The evolution of Milk Protein Technology

October 31st 2012

Cal Flynn

KERRY

Where It All Comes Together

Agenda

- Overview of Kerry
- Composition of Bovine Skim milk
- Milk Protein Applications
- Current Technologies Used To Extract Protein From Milk
- Milk Proteins With Complimentary Benefits
- Milk Protein Hydrolysates
- Food Health Ireland
- Potential Health Benefits
- Support Technologies Required and Challenges
- Q&A

Kerry – A Global Overview

Quoted on the London & Dublin Stock Exchanges

Corporate Headquarters

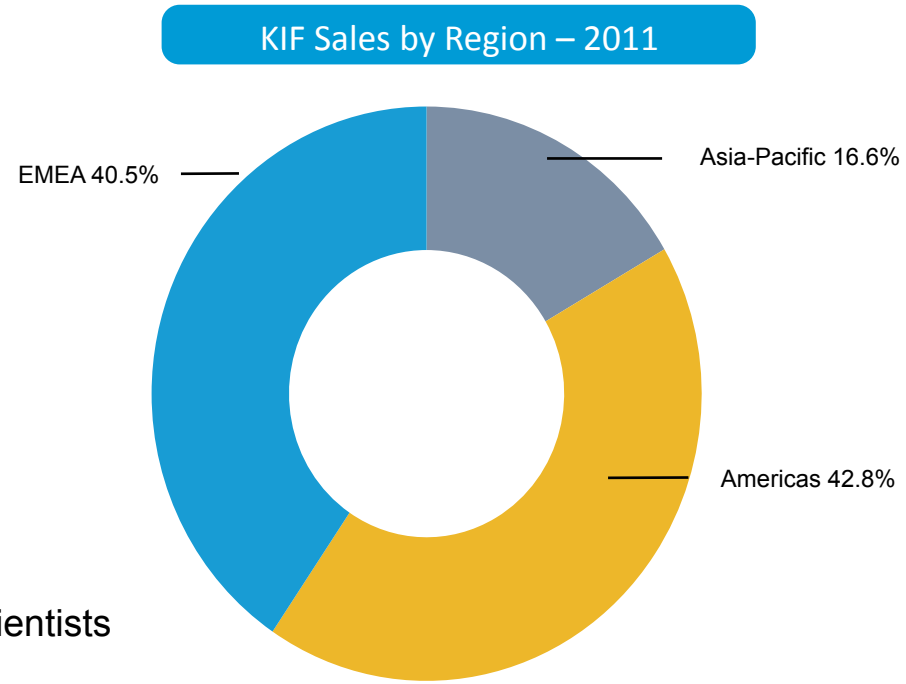
- Tralee, Ireland

2011 Revenues*

- Kerry Global €5.3 billion
- Ingredients & Flavours Global € 3.7 billion

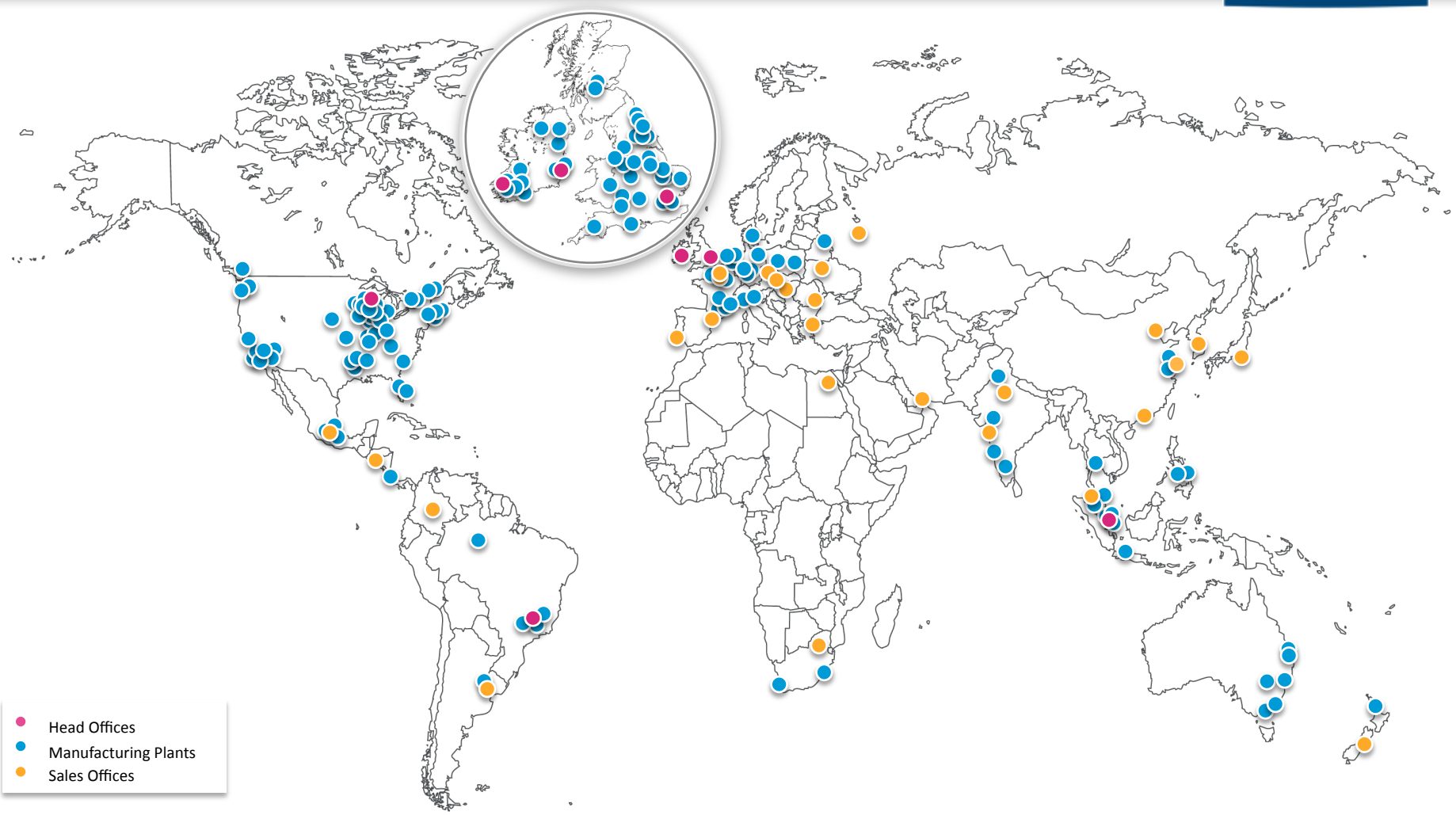
Global Reach

- 24,000+ employees
- 15,000+ products
- 150+ manufacturing facilities
- Operations in 25 countries
- 700+ food scientists concentrated around our global Customer Centres of Excellence
  - Product Developers
  - Culinary Chefs, Mixologists and Application Scientists
  - Sensory Scientists
  - Processing & Packaging Engineers
  - Analytical Chemists
- Supplying customers in 140 countries



*based on 3rd party revenue

Kerry Group Worldwide

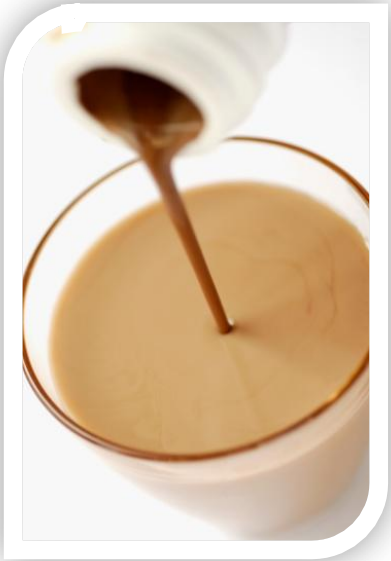


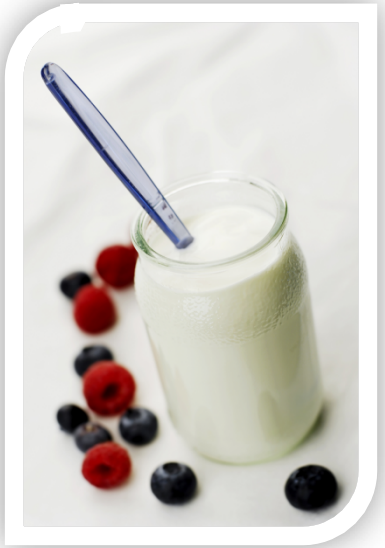
150 Manufacturing Facilities in **19** Countries

Kerry Ingredients & Flavours

- Kerry develops, manufactures and delivers innovative taste systems, functional and nutritional ingredients and integrated solutions for the Food, Beverage and Pharmaceutical markets.

- Customers derive maximum synergies through utilising Kerry's broad and deep range of food technologies, application capabilities and processing expertise.





Nutritional and Functional Ingredients Application Focus

Dairy Proteins

PORTFOLIO

- Milk Protein Isolates
- Functional Milk Proteins
- Protein Fractions
- Milk Protein Concentrates

Ultranor™

Specialised Functional Proteins

PORTFOLIO

- Functional Hydrolysed Dairy Protein
- Functional Hydrolysed Vegetable Protein

Hyfoama™ Versawhip™
Hygel™

Protein Hydrolysates

PORTFOLIO

- Hydrolysed Dairy Protein
- Hydrolysed Vegetable Protein

Hyprol™

Enzymes

PORTFOLIO

- Amylase
- Lactase
- Protease
- Glucanase
- Xylanase
- Invertase
- Cellulase
- Alpha-Gal

Fermented Ingredients

PORTFOLIO
Live Cultures
Fermentates – Shelf Life Extension
Fermentates – Texture & Flavour

Saga™

Probiotics, Prebiotics & Metabolites

PORTFOLIO
Emulgold™ - Prebiotic Fibre
Durafresh™
Upgrade™
Hybake™
Accel™
Metabolites

Soy Proteins

PORTFOLIO
Soy Protein Isolate
Soy Protein Concentrate

Nutriant™

The Evolution Of Milk Protein Technology

Nutritional and Functional Ingredients Application Focus

Infant Nutrition

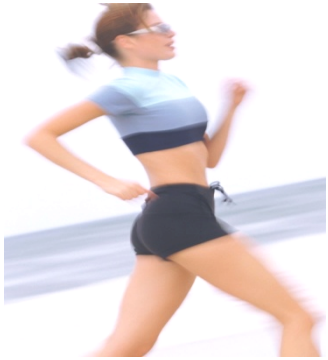
Starter Formula
Follow-on Formula

Growing up Milk

Clinical Nutrition

Enteral Feeds (Sip / Tube)
Modified Texture

Mainstream Beverages



Sports & Lifestyle

Nutritional Beverages

Nutritional Bars

Fermented Dairy

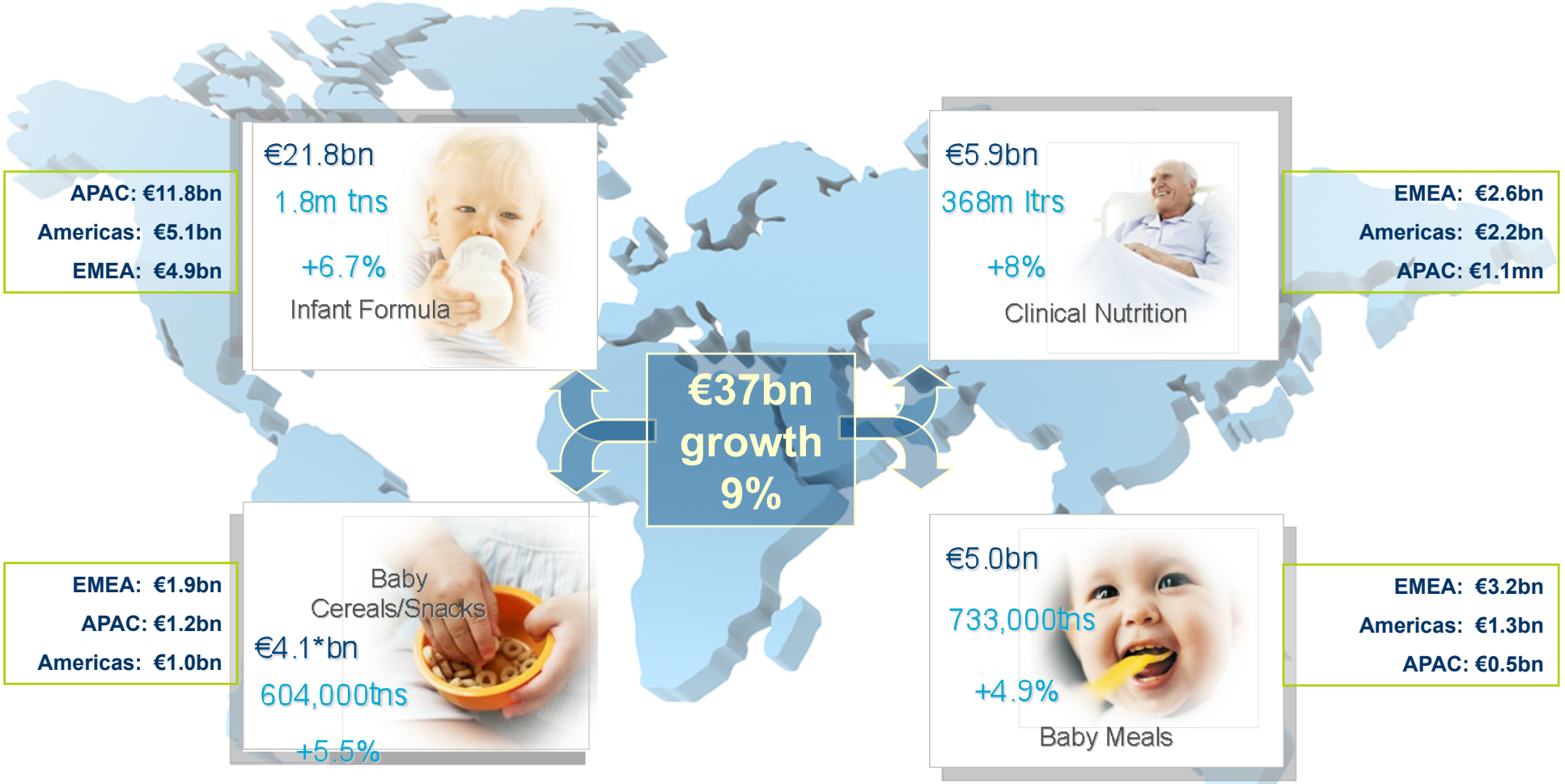
Weight Management

Nutritional Beverages

Nutritional Bars

Fermented Dairy

Global - Nutrition Overview



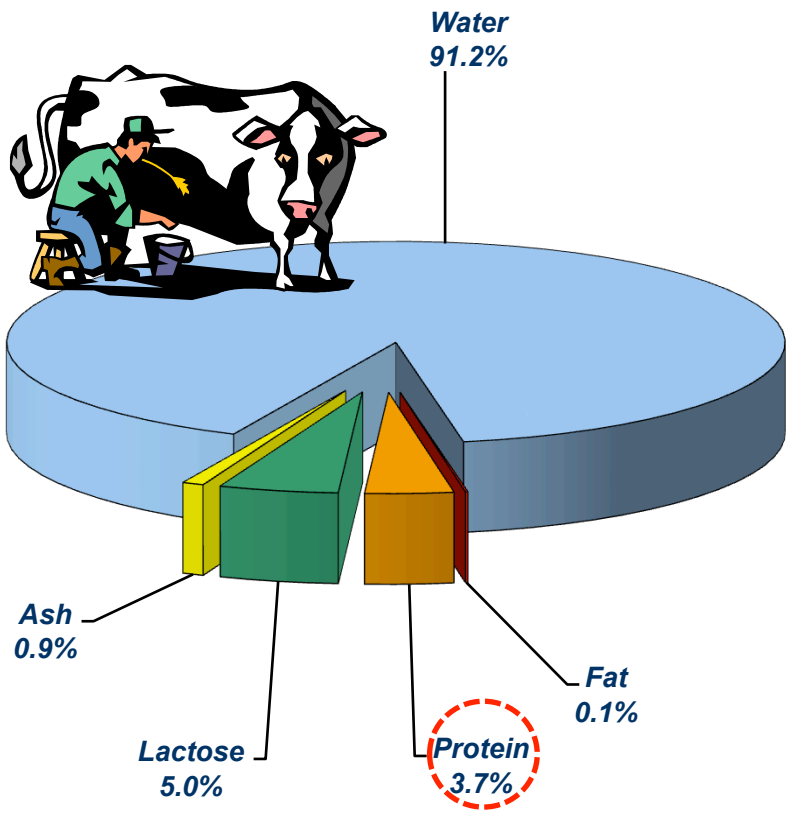
*Including juice

Source: Euromonitor & Internal Analysis (Clinical Nutrition)

Typical Composition (%) of Bovine Skim Milk

Water (H20)	~91.2
Total Solids	~9.8
Fat (Lipid)	≤ 0.1 (As dispersed globules)
Protein	~3.7
Lactose	~5.0
Ash	~0.9
Minor Constituents	Trace
pH:	~6.7

Typical Bovine Skim Milk
Average Composition



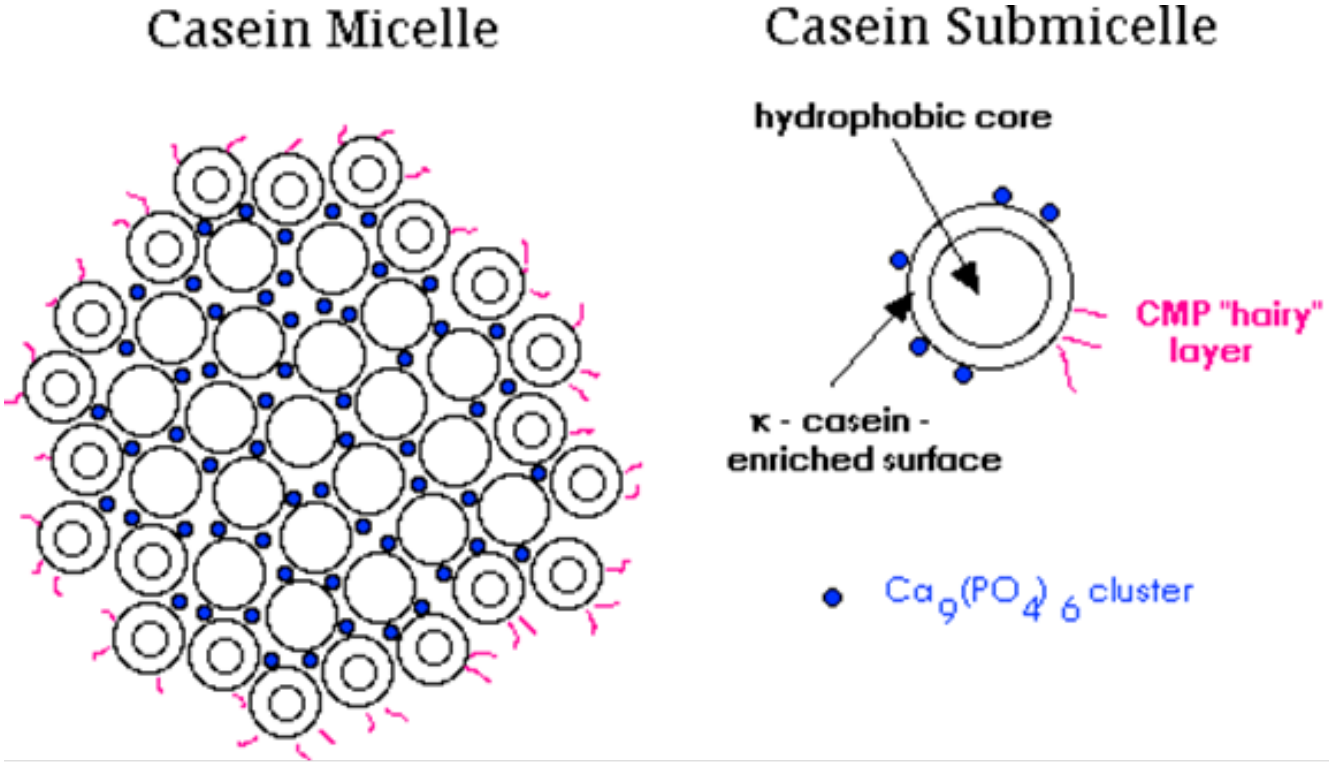
80% Casein : 20% Whey

Breakdown of the types of Protein in bovine milk

	Grams / litre	% Total Protein
alpha S1	10	30.6
alpha S2	2.6	8.0
beta	9.3	28.4
kappa	3.3	10.1
TOTAL CASEINS	**26**	**79.5**
alpha lactalbumin	1.2	3.7
beta lactoglobulin	3.2	9.8
BSA	0.4	1.2
Immunoglobulins	0.7	2.1
Proteose Peptone	0.8	2.4
TOTAL WHEY PROTEINS	**6.3**	**19.3**
TOTAL PROTEIN	**33**	**100**

Models of Casein Micelle Structure

The representation of casein micelle structure shown here is that of the Casein Sub-Micelle" model

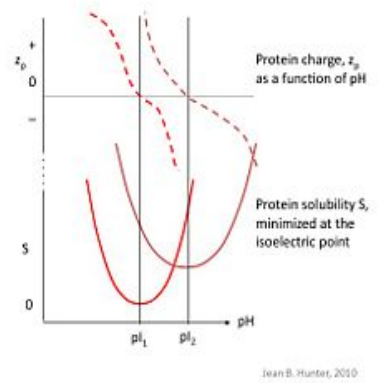


Current Technologies used for Protein Extraction from Milk

- Iso-electric precipitation of casein protein
  - Acid Casein , Caseinates and Acid Whey
- Rennet coagulation of casein protein
  - Rennet casein and Rennet whey powder
- Membrane concentration of whey proteins
  - WPC (34 % - 75 %)
- Membrane extraction of Casein
  - Milk Protein Isolate
  - Micellar Casein
- Enzyme hydrolysis of milk proteins
  - Casein protein, Whey protein

Iso-electric precipitation of casein protein

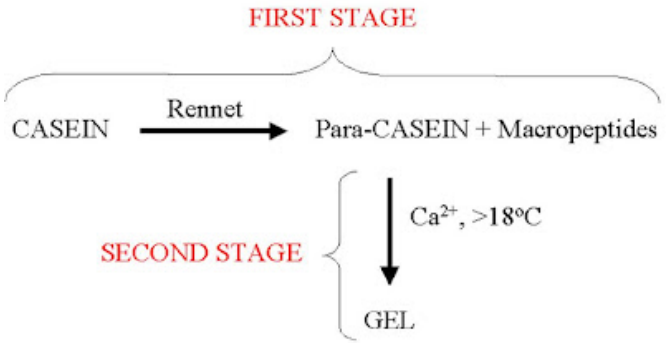
- Isoelectric point pH 4.6 by acids
- Protein Precipitated & Washed
- Spray dried / Roller dried



- Acid Casein Converted To Caseinates Using A Range Of Alkali
  - Sodium Hydroxide: Taste not pleasant
  - Calcium Hydroxide: Product Chalky taste and not heat stable
  - Potassium Hydroxide: Taste not pleasant
  - Caseinates used in food applications as fat emulsifiers in eg Creamers

Enzyme coagulation – Rennet Casein

- Protein is coagulated into a gel using rennet enzyme
- Developed from cheese making
- Protein is extracted, washed, and dried
- Initial uses mainly industrial
  - Button manufacture , Glues and paper coating
- Protein used mainly in processed cheese manufacture
- Rennet whey sweeter in taste
  - Minerals reduced by Ion Exchange / ED
  - Infant formula , Confectionary



Membrane concentration of whey proteins

- Plants
  - Plate and Frame
  - Tubular
  - Ceramic

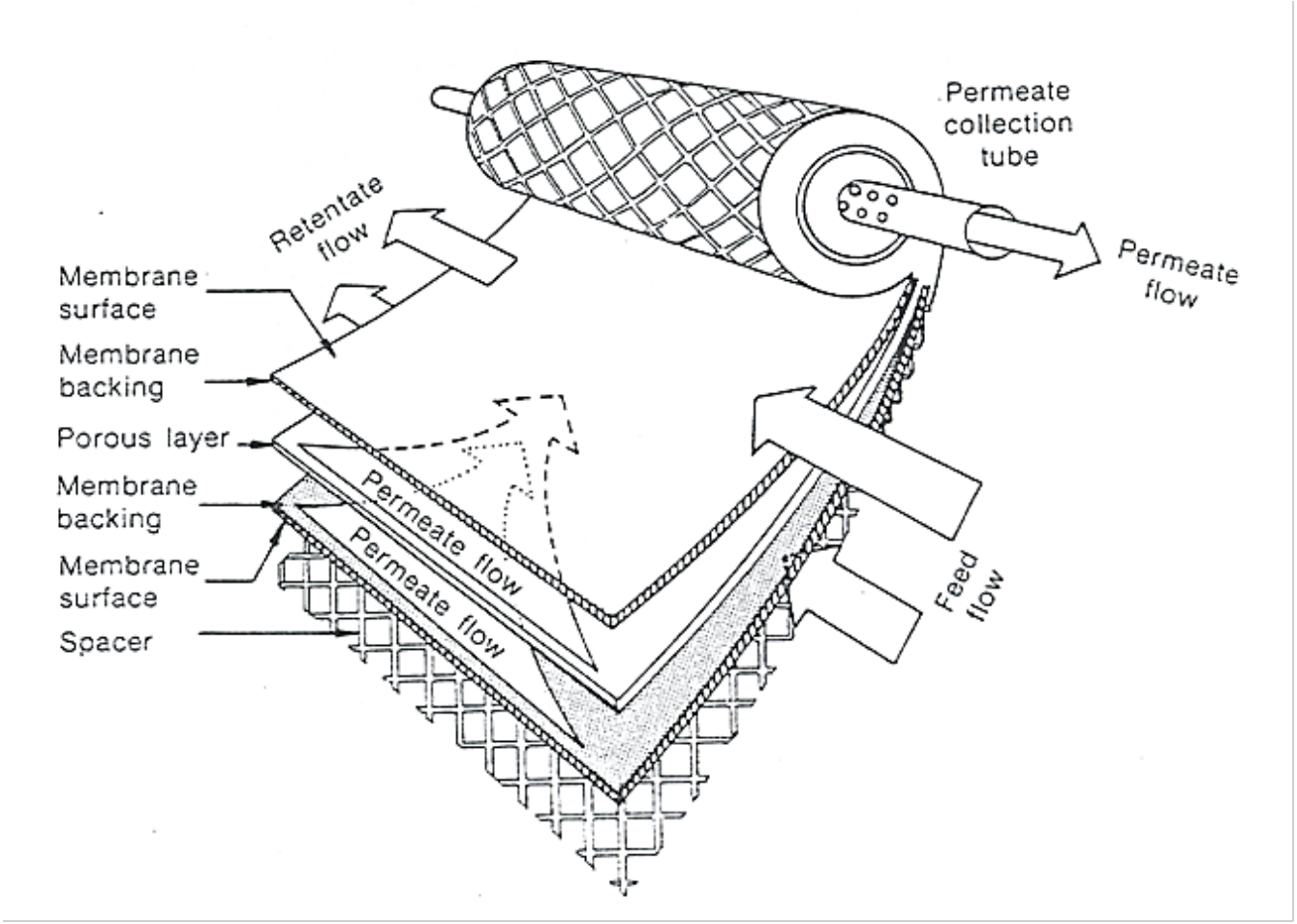
- Large plant size to achieve membrane area and low concentration factor

- Protein level 34 % - 75 %

Membrane extraction of casein and whey proteins

- Developments in membrane technology allowed separation of casein protein and whey protein from the other components with low lactose and protein in natural form
  - Spiral wound modular plants
  - Accurate pore size
  - Diafiltration
  - Less fouling and increased flux
- Milk Protein Isolates / Concentrates
  - Casein in micellar form
  - Micellar Casein
  - Heat stable ,clean flavour product

Spiral Wound membranes



Protein with complimentary benefits

- Protein Fractions

Beta casein enriched:	Clinical Nutrition Wound healing
Alpha lactalbumin enriched	Infant formula application
Lysozyme	Infant formula application

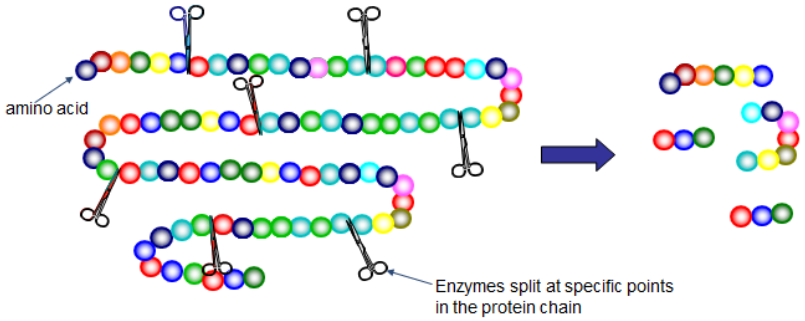
- Targeted selective hydrolysis to generate bioactive properties
  - ACE inhibition peptide

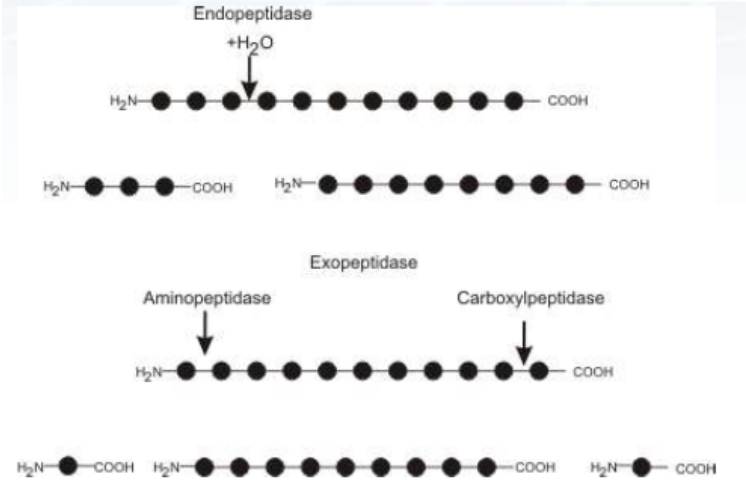
- Physical Properties
  - Foaming
  - Emulsification

- Fermentation with selected bacterial cultures
  - Bioactive peptides

Enzyme hydrolysis of Milk Proteins

- Characteristics of Earlier Hydrolysates
  - Enzyme non specific
  - Bitter taste Hydrophobic peptides produced
  - Re formation of peptide bonds
  - Limited bioactivity
  - Hypoallergenicity in IMF



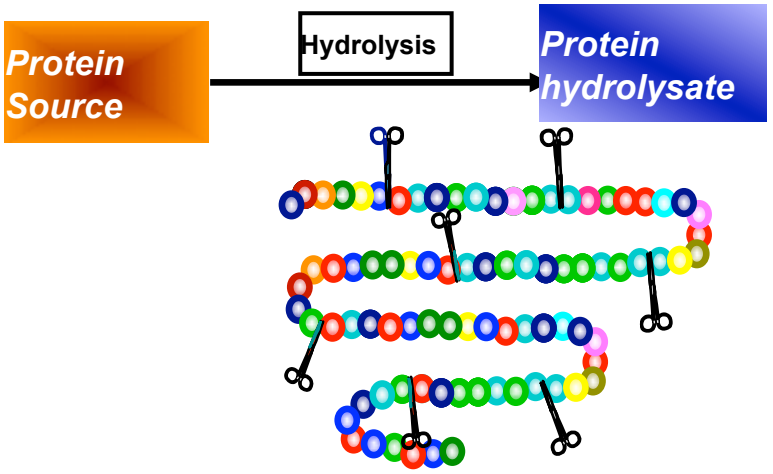


Benefits of Current Enzyme Technology

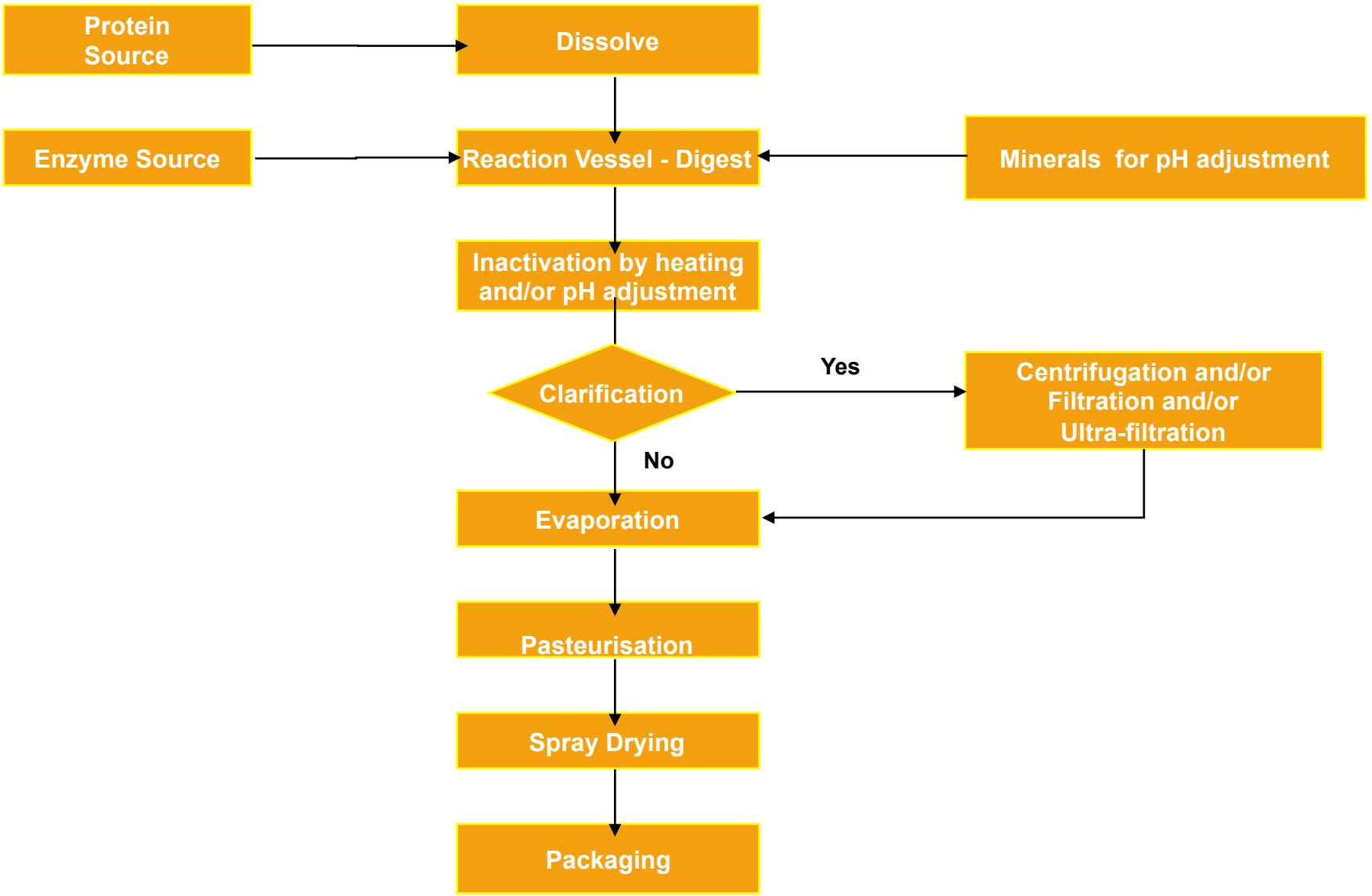
- Specifically designed and tailored to meet the nutritional and functional requirements of the infant, clinical, and sports nutrition sectors.

- Enzymatically hydrolysed from casein, whey, soy, collagen, rice, pea and gluten.
  - Non GMO
  - Increased purity of enzyme systems
  - Selective targeted hydrolysis

- Carefully designed and selected to suit customer requirements around :
  - **Degree of Hydrolysis**
  - **Molecular Weight Distribution**
  - **Taste**
  - **Emulsifying Properties**
  - **Downstream Purification**
  - **Amino-acid Composition**
  - **Nutritional value**
  - **Allergen Reduction**



Hydrolysed Proteins Production Flowchart



The commercial opportunity

Health and wellness market:
156 billion $
2-8 % annual growth

Leatherhead, Key Players in the Global Functional Foods Industry, 2012

KEY TRENDS FOR 2012

1. Naturality
2. Energy
3. Digestive health
4. Feel the benefit
5. Weight management
6. Movement
7. Senior nutrition
8. Fruit & vegetables
9. Dairy
10. Good grains

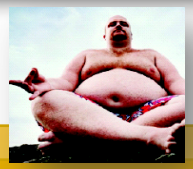
A healthy diet for a healthy life: preventative potential of food, addressing global, societal concerns in a natural way.

What is FHI ?

- Partnership between:
  - Public Research Organizations
  - Irish food industry
- Funded by
  - Enterprise Ireland and Industry partners
  - Total budget € 22,5 mio
- Industry-led research agenda:
  - Identified health pillars
  - Stipulated dairy based
  - Strong market position, scale-up and manufacturing capabilities of industry partners

One centre aimed at developing, manufacturing, marketing and selling functional food products to improve people's health and wellness

FHI target groups and health benefit areas



Target group

Infants | **Obese** | **Elderly**

Target health benefits

Hypo-allergenic
Mineral binding
Bifidogenic
Anti-infective

Weight Management: satiety

Glycemic Management

Muscle metabolism for healthy ageing

Related health benefits

WP 5

WP 6

WP 8

Inflammation
Atherothrombosis
Platelet aggregation

Food safety:
C.sak.

Overall gut health
Reduction pathogens
Infections

WP 7

FHI Sample Generation & Delivery

- ~ 1100 enzyme hydrolysates
- ~ 900 bacterial fermentates
- ~ 40 synthetic peptides

} generated by FHI

61 Lead Functional Compounds (LFC) – proven functionality in 1 or more bioassay

Strategy Type	Weight Mgt	Glycaemic Mgt	Anti-inflammatory	Cardiovascular health	Hypoallergenic	Anti-bacterial
Enzyme hydrolysis	4	3	8		3	
Bacterial fermentation	7		10	2		1
Bioinformatics (*In Silico*)		1		2		20

Potential bioactive benefits

Health Pillar	Bioassay	
Metabolic Health	Activation of serotonin receptor (satiety)	Bacterial Fermentation / Enzymes
	GHS-R1a receptor modulator (satiety)	Enzyme Hydrolysis
	Gut satiety	Bacterial Fermentation and Enzyme hydrolysis
	Insulinothrophic (glycemic management)	Enzyme Hydrolysis
	Anti-inflammatory in gut epithelial, macrophages, adipocytes and/or dendritic cells	Bacterial Fermentation and Enzyme hydrolysis
	Endothelial cell & inhibition of endothelial-monocyte cell adhesion	Bacterial Fermentation and Enzyme hydrolysis
	ACE inhibition	Enzyme Hydrolysis
	Platelet aggregation	
Infant Nutrition	Hypoallergenic	Enzyme Hydrolysis
	Growth of Bifidobacteria	
Food Safety	Anti-bacterial	Bio-informatics

Key Support technologies required

- Fractionation Technologies
  - Membrane separation with specified targeted pore size
  - Chromographic / Charged membranes
  - Immobolised ligands for specific proteins and peptide binding
- Biotechnologies
  - Targeted / more specific enzymes
  - Bacterial cultures with bioactive enhancing capability
- Peptide stabilisation
  - Encapsulation to maintain bioactive properties
- Peptide characterisation
  - Proteonomics
  - Bioinformatics
  - In vitro evaluation

Challenges

- Cost efficient extraction
  - When compared to other alternatives
  - Current available technologies capital intensive and expensive to operate
- Yield of Bioactive material and return / use of side stream
- Customer requirement no stripping of components
- Retention of Bioactivity
- Taste of Bioactive component
  - Market will not accept less than perfect product
- Carrier product eg. Yoghurt

Q & A