

Phospholipids in nutritional products

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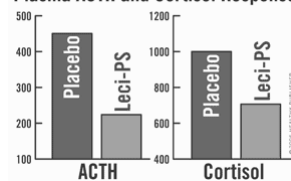
Targets, research, products, brands

Brain

Heart health

Liver health

Plasma ACTH and Cortisol Response



Sources of nutritional phospholipids

- Plant oil lecithin (soy, sunflower, canola)
- Egg yolk lecithin
- Milk fat polar lipids
- Bovine brain
- Marine PLs
- Modified PLs



Use of lecithin (Gunstone 2001)

	1000 tonnes	%
Animal feed	50	29
Chocolate	35	21
Baking	25	15
Margarine	19	11
Convenience foods	11	6
Dietary	8	5
Pharma/cosmetic	7	4
Technical appl.	15	9
TOTAL	170	

Lecithin use in animal feeds

- Young animals with high growth rates: weaning pigs, young poultry, fish
- Lecithin improves digestion of fat and feed conversion rates
- Important for supply of choline, inositol and essential fatty acids
- Animal feed is the sink for lecithin that cannot be sold for higher prices



Use of lecithin (Gunstone 2001)

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Chocolate	35	21	} 53%
Baking	25	15	
Margarine	19	11	
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Lecithin use in foods



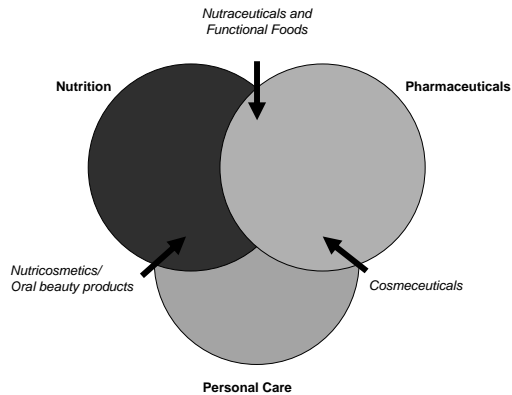
- Predominant use as emulsifiers, wetting and dispersing agents (0.3 to 1.0%)
- PL based functional foods?
 - amounts needed - texture, viscosity problems
 - sensitivity to hydrolysis
- Liposomal drinks; enhanced bioavailability of lipophilic nutrients
- Souvenaid™ (Danone) – brain drink for patients with early Alzheimers (choline, EPA + DHA, phospholipids, B-vitamins, antioxidants, UMP)

Google for 'phospholipid' 'functional food'



"Bird's nest is proven scientifically and clinically contains high nutritious value to human body since Ancient times. The study of the characteristic of Bird's nest to human health has never ceased"

Dietary use of PLs



Oilseed lecithin



- By-product of soybean oil degumming
180 million tonnes of oil (2001)
-> 0.1% refined lecithin (2001)
- Genetically modified soy crops
-> sunflower and canola
- Phospholipids – PC, PE, PI, PA
- Lecithin derivatives – PC, PS, GPC, PA



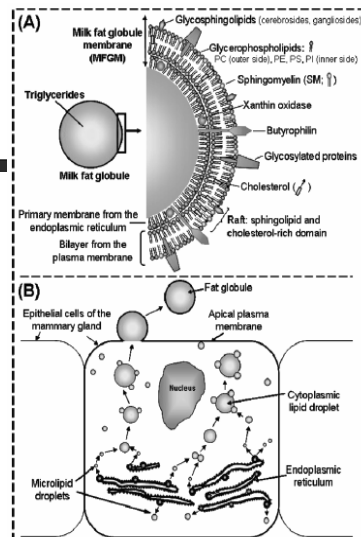
PL nutritional products and their uses

- Lecithin and its derivatives

Lecithin	Cholesterol reduction, hepatoprotection (HP), cognitive function (CF)	Low cost supplement formulas
PC	HP, CF, source of choline (SC)	Bulk ingredient
PS	CF	6-fold price advantage vs. PC
GPC	CF, SC	
PA	Enhance CF of PS	
NOPE	Stay on calorie restriction diet	

Milk fat polar lipids

- 0.25% of total lipid; PC, PE, SM
- buttermilk and other dairy by-product streams
- technological challenges to separate and enrich



Lopez et al. (2008)

PL nutritional products and their uses - MFGM lipids for infant formulas

	Soy PL	Egg yolk PL	Bovine milk PL	Human milk PL
PC	34	75	28	28-33
PE	21	15	22	25
PI	18	-	8	6
PS	0.5	0.4	12	4-8
SM	-	1.5	27	29-37
Other	17.5	8.5	-	-

Source: Arlafoods

Food ingredients based on MFGM



Phospholipid Concentrate 700, Ganglioside 500

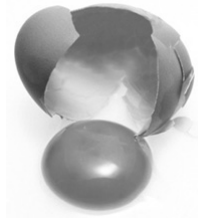


Lacprodan MFGM 10, Lacprodan PL-20



SM2 and SM3 powders

Egg yolk phospholipids



- 30% lipid of wet weight
- 10% PL; PC, PE, PS, SL
- Naturally enriched in DHA and AA
- Fatty acid content can be modified by the diet fed to chicken
- Uses for egg oil?

PL nutritional products and their uses - Egg lecithin for infant formulas

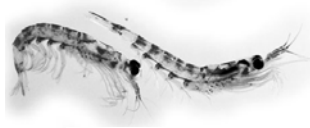
250 ml of breast milk = 10 g of egg lecithin product

- arachidonic acid 30 mg
- DHA 30 mg
- Choline 35 mg
- Cholesterol 45 mg



Marine phospholipids

- Extracted from Antarctic krill, fish heads and other fish by-products, fish roe
- Krill (*E. superba*) is "world's largest single specie biomass"; current catch is <0.1% of the biomass; mostly for fish feed
- *E. superba* stores energy as PL; lipid content 2 – 8%, 30 – 60% PL



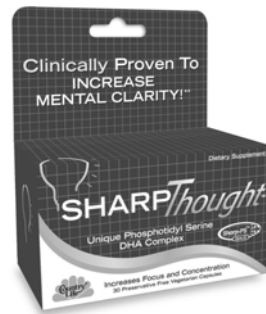
Marine phospholipids

- Sales of super premium priced krill oil (est. 170 US\$/kg) have created an opportunity for other, competitively priced MPL products
- Fish by-products and fish meal are rich in PLs – extraction technologies are being developed



Modified phospholipids

- Membrane PLs contain high levels of DHA; PS traditionally sourced from bovine brain
- PS derived from soy does not contain DHA
- PS-DHA conjugates available as brain nutrients



PL nutritional products and their uses - Marine phospholipids

"Super omega-3"

- Superior bioavailability
- Stability and high antioxidant activity (ORAC)
- Low levels of environmental pollutants
- Stunning effects in clinical studies
- Promising nutritional product in its infancy

Regulatory status of PL nutritional products

- Need for regulation of nutraceuticals
– safety and health claims
- Lecithin – non-novel in EU, GRAS in US
- PS – FDA qualified health claim
- Choline – FDA nutrient content claim
- Egg yolk PL product as a novel food
- Health claims in EU?



Claims and disclaimers:

"Consumption of phosphatidylserine may reduce the risk of dementia in the elderly".

Very limited and preliminary scientific research suggests that phosphatidylserine may reduce the risk of dementia in the elderly.

"Consumption of phosphatidylserine may reduce the risk of cognitive dysfunction in the elderly.

Very limited and preliminary scientific research suggests that phosphatidylserine may reduce the risk of cognitive dysfunction in the elderly.

FDA concludes that there is little scientific evidence supporting these claims."

How to communicate the difference – fish oil vs. krill oil



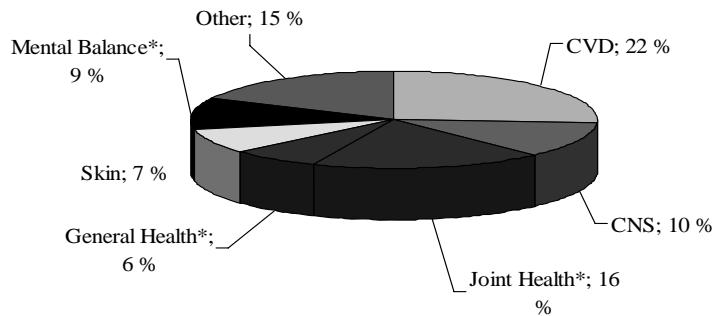
Omega-3 market



The global dietary and nutritional supplements market has an estimated retail value of billion USD 53 – 74; growth 4-6%

Marine omega-3 - million USD 500 - 760; growth 24% in Europe

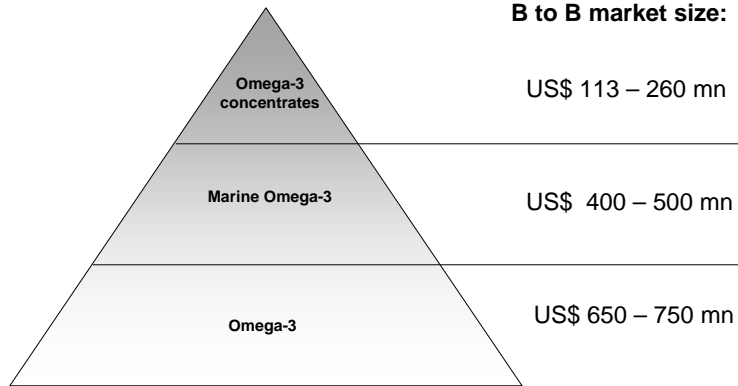
Marine omega-3 for specific health conditions



High consumer awareness for omega-3

Familiarity	EU	US
Heard of Omega-3	92 %	88 %
Heard of n-3 in food	84 %	70 %
Heard of n-3 in DS	83 %	86 %
Aware of advertising of food with n-3	69 %	41 %
Aware of advertising of DS with n-3	37 %	32 %

The consumers may not be able to distinguish between omega-3 sources



Evolution of marine omega-3 products



Krill oil advantage



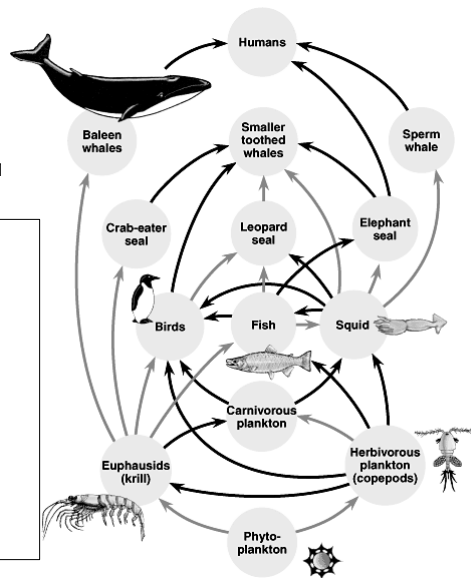
Single specie source of oil,
defined origin

Krill harvested in the pristine
waters of Antarctic

Production chain controlled by
one operator

Krill in the antarctic food chain

- Low levels of pollutants
- Ecological responsibility,
management of natural
resources
- Quotas, control, research



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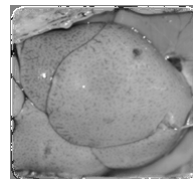
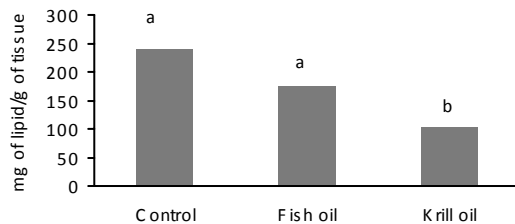
Unique krill lipids, Superba™



Krill oil	g/100 g lipid
PL	45
TAG	25
EPA	12
DHA	7
% n-3 in PL	70
Astaxanthin	110 ppm

Krill oil vs. fish oil on fatty liver

Study in obese Zucker rats, 4 wk treatment, Superba™

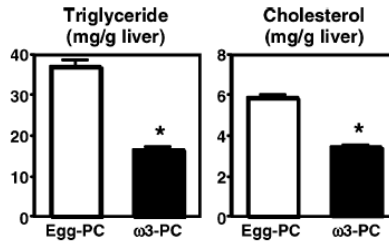


Stronger krill oil effect at equal level of dietary omega-3

-> carrier molecule of omega-3 is important

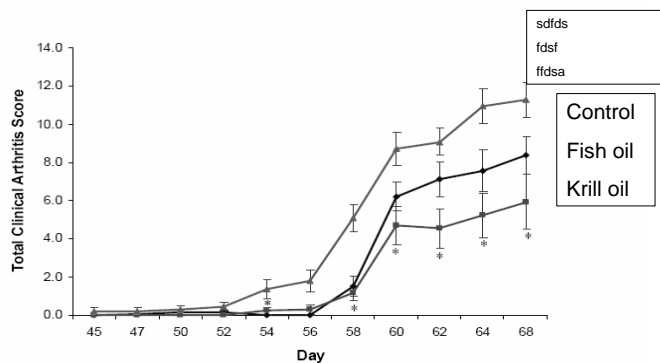
Salmon roe PC vs. egg PC on fatty liver

Study in obese OLETF rats, 4 wk dietary treatment
(Shirouchi et al. 2007)



Stronger salmon roe effect at equal level of dietary PC
-> fatty acid profile of PC is important

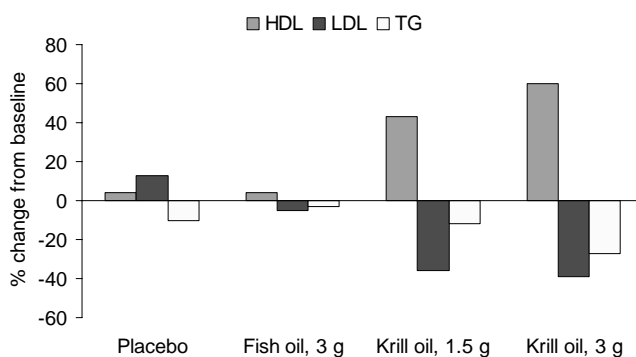
Krill oil vs. fish oil on collagen induced arthritis; Study in mice, 10 wk treatment, Superba™



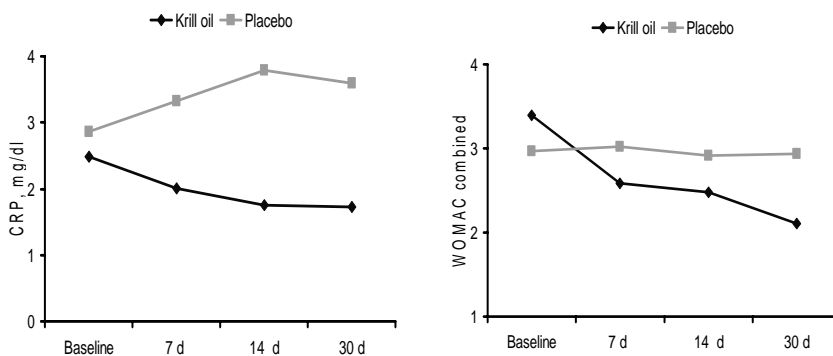
Krill oil vs. fish oil on collagen induced arthritis; Study in mice, 10 wk dietary treatment, Superba™

	Severe	Moderate	Minor	None
Control	71	29	-	-
Fish oil	50	43	7	-
Krill oil	31	15	39	23

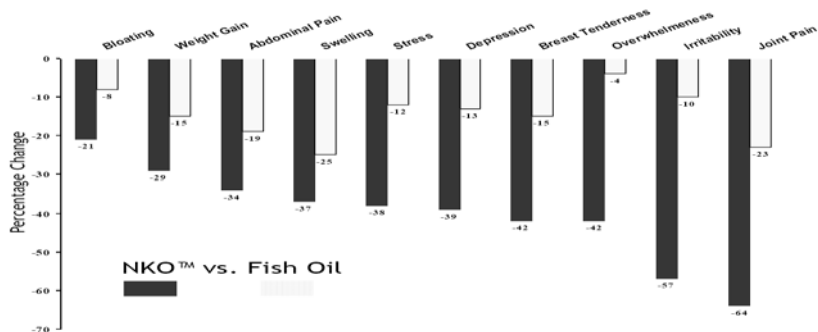
Krill oil vs. fish oil in dyslipidemic patients; Bunea et al. (2004); NKO™



Krill oil in CVD and arthritis patients; Deutch (2007); 300 mg/d NKO™



Krill oil vs. fish oil on PMS symptoms; Sampalis et al. (2003); NKO™



Krill oil vs. fish oil summary

- Krill oil is a unique source of omega-3
- Krill oil effects may be attributable to the omega-3 PLs
- Animal studies provide useful leads to possible mechanisms
- Better controlled clinical studies are needed

Phospholipids in nutritional products

- Growth in the dietary supplement market is slowing down; functional food market?
- Technological innovations for food applications?
- Omega-3 phospholipids – from niche to mass market?