

SiRena

MODIFIKACIJA PROCESA ZRENJA SIRA
I RAZVOJ PROIZVODA NA BAZI SIRUTKE



VELEUČILIŠTE
U KARLOVCU
Karlovac University
of Applied Sciences



prehrambeno
biotehnološki
fakultet

Sveučilište
u Zagrebu



EUROPSKI
STRUKTURNI
I INVESTICIJSKI
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Operativni program
KONKURENTNOST
I KOHEZIJA



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WHEY AS A VALUABLE SOURCE OF FUNCTIONAL BEVERAGES

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INTRODUCTION



ACID COAGULATION
(by acids or lactic acid bacteria)

ACID WHEY

1 kg cheese



9 L whey

ENZYMATIC COAGULATION



SWEET WHEY



Proximate composition of milk vs. whey (Smithers, 2008)

Component	Content (% w/v)	
	Milk	Whey
Casein protein	2.8	<0.1
Whey protein ^b	0.7	0.7
Fat	3.7	
Ash	0.7	
Lactose	4.9	
Total solids	12.8	

STRICT REGULATIONS – no DISPOSAL in the environment!!

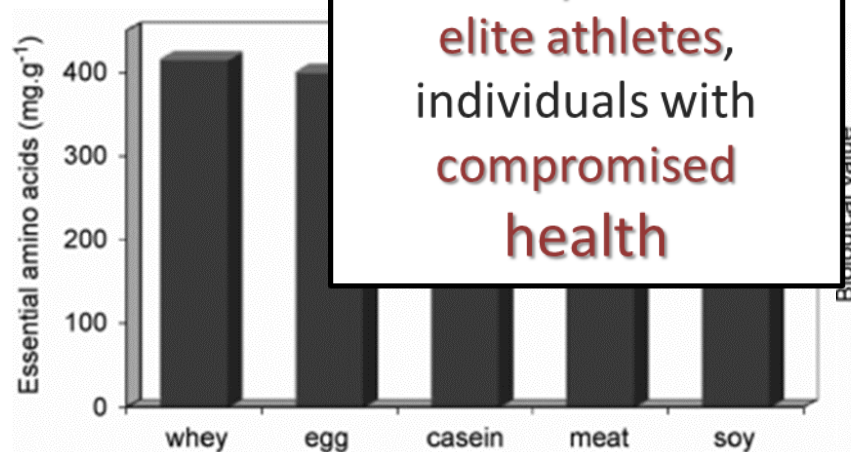
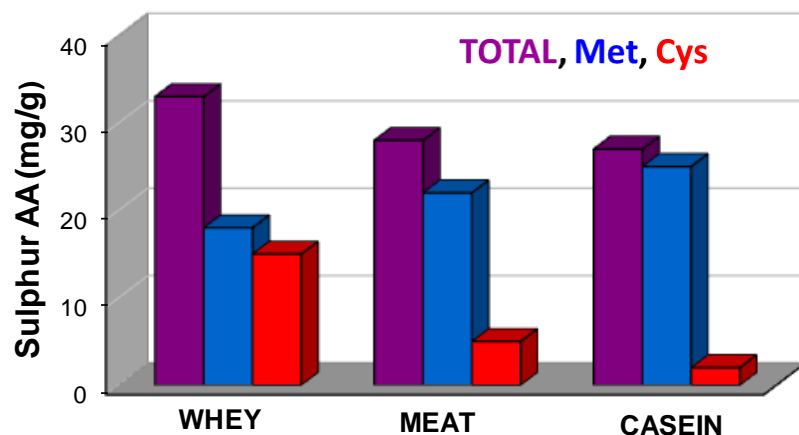
High **BOD (35-45 g/L)** and **COD (> 60 g/L)**

175-fold higher than typical sewage effluent!!!

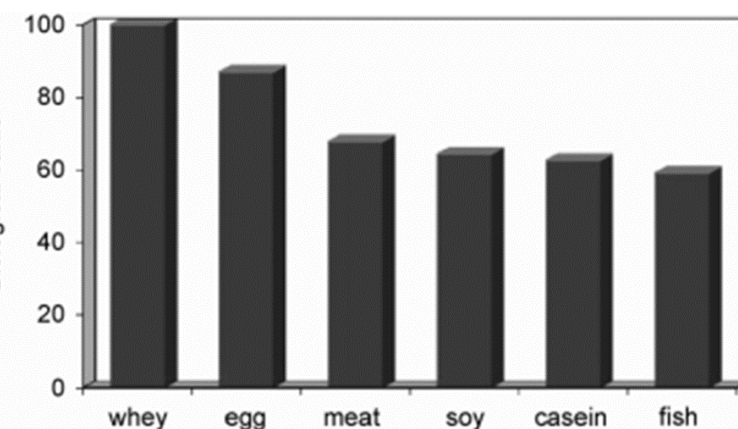
High polluting power!

1 L whey = sewage from 1900 individuals

WHEY PROTEINS



WP = 1.st choice
for **body builders,**
elite athletes,
individuals with
compromised
health



Rich on BCAA (Val, Leu, Ile); > 20 % (w/w)
Metabolic regulators in protein & glucose
homeostasis & lipid metabolism

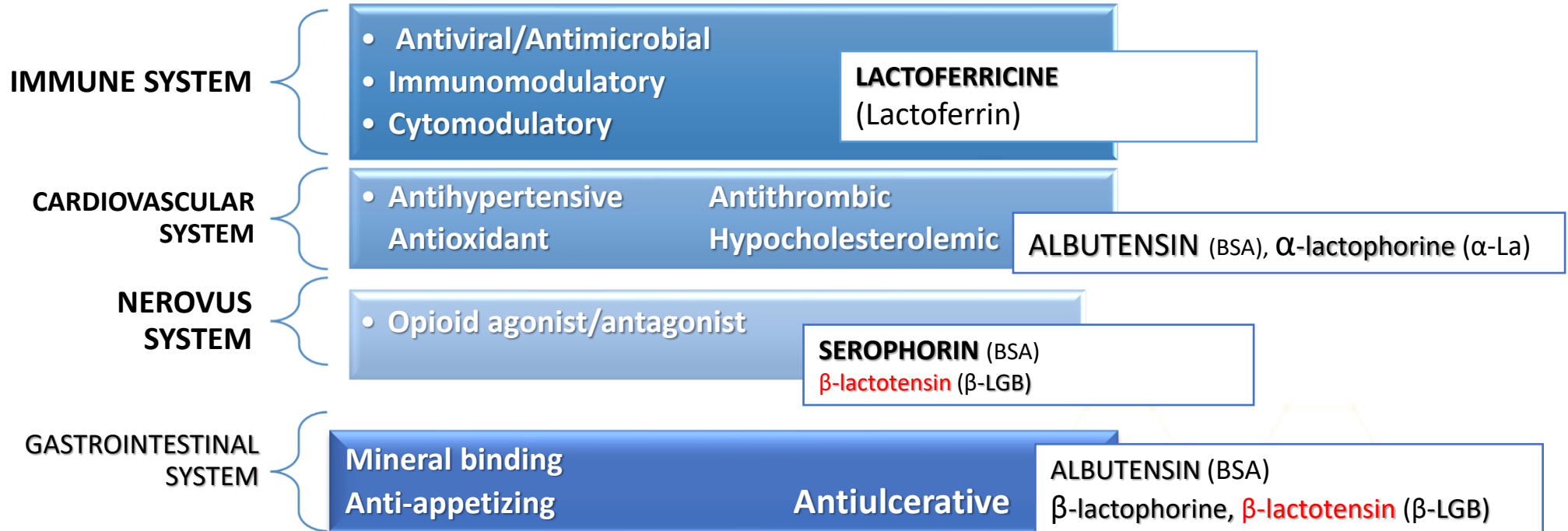


Potentially involved in weight management!!!

- **Fast utilisation of consumed WP**
- **High ratio (%) consumed/utilised WP**

BIOACTIVE PEPTIDES

AA sequences originating from WP (mostly α -LA i β -LG) hydrolysis by digestive enzymes, proteolytic m.o. or plant proteases:



β -lactotensin - binding to neuroreceptors \rightarrow satiety feeling!! = suppression of food intake \rightarrow synergistic with dairy Ca

OTHER HEALTH BENEFITS ASSOCIATED TO WHEY

- **Contains minerals of high bioavailability (Ca, P, Na, Mg...)** – muscle contractions, transmitting of nerve impulses, weight loss, preventing colon cancer
- **Contains lactose** - ↑Ca, P & Mg and fat digestion, ↓caries and intestinal colonization by „bad” bacteria
↓GI ↔ prevention of diabetes type 2
- **Good** for skin health, liver regeneration, weight loss, rehydration after exercise, etc..



PROBLEMS IN WHEY UTILISATION

Composition & characteristics:

↑ H₂O and sugar in dry matter → susceptible to spoilage, especially sweet whey

thermosensitive WP, ↑ minerals

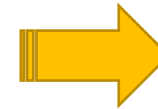


TECHNOLOGICAL PROBLEMS: sediment formation; clotting and grainy texture; poor, salty and bitter taste

Economically not cost-effective

Application of high energy consuming technologies – environmental point of view !

PROCESSING
ASAP !!!



BEVERAGES THE BEST SOLUTION

WHEY BASED BEVERAGES

- ✓ Alcoholic and non-alcoholic
- ✓ 3 main groups of non alcoholic whey beverages :
 - (a) mixtures of whey with fruit or vegetable extracts, grains, spices, seeds, and similar ingredients
 - (b) fermented, yogurt-like beverages
 - (c) refreshing beverages with the addition of carbon dioxide



BASIS:

Natural, only thermally processed whey (SWEET or **ACID**)

Deproteinised whey

Demineralized whey

Permeate remaining after UF, MF or other membrane processes

Whey powder

Avoiding sediment
and blurring

PROCESSING TECHNOLOGY

- Most often concentration and pasteurisation
- Sometimes stabilization by adding hydrocolloids and sugar
- Very often the addition of CO₂ been proposed to improve sensory characteristics
- High intensity ultrasound tested for purposes of homogenization and microbiological stabilization (alternative to pasteurisation!)
- Membrane processes – expensive, rather for WPC/WPI; use of permeates to improve efficiency of the process!



Non fermented beverages

To overcome milky, salty, pour flavour and mouthfeel, **best** options:

- Tropical fruits (papaya, mango, pineapple, maracuja, guava)
- Citrus fruits – ORANGE!
- Berries (strawberry, black currant)
- Cherries
- Cereals and seeds (oats, millet, chia seeds)

Nowadays, often different herbs are combined with fruits or used solely:

- *Mentha arvensis*



- usually by a starter culture able to metabolize lactose, often probiotic cultures
- *Lb. acidophilus*, *Lb. delbrueckii* ssp. *bulgaricus*, *S. thermophilus*, *Lb reuteri*, *B. bifidum*, *Lb. rhamnosus*, *Lb. casei*, *Lb. plantarum*, *Lb. helveticus*, *Enterococcus faecium*, *B. animalis* ssp. *Lactis*
- Basis – whey powder or sweet whey, demineralised whey, rarely acid whey (pH already low!)
- Often smaller amounts of milk added – better consistency!
- Inulin and oligosaccharids; fruit concentrates – orange powder, pineapple
- Current trends – kefir-like whey beverages



Formulation	Outcome	Source
acid whey + orange juice concentrate + water vs. orange juice concentrate + water	beverage containing whey had more proteins, ash, glucose, lactose, and vitamin B, but contained less sucrose, fructose, and vitamin C.	Sady et al. (2013)
Orange juice and whey in different ratios (70:30, 60:40 and 50:50) + CO ₂	Best properties for the formulation 70:30	Pareek et al. (2014)
Orange juice and concentrated whey in different ratios	the mixture of orange juice and concentrated whey in ratio 3:2 optimal formulation, the best sensory properties. The shelf life at room temperature - 11 days, up to 3 months at refrigerator temperatures	Chatterjee et al. (2015)
whey-guava beverage of approximately 68% whey and 20% guava pulp –past. & cool stored 90 days	the best beverage in overall quality - pasteurized at 65°C/25 min and cool stored 45 days	Singh et al. (2014)
whey powder, WPC, or fresh whey + mango pulp or mango powder in different rations - tested for chemical, m.b. & sensory properties	acid whey, whey powder, and WPC could be successfully utilized for beverage production beverage from WPC and mango powder - good overall acceptability after 30 days of cold storage!!	Chavan et al. (2015a)
Ricotta cheese whey + different fruits for sports drink production	tangerine, passion fruit, and strawberry-passion fruit recipes achieved the best sensory scores	Valadao et al. (2016)
Blackcurrant + acid whey vs. the characteristics of pure blackcurrant juice	blackcurrant-whey beverage - higher amounts of ash, proteins, and vitamin B2; pure blackcurrant juice - somewhat higher antioxidant activity and received higher score at sensory evaluation	Jaworska et al. (2011)

Formulation	Outcome	Source
strawberry flavored fermented and non-fermented whey beverages	Non-fermented whey-strawberry beverages were less liked since - recognized as not enough acidic and viscous, with a more intense artificial strawberry aroma.	Janiaski et al. (2016)
whey fermentation by yogurt culture (<i>Lb. delbrueckii ssp. bulgaricus</i> ; <i>S. thermophilus</i>)	more intense yogurt flavor in comparison to the one obtained by skim milk yogurt fermentation	Gallardo-Escamilla et al. (2007)
whey beverage fermented by commercially available yogurt culture DELVO®-YOG TY-17A vs. beverage from WPC reconstituted	no considerable difference in the nutritional properties, fermented beverage significantly higher overall acceptability and sensory scores	Sohrabi et al. (2016)
Cheddar cheese whey + orange juice powder +orange flavor, fermented at 42°C by a combined thermophilic probiotic (<i>L. acidophilus</i> LA-5 , <i>Lb. delbrueckii subsp. bulgaricus</i> , <i>S. thermophilus</i> , <i>Bifidobacterium sp. BB-12</i>)	The incorporation of orange flavor and sugar into whey fermented with probiotic culture - a successful pattern for utilizing cheddar cheese whey into organoleptically acceptable beverages!	Faisal et al. (2017)
Different ratios whey + pineapple juice fermented by <i>Lb acidophilus</i> LA-5	The blend of 25% whey + 75% pineapple juice could be preserved for 42–56 days at 4 °C with good acceptability shelf-life and probiotic viability	Islam et al. (2021)
Acid whey + UHTmilk/unsweetened condensed milk, or skim milk powder; fermented by <i>Lb acidophilus</i> LA-5 or <i>Bifidobacterium animalis ssp. lactis</i> BB-12 .	Beverage made from whey, milk, condensed milk, and <i>L. acidophilus</i> , had the best sensory properties, bacteria count throughout the storage period exceeded 8 log cfu/mL	Skryplonek et al (2019)

✓ whey + fruit **concentrate** (**sour cherry**, apple), **aroma** + **other additives**

SWEET  **ACID**  shelf life 15 days



✓ Fermentation by probiotic bacteria with or without prebiotics
inulin, lactulose, BB-12, La-5, Lc-01



ULTRASONIC TREATMENTS OF WHEY FOR PURPOSES OF:

Microbiological stabilization: whey ultrasonication (600W, 480W) at constant T (45°C, 55°C) during 6.5, 8 or 10 min

→ **BEST TREATMENT:** 480 W - 55°C – 8 min

Improving fermentation:



1) reconstituted sweet whey (past. or thermosonicated) → inoculation with YC-380/La-5 → ultrasonication at 84/102 W for 75 s/150s → fermentation

2) inoculum activation at 84/102 W for 75 s/150s → whey (past. or thermosonicated) inoculation with YC-380/La-5 fermentation



inoculum activation 84W/150s shortened fermentation by La-5 for 30 min!
fermented thermosonicated (480W/55°C/8 min) whey had higher viable cell count, no sediment and better sensory properties vs. past. whey

- Whey- beverages target a large scale of consumers – from little children to old people!
- Nutritional properties and potential health-promoting effects meet the requirements of modern consumers
- Beverages containing fruits or carbonated beverages have gained the most attention up to now, and were evaluated as acceptable to the consumers
- Very large interest also noted for fermented beverages, especially with probiotic strains

The main problems:

- **lack of information** available to the consumers considering the advantages of these products
- **insufficient interest** for such beverages, which makes the reviewing of their production rather risky from the dairy industry point of view!

FUTURE PERSPECTIVE

putting more efforts into marketing and informing activities in order to draw the consumer attention to the outstanding nutritional and functional properties of whey!!!!

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