Fish proteins and peptide products. Processing methods, quality and functional properties

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-seminar-

Seafood and health (ingredients)
What is the full story for the consumer and industry?
25th March 2009, Copenhagen

Overview

- Products
- Processes
- Properties
- Problems
Very diverse pool of products from seafoods

- Organic acids
- Polyphenols
- Fatty acids
- Polysaccharides
- Monosaccharides
- Cartilage compounds
- Secondary metabolites
- Proteins
- Peptides
- Enzymes
- Trace elements

Products

- Fish by-products
- Pelagic fish
- Fish feed industry
- Animal feed industry
- Ready to eat
- Injection/tumbling
- Flavours
- Fish sauce
- Supplements
- Inner cosmetics
- Fermented bonito
- Sardine protein hydrolysate

Volume

Price

Health effects ???
The Food Chain

Raw material producers → Small companies → End user

Upgrade by-products
Environment and cost

Wet products
Dried proteins
Hydrolysates
Peptides

Producers
Consumers

Criteria for raw material

Fisheries
Aquaculture

Primary processing

Sustainability
Contaminants

Quality
Safety
Traceability

Functionality

Pelagic fish
Backbones
Skins
Washing water
Cooking juices
Saw dust
Viscera
Cut offs
### Resources in the Nordic countries

<table>
<thead>
<tr>
<th></th>
<th>Million tons</th>
<th>Traditional products</th>
<th>Surimi</th>
<th>Fish meal</th>
<th>Silage</th>
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<td>Trout</td>
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<tr>
<td>Codfish</td>
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<td></td>
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<tr>
<td>Saithe</td>
<td>0.4</td>
<td>X</td>
<td></td>
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<tr>
<td>Flatfish</td>
<td>0.1</td>
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<td>Crustaceans/Mollusks</td>
<td>0.24</td>
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<td></td>
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<tr>
<td>Herring</td>
<td>1.4</td>
<td>X</td>
<td></td>
<td>x</td>
<td></td>
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<tr>
<td>Mackerel</td>
<td>0.16</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>Blue Whiting</td>
<td>1.3</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>Capelin</td>
<td>0.7</td>
<td>X</td>
<td></td>
<td>x</td>
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<td>Sand eel</td>
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<td>Sprat</td>
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</table>

*Yearbook of Nordic Statistics 2005*

### Fish protein ingredients - two dimensions

- **Technologically functional ingredients**
  - Classical foods
    - Low interest in consumer communication re. ingredients
- **Biological/nutritional/functional ingredients**
  - Functional foods
    - High interest in consumer communication re. ingredients

*Adapted from: Werner Kofod Nielsen and Tage Affertsholt 3A Business Consulting*
**Fish protein isolates**

Used as a binding agent, to decrease volume shrinkage and to increase water content while maintaining protein content in the final cooked fish product.

The extract is added to fresh or frozen seafood of the same species by needle injection into fillets, static soaking, or vacuum tumbling.

Also used as an alternative surimi source with better functionality

The product has a GRAS (Generally Regarded as Safe) status in the United States. (GRAS Notice No. GRN 000147).

**Fish flavours**

There are several producers of fish flavours and extracts.

The products are either sold in liquid form as pastes, dried flakes or powders.

The market for seafood-based extracts and flavorings is significant and growing.

Markets for them are primarily in Europe and Asia but growing in N-America.
Fish gelatines

The annual production of gelatin is about 300 thousand tons. Fish gelatines account for only 1-2% of the production.

In Europe and United states gelatines are used in various food products and also sold as food supplements and to the cosmetic industry.

In Japan in both health foods and cosmetic markets there are a remarkable number of products based on collagen, from drinks to tablets ("beauty from within")

Fish protein hydrolysates/peptides

Significant efforts in the past 50 years to produce palatable and commercially viable products.

Characterized and consistent peptide products is the next major development in the protein industry.

We still need to overcome some major production and quality issues to be able to successfully compete with other high value protein sources.
Why produce specialty FPH products?

Tremendous value addition opportunity

Fish meal  SeaCure  Vita Springs

0.13 Kr/g protein  81.33 Kr/g protein  79.90 Kr/g protein

625 fold more!

Peptide products

Katsuobushi oligopeptide (Vasotensin®)  Sardine peptide SP100N  Seacure®
Nippon Supplements  Senmiekisu  Proper Nutrition

Nutripeptin  Peptides de Poisson
Nutrimarine Life Science  Grand Ocean

NUTRIPEPTIN™  PeptiStress  AntiStress

DjFusion  Forté Pharma
Reykjavík, 19/3/2009

**Processes**

**HOW?**

**Megatons** ➔ **Molecules**

**Fish meal for livestock and farmed fish**
- Heating
- Grinding
- Centrifugation
- Drying
- Milling

**Hydrolysed, fractionated, dried fish protein hydrolysate**
- Grinding
- Hydrolysis
- Filtration
- Drying
- Stamping

**Liquids/powders enriched in active compounds for functional foods and nutraceuticals**
- Gel filtration/size exclusion
- Ion exchange
- HIC/RPC
- Affinity chromatography
Processes: Enzymatic hydrolysis

- Mixing
  - With water to 8-12% protein concentration
  - Then pH and temperature adjusted to enzyme requirements

- Hydrolysis
  - Enzyme added, 0.5-2.0 of protein weight
  - Mixture of endo- and exopeptidases
  - Time and extent depend on product properties

- Termination
  - At fixed degree of hydrolysis
  - By heat
  - Or by pH 4.0 or lower

- Post-processing
  - Fractionating (filtration)
  - Drying
  - Concentrating

Characteristics of selected proteases and protein hydrolysates produced by these processes:

<table>
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<tr>
<th>Enzyme</th>
<th>Optimum pH</th>
<th>Optimum T°C</th>
<th>Max. DH%</th>
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<tr>
<td>Alcalase</td>
<td>8</td>
<td>50-60</td>
<td>15-25</td>
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<tr>
<td>Novo-Pro D</td>
<td>7-10</td>
<td>55-65</td>
<td>15-25</td>
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<tr>
<td>Neutrase</td>
<td>7</td>
<td>40-50</td>
<td>10-15</td>
</tr>
<tr>
<td>Protamex</td>
<td>7-8</td>
<td>50</td>
<td>10-20</td>
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<tr>
<td>Flavourzyme</td>
<td>5.5-7.5</td>
<td>50-55</td>
<td>Ca. 60</td>
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<tr>
<td>Cryotin</td>
<td>8-10</td>
<td>30-40</td>
<td>25</td>
</tr>
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</table>
Processes

Protein processing technologies
- Demineralization
- Chromatography
- General liquid processing
- Centrifugal separation
- Membrane filtration
- Reverse osmosis
- Nanofiltration
- Electrodialysis
- Ultrafiltration
- Nanofiltration
- Ion exchange
- Freeze drying
- Fluid bed drying
- Spray drying
- Homogenization
- Separation
- Clarification
- Decanter
- Heating/cooling
- Freeze drying
- Evaporation
- Plate
- Stirred tank
- Freeze drying
- Falling film
- Shaved surface
- Pre-treatment
- Microfiltration
- Ash removal
- Powder
- Protein processing

Functional properties
- Gelation
- Water holding
- Solubility
- Emulsification
- Foaming
Bioactive Properties

Antioxidative  Anti-inflammatory
Anti-hypertensive  Satiety
Anti-carcinogenic  Diabetes

Bioactive classical foods

Apertizers with low GI: Nutripeptin
Bread with Phoscalim
Cakes and orange juice with Collagen HM
Chocolate with Protizen: relaxing properties

From Copalis
Protein problems

Reykjavík, 19/3/2009


Main problem

Lipid oxidation

Consumer acceptance threshold

Reykjavík, 19/3/2009
Main problem

Lipid oxidation

Lipid hydroperoxide (mmol/kg)

- Untreated
- Untreated dried
- pH shift treatment
- pH shift dried