

LUND UNIVERSITY

Food Technology and Engineering



Bioactive Proteins and Peptides in Milk

Marie Paulsson

*Dept of Food Technology,
Engineering and Nutrition*

Lund University



BIOACTIVE PROTEINS - DEFINITION

- Food components that can affect biological processes or substrates and, hence, have an impact on body function or condition and ultimately health
 - A dietary component should impact a measurable biological effect at a physiologically realistic level
 - The bioactivity measured has to have the potential to affect health in a beneficial way, thus, excluding from this definition potentially damaging effects (such as toxicity, allergenicity and mutagenicity)

(Schrezenmeir *et al* 2000)



FUNCTIONS OF PROTEINS

- Bioactivity
 - Protective functions
 - Regulation of biological functions
- Nutritional value
 - Source of nitrogen for protein synthesis
 - Source of energy
- Technological value
 - Functional (physicochemical) properties
 - Sensory properties



BIOACTIVE PROTEINS IN MILK

- **Caseins**
 - α s1-casein
 - α s2-casein
 - β -casein
 - κ -casein
- **Whey proteins**
 - β -lactoglobulin
 - α -lactalbumin
 - BSA
 - Immunoglobulins
 - Lactoferrin
- **Minor proteins**
 - Growth factors and growth hormones (IGF-1, TGF- β 2, GH)
 - Milk basic protein and cytokines
- **MFGM proteins** (Butyrophilin, Xanthine dehydrogenase/oxidase, MUC1, PP3)
- **Enzymes** (Lactoperoxidase, glutathionperoxidase)



PROTEIN COMPOSITION

| COMPONENT | COW MILK content (g/l) | COLOSTRUM content (g/l) |
|------------------------|------------------------|-------------------------|
| CASEINS | 26 | 27 |
| α s1-CN | 10 | 10.3 |
| α s2-CN | 2.6 | 2.7 |
| β -CN | 9.3 | 9.5 |
| κ -CN | 3.3 | 3.4 |
| WHEY PROTEINS | 6.3 | 34 |
| β -lactoglobulin | 3.2 | 8.0 |
| α -lactalbumin | 1.2 | 3.0 |
| Bovine serum albumin | 0.4 | 1.3 |
| Immunoglobulins | 0.6-1.0 | 20-150 |
| Lactoferrin | 0.1 | 1.5 |
| MFGM PROTEINS | 0.4 | 0.4 |



BETA-LACTOGLOBULIN

- Bioactive functions
 - Transport of retinol (vitamin A)
 - Binding of fatty acids
 - Antioxidant (potential)
 - Antimicrobial and Antiviral effect
 - Pathogenic adhesion effect
 - Controlling enzymes in mammary secretory vesicles
 - Mammalian cell growth factor activity, mitogenic activity
 - Anticarcinogenic activity



LACTOFERRIN

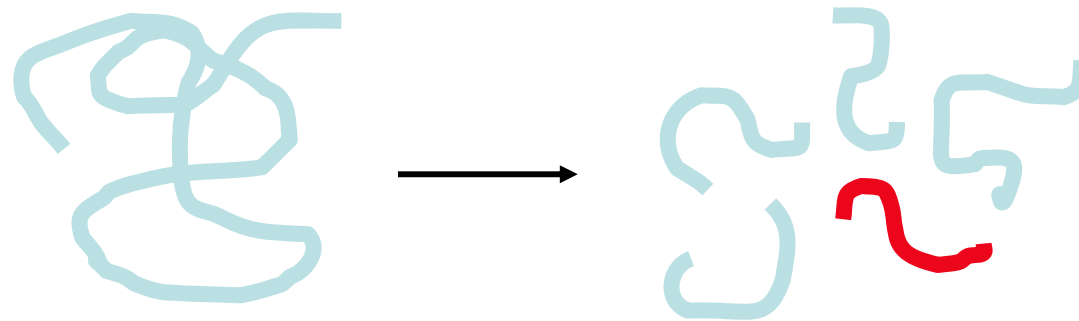
- Bioactive functions
 - Regulation of iron transport
 - Antimicrobial activity
 - Antiinflammatory and Immunomodulatory activity
 - Antioxidative effect
 - Antiinflammatory and Anticarcinogenic activity
 - Stimulation of cell proliferation



BIOACTIVE PEPTIDES - DEFINITION

- Biological active peptides or functional peptides are food derived peptides that in addition to their nutritional value exert a physiological effect in the body
 - Defined sequences of amino acids which are inactive within the original protein, but which display specific properties once they are released by enzymatic hydrolysis

(Vermeirssen *et al* 2004)



Inactive or less active form

Bioactive peptide



ORIGIN OF BIOACTIVE PEPTIDES

- In the cow
 - Natural occurring peptides
 - Proteolysis in the udder
- Dairy product processing
 - Enzymatic hydrolysis
 - Proteolytic action of microorganisms
- In human after ingestion
 - Digestion in the intestinal tract



LACTOFERRICIN

- LF f(17-42) from lactoferrin during the digestion in the gut by pepsin proteolysis
- Bioactive functions
 - Antimicrobial effects
 - Immunomodulatory effects
 - Antiviral effects
 - Anticarcinogenic activity



VARIATION IN PROTEIN COMPOSITION

- Genetic
- Physiological
 - Lactation stage
 - Udder health
- Environmental
 - Seasonal changes
- Processing
 - Heat treatment
 - Storage

COMMERCIAL PRODUCTS



| Brand name | Type of product | Claimed functional bioactive peptides | Health/function claims | Manufacturers |
|--------------------------|---|---|---|---|
| Calpis | Sour milk | Val-Pro-Pro, Ile-Pro-Pro, derived from β -casein and κ -casein | Reduction of blood pressure | Calpis Co., Japan |
| Evolus | Calcium enriched fermented milk drink | Val-Pro-Pro, Ile-Pro-Pro, derived from β -casein and κ -casein | Reduction of blood pressure | Valio Oy, Finland |
| BioZate | Hydrolysed whey protein isolate | β -lactoglobulin fragments | Reduction of blood pressure | Davisco, USA |
| BioPURE-GMP | Whey protein isolate | κ -casein f(106–169) (Glycomacropeptide) | Prevention of dental caries, influence the clotting of blood, protection against viruses and bacteria | Davisco, USA |
| PRODIET F200/Lactium | Flavoured milk drink, confectionery, capsules | α_{s1} -casein f (91–100) (Tyr-Leu-Gly Tyr-Leu-Glu-Gln-Leu-Leu-Arg) | Reduction of stress effects | Ingredia, France |
| Festivo Cysteine Peptide | Fermented low-fat hard Ingredient/hydrolysate | α_{s1} -casein f (1–9), α_{s1} -casein Milk protein derived peptide | No health claim as yet Aids to raise energy level and sleep | MTT Agrifood Research DMV International, the Netherlands |
| C12 | Ingredient/hydrolysate | Casein derived peptide | Reduction of blood pressure | DMV International, the Netherlands |
| Capolac | Ingredient | Caseinophosphopeptide | Helps mineral absorption | Arla Foods Ingredients, Sweden |
| PeptoPro | Ingredient/hydrolysate | Casein derived peptide | Improves athletic performance and muscle recovery | DSM Food Specialties, the Netherlands |
| Vivinal Alpha | Ingredient/hydrolysate | Whey derived peptide | Aids relaxation and sleep | Borculo Domo Ingredients (BDI), the Netherlands |