



Purity | Quality | Innovation

The Omega3 industry Process- and technology development

International Marine Ingredients Conference (MIC), Oslo 22-24 September 2013

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Content

1. The omega3 business

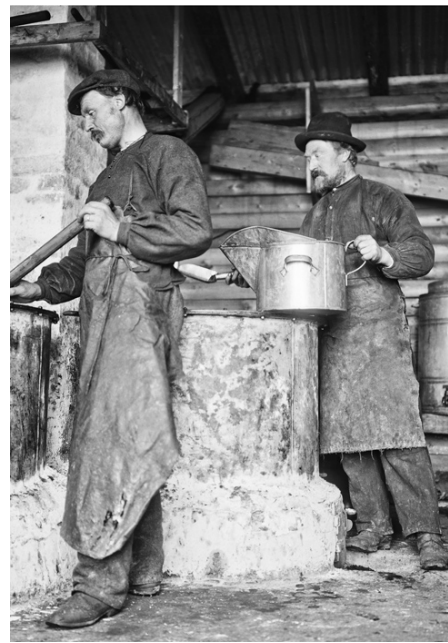
- Key for success, product segments, supply of fish oils, value chain

2. Process and Technology development

- Various starting materials
- **Purification of oils**
- **Concentrating technologies**

The Omega3 industry

- A young industry based on long traditions
 - From cod liver oils: 1800s
 - Fish body oils: 1980s
 - Rapid growth - Higher concentrates!
 - Modern process industry
 - Nutraceuticals
 - Pharmaceuticals
 - Functional food



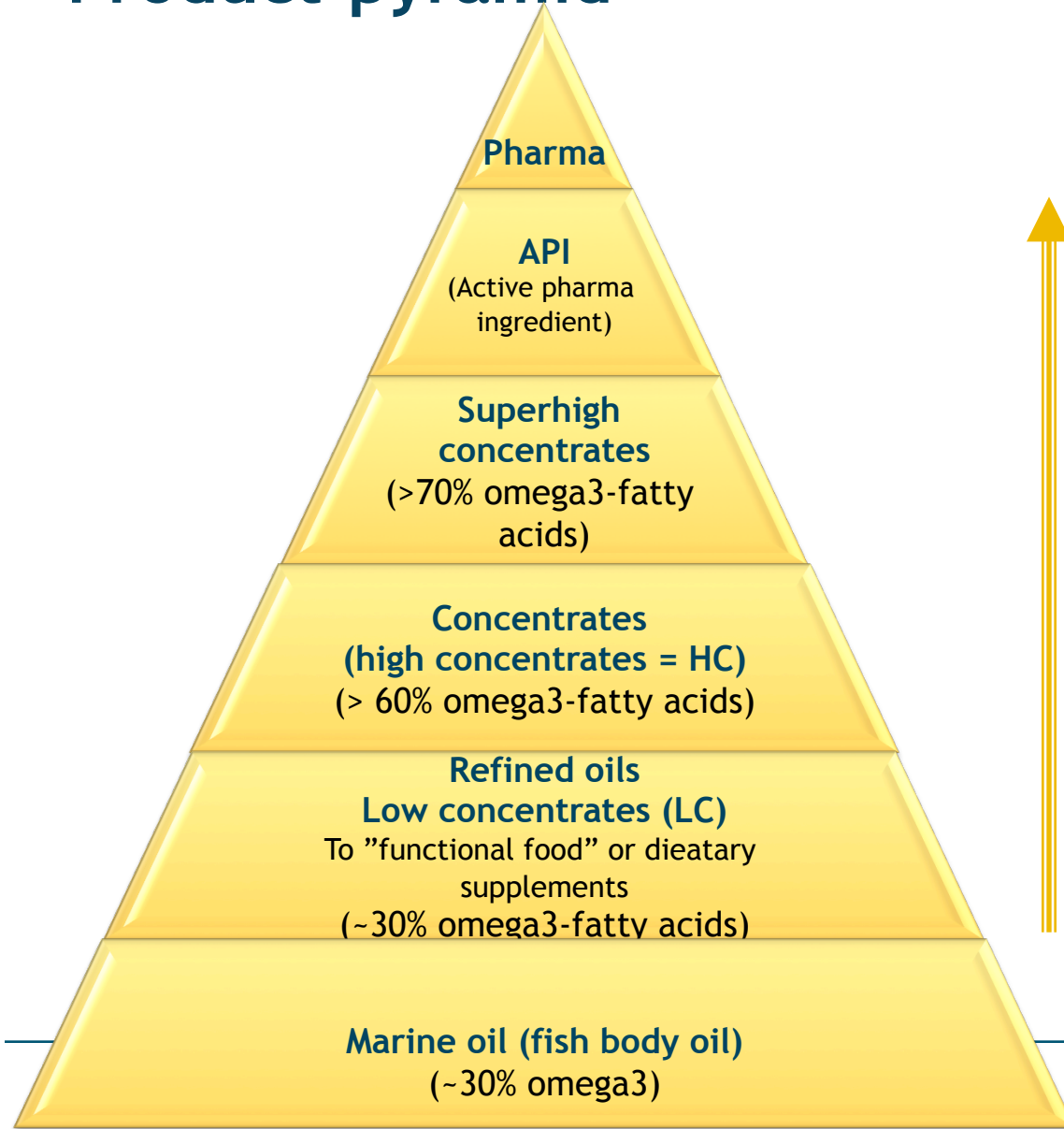
- Most development has not taken place yet!
- Exiting future!

The Omega3 business

- Key for success
 - Health!
 - 20.000 scientific papers and 2.000 klinical studies document the favourable health effects by intake of omega3



Product-pyramid



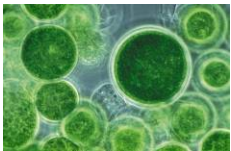
Increasing
requirement to:

- Equipment
- Processes
- Control- and
quality systems

Fish oil

Food chain for EPA/DHA

- Primary producers of EPA and DHA
 - Marine microalgae
 - Micro algae utilise sunlight to convert carbon dioxide and water to fat and other essential nutrients
 - EPA and DHA are formed in this process
- The food chain
 - EPA and DHA accumulates in the food chain
 - Microalgae - zooplankton - crustaceans (krill) - small fish - large fish



Fish oil

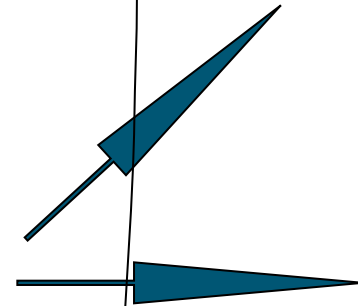
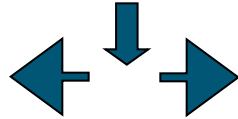
Catch and processing

Meal and oil factory in Chimbote, Peru



Anchovies are caught off the coast and brought to land for processing to meal and oil

Epax value chain



Process and technology development



Purity - Quality - Innovation

- Sustainable marine resources
- Environmental friendly processing
- GMP (Good Manufacturing Practice)

Process and technology development

- Young advanced processing industry
- Busy on development !
 - Utilize more types of marine oils
 - Develop processes for purification and concentration
 - choose the right ones!
 - Find best **combination** of techniques
 - Find best **order** of unit operations
 - From batch to continuous processing



Starting material - crude oils

- Various starting material - crude marine oil (Food grade!!)
 - Anchovy/sardine oils (EPA+DHA ~30%)
 - Other oils: Tuna, Krill, Squid, Cod liver, Menhaden, Salmon, Herring, Mackerel, Micro algae ++

- Variation between fish species
- Variation during seasons and from year to year

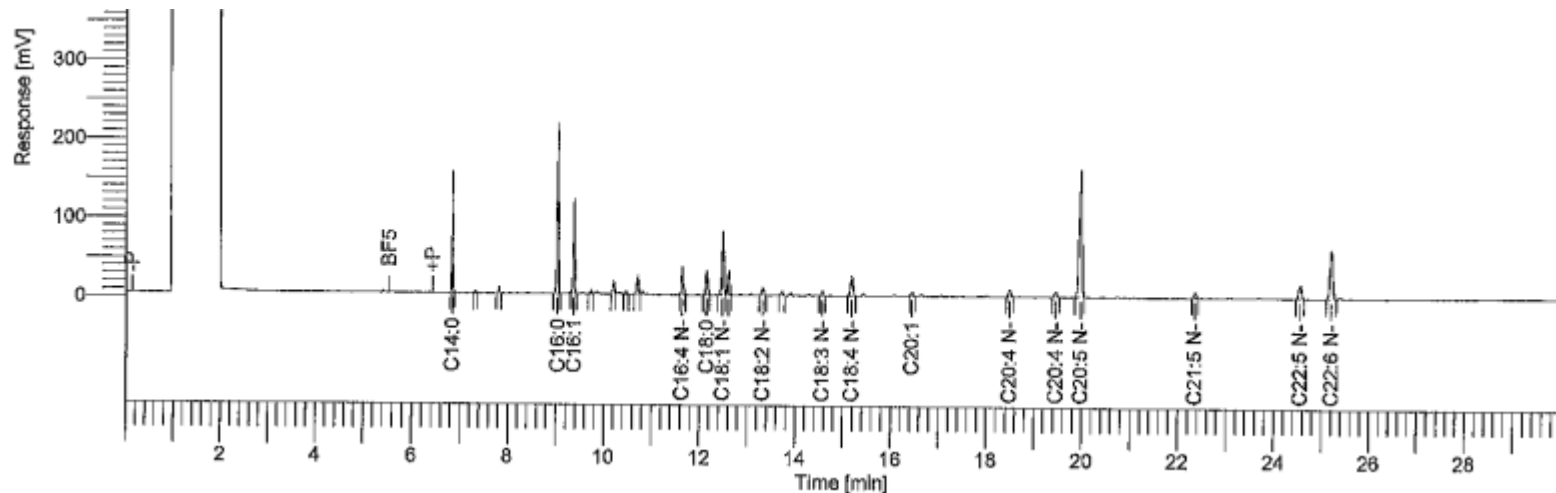
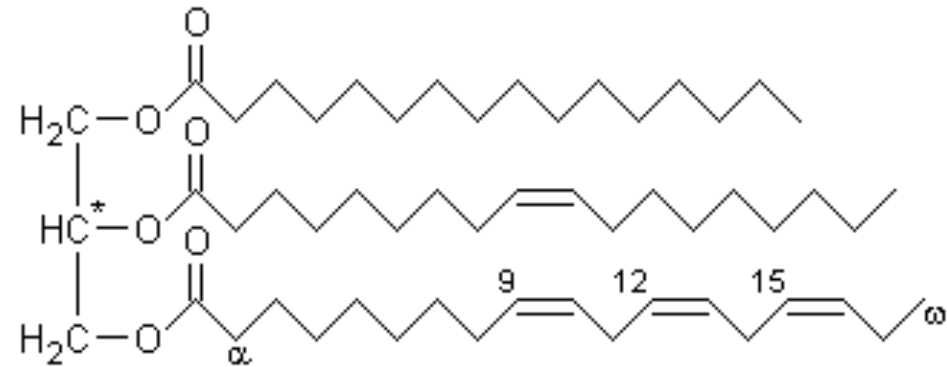
Species	EPA (%)	DHA (%)	EPA+DHA (%)	Tot Omega3
Anchovy	18	12	30	36
Tuna	6	24	30	36
Sardine	16	9	25	31
Pollock	12	6	18	21
Herring	7	10	17	20
Mackerel	7	14	21	30

Numbers in table are example of values

Complexity in fatty acid composition

- Complex fatty acid composition
- High variety in amount and composition - seasonal
- Needs robust and selective processing tools

- More than 30 fatty acids in fish oils
- Distributed «randomly» in Triglycerides



Process operations

The processing has two main goals:

1. Purify the fish oil
2. Concentrate Omega3 (especially EPA and DHA)

1. Purification:

- Removes:
 - Environmental pollutants, heavy metals, proteins, phospholipids, free fatty acids, cholesterol, saturated fatty acids (stearins), color pigments, oxidation products, smell and aroma compounds

2. Concentrating:

- Increase amount of EPA+DHA from 30% to target (60-90%)



Purification of fish oil

- Refining processes and technology

Remove unwanted substances from crude oil

- **De-acidification** - remove free fatty acids
- **Distillation** - remove environmental pollutants
- **Active carbon treatment** - remove PAHs, furans, dioxin
- **Winterization** - remove stearins
- **Bleaching** - remove peroxides, trace metals, dioxins, furans, PAHs
- **Steam deodorization** - remove smell/taste, color

Purification of fish oil

- Refining processes and technology

- Order of unit operations
- Avoiding oxidation

- New technologies
 - Enzymatic processing
 - More effective absorbents
 - More effective filtration

Key factors:

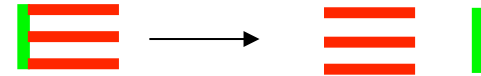
- Purity («no» traces left of impurities, «no» oxidation)
- Recovery of EPA and DHA (yield)
- Capacity
- Eco friendly

Concentrating omega3 fatty acids

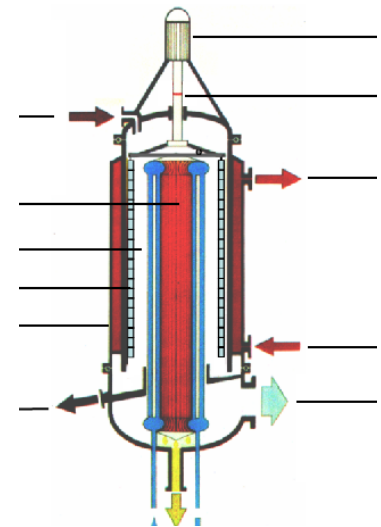
Main goal: Concentrate targeted fatty acids (EPA and DHA)

Pre-treatment:

- Converting from triglycerides to ethyl esters



1. Molecular distillation (short path distillation)
2. Urea precipitation
3. Chromatography
 - SMB (Simulating Moving Beds)
4. Supercritical fluid extraction/fractionation
5. Enzymatic processing



Combination of concentrating techniques

1. Selectivity based on **molecular size** (chain length)
 - Distillation
2. Selectivity based on **number of double bonds** and **molecule conformation**
 - Urea precipitation
 - Chromatography
 - Enzymatic processes

Combination of techniques in use:

- Molecular distillation + urea precipitation
- Molecular distillation + chromatography (SMB)
- Molecular distillation + selective enzyme process

Crude oil:	~ 30% EPA + DHA
After distillation:	~ 60% EPA + DHA
After distillation + extra technique:	~ 70-90% EPA + DHA

Process and technology development

Approx 8-10 unit process operations needed for omega3 concentrates

- Process development and new technologies are wanted!

- **More use of White biotechnology**

- Enzymes instead of chemicals

- **Secure high EPA and DHA recovery**

- Smart use of byproducts

- **GMP (Good Manufacturing Practice)**

- Prepare for a high standard

Summary



A young processing industry!

- *Most development has not been done yet!!*
- Be able to **utilize marine oils** with variable fatty acid content and composition
- Secure **high purity** by smart combining and development of refining processes
- Secure **high productivity** and **recovery** of **EPA** and **DHA** by smart combining of advanced concentrating technologies



Looking ahead with Epax

A Leader in Omega-3 Concentrates

