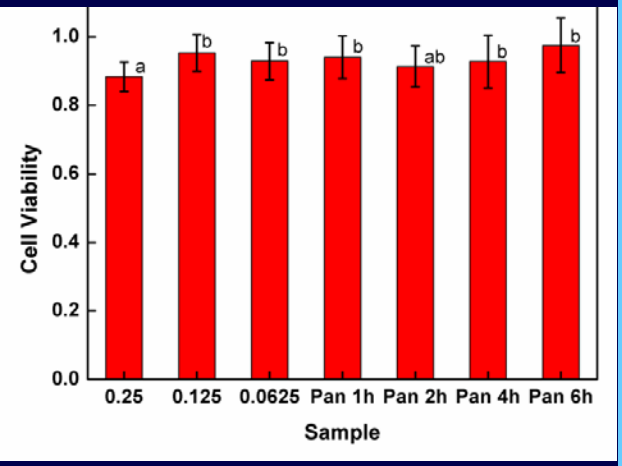


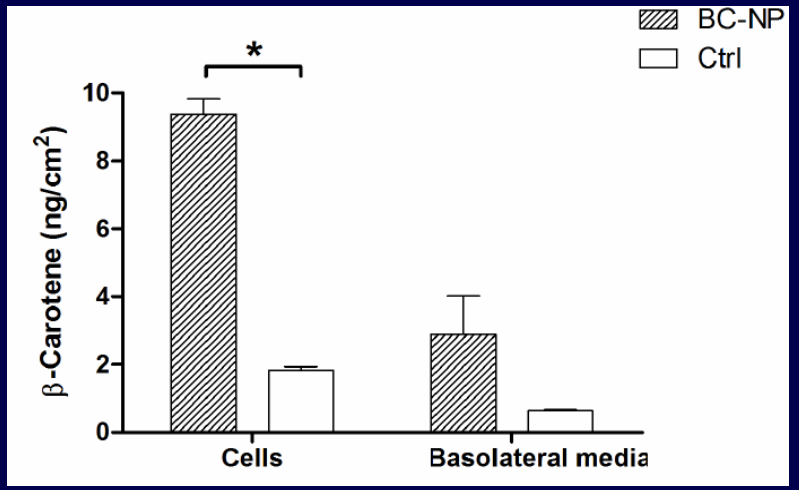
Caco-2 cells





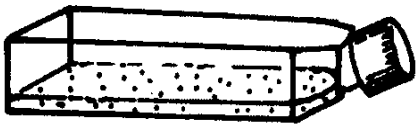


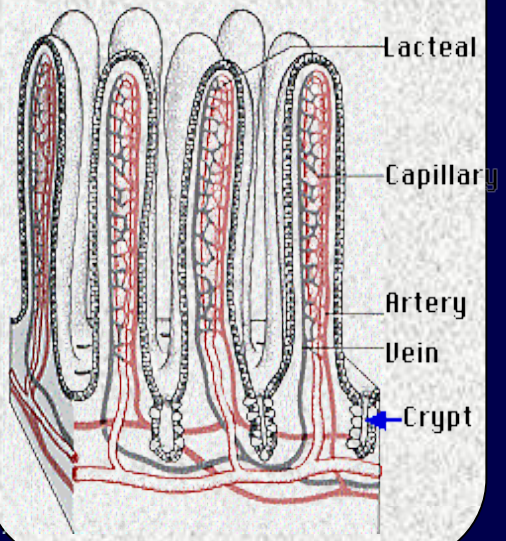


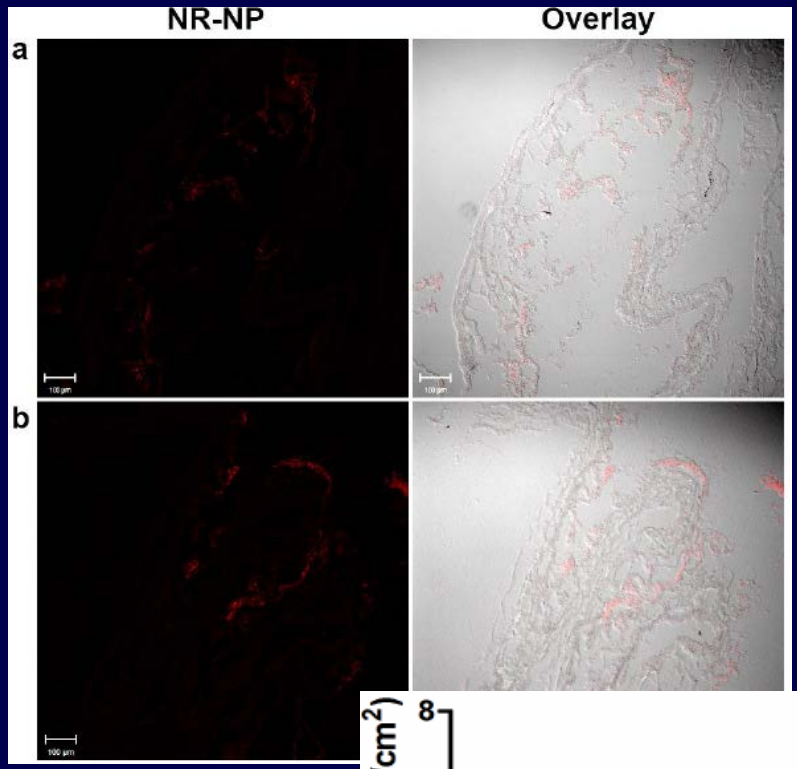


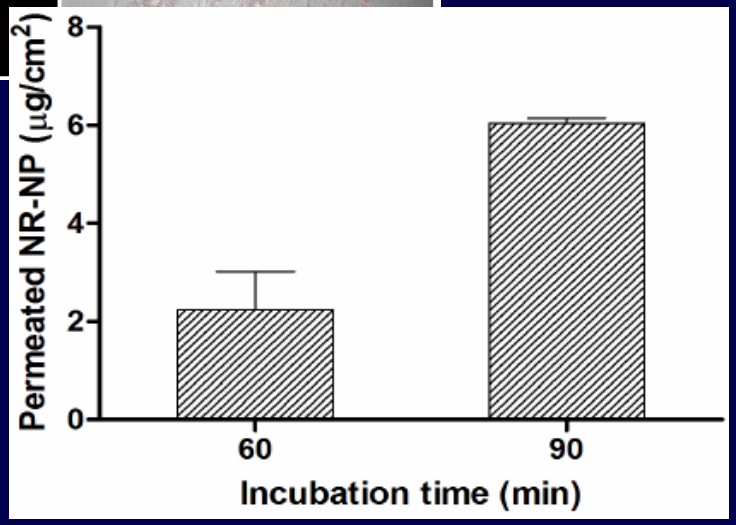
Transport

Caco-2 cells





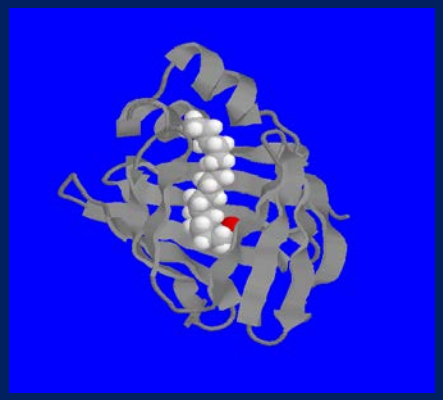


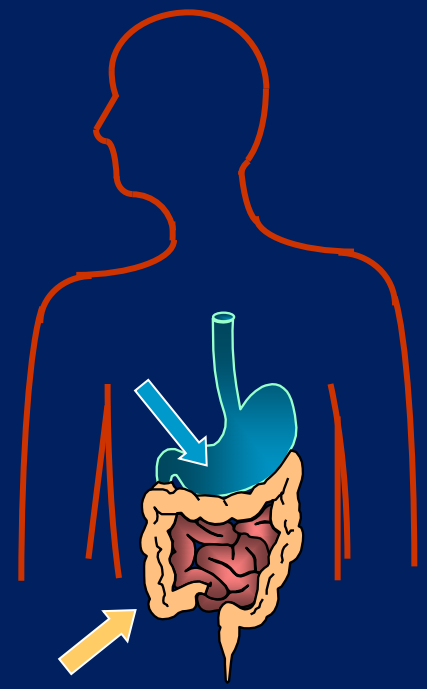


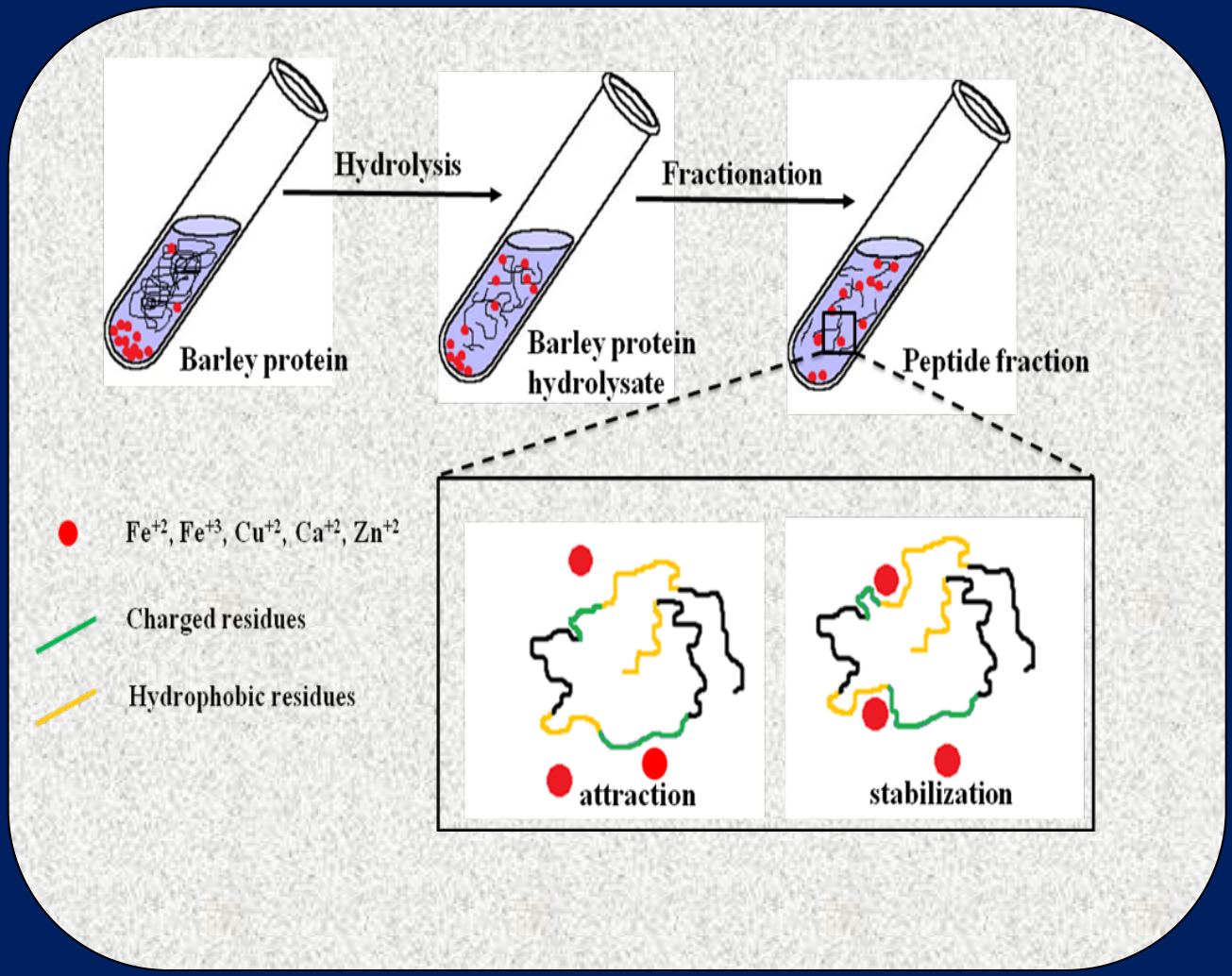
Advantages

- Capable of encapsulating various lipid soluble active compounds (vitamins, beta-carotene, coenzyme Q10.)
- Safe for food and other utilizations
- Effectively prolong shelf-life of active compounds
- Resist stomach harsh condition
- Completely degradable in small intestinal condition
- Abundant and cost-effective raw materials and processing feasible for scale up

Metal ion binding peptides







Improve nutritive metal ion solubility

Table 3- Solubility of metal ions expressed as µg/ml in the presence of hydrolysates and peptides at 1 mM concentration of each metal salt. Values in parentheses are solubility percentages calculated based on the dry weight of metal salt.

Solubility of metal ions	Fe^{+2}	Fe^{+3}	Ca^{+2}	Cu^{+2}	Zn^{+2}
without peptides	1.5 (0.8%)	1.9 (1.1%)	13 (9%)	5 (2%)	2.5 (1.3%)
with Fla-0.5h	141 (71%)	51 (31%)	46 (31%)	131 (53%)	70 (38%)
Fla-0.5h-membrane fraction 1-5 kDa	187 (93%)	101 (62%)	137 (93%)	152 (61%)	97 (53%)
Sub-fraction I (RP-HPLC fractionation of 1-5kDa fraction)	188 (95%)	87 (54%)	141 (96%)	133 (54%)	125 (68%)

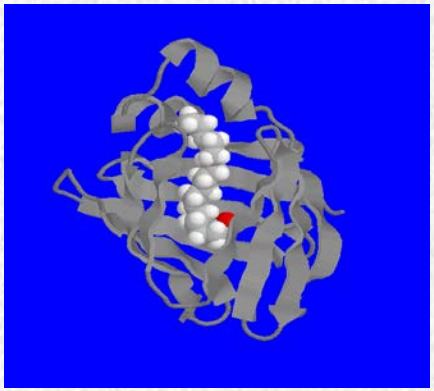
All data were expressed as mean values (mean ± SD, n = 3).

Improve nutritive metal ion solubility

Synergistic combination of both charged and hydrophobic residues

•Electrostatic interactions via charged side chains

•Hydrophobic interactions stabilize metal ions in the structure of the peptide.

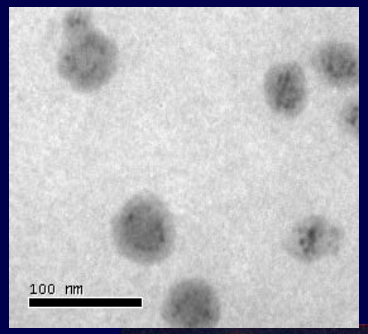


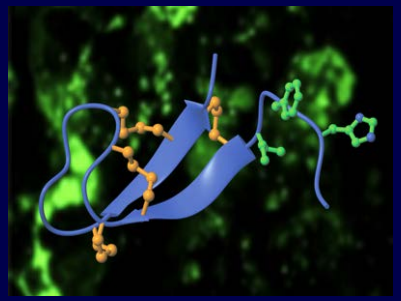
Antioxidant capacity

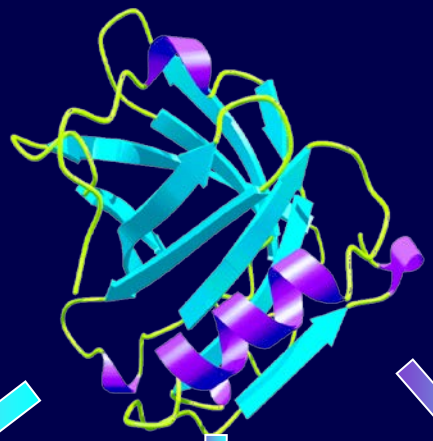
Antioxidant assay *	2 h-AH	Fraction I (> 10 kDa)	Fraction II (10-1 kDa)	Fraction III <1 kDa	Positive control
(A) Fractions separated by ultra-filtration					
DPPH Scavenging %	31.5 ± 0.6	61.9 ± 1.7	40.8 ± 1.0	18.3 ± 0.5	78.9 / 99.0 (BHT)
Reducing Power	0.18 ± 0.004	0.29 ± 0.009	0.065 ± 0.002	0.040 ± 0.004	0.25/0.39 (ascorbate)
$O_2^{\cdot-}$ Scavenging %	18.7 ± 0.9	24.4 ± 1.1	16.2 ± 0.9	25.5 ± 0.8	32.0/47.9 (BHT)
Fe^{2+} Chelating%	86.1 ± 0.8	70.1 ± 1.8	82.5 ± 1.8	85.3 ± 1.3	38.5/98.5 (EDTA)
$OH^{\cdot}$ Scavenging %	51.1 ± 0.2	60.2 ± 1.0	63.7 ± 0.8	69.1 ± 0.9	42.4/87.2 (BHT)
	Fraction 1	Fraction 2	Fraction 3	Fraction 4	
(B) Fractions separated by reverse-phase column					
$O_2^{\cdot-}$ Scavenging %	18.2 ± 0.9	25.6 ± 1.1	20.4 ± 0.7	21.3 ± 0.9	32.0/47.9 (BHT)
Fe^{2+} Chelating %	70.1 ± 1.2	82.5 ± 0.8	85.3 ± 1.0	93.0 ± 1.1	38.5/98.5 (EDTA)
$OH^{\cdot}$ Scavenging %	45.9 ± 0.7	64.1 ± 0.5	65.7 ± 0.3	70.4 ± 0.5	42.4/87.2 (BHT)

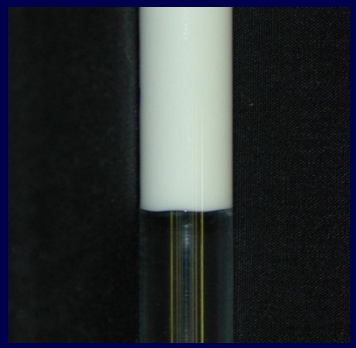
* The concentration of barley glutelin hydrolysate fractions was 1.0 mg/ml; the concentration of BHT, ascorbate acid and EDTA was 0.01 and 0.1 mg/ml.

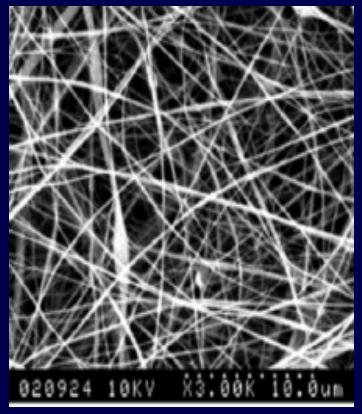
Plant protein value-added applications

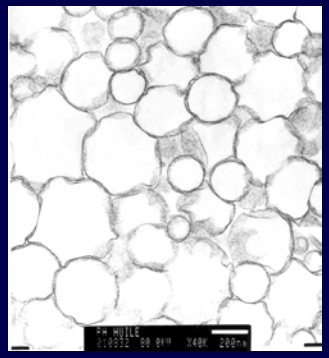












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