

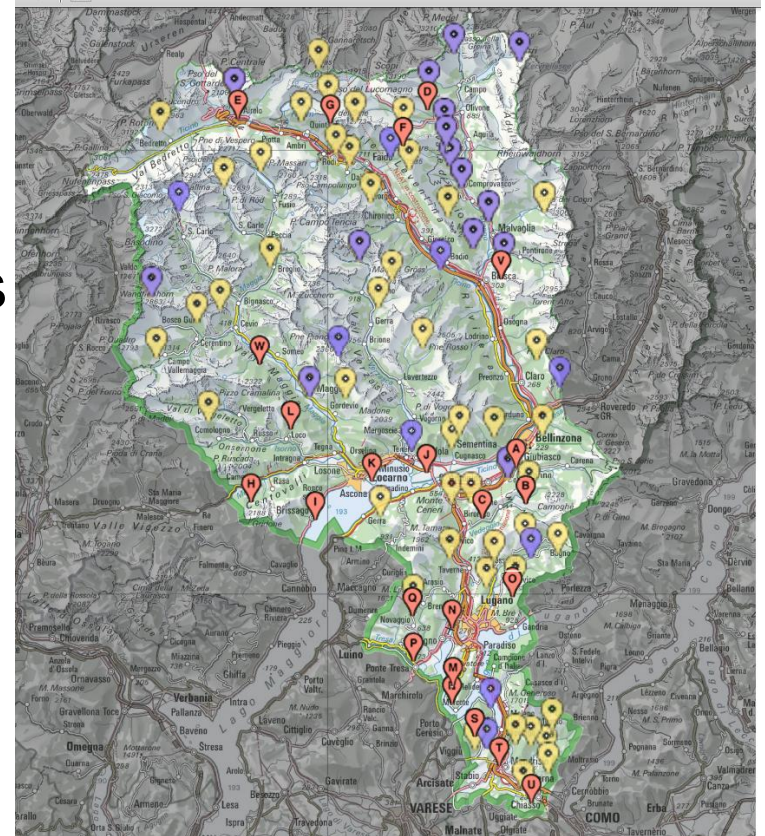
SUPSI

A case-study of valorization of whey from cheese producers in the Alps

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Ticino dairy and Alps factories

- Total production 1800tons (1%)
- Alpine cheese factories 439 tons seasonal
- Level cheese factories 1361 tons



Alpine cheese factories: PIORA *summer2013*

- ✓ 3500ha (widest in ticino)
- ✓ isolated facility
- ✓ three/four months/y activity
- ✓ 500cows (250dairy cattles)
- ✓ 4000liters milk
- ✓ 23000kg/y cheese
- ✓ pristine area
- ✓ main issue: environmental protection



Alpine cheese factories: PIORA *summer2013*

typology	flow (m3/day)		COD g/L	BOD g/L
whey	4		54	40
cooling waters	37-40	48	0.16	0.08
wastewaters	8-11			



Fate of the output

- Animal feeding (pig)
- No valorization, environmental costs
- Disposal costs (2 cents/L) for valorization ?
- Disposal costs for delivery to AD central facility (5 cent/L)

scenarios

output (liquid and/or solid)	wastewater	whey
technological process	sedimentation/ settling	reverse osmosis (RO) + transport
		trickling filter
		storage + transport
	wastewater + whey: Dissolved Air Flotation + trickling filter	

technologies	wastewater	whey			Wastewater + whey
	sedimentation /settling	RO + transport	trickling filter	storage + transport	Dissolved Air Flotation + trickling filter
*** high * medium * low					
footprint	***	*	***	***	*
start-up	**	*	**	*	**
management	*	***	*	**	**
skills	*	***	**	*	**
investment costs	*	***	**		**
	(8'000-12'000chf/y)	(80'000chf)	(20'000-30'000chf)	No	(110'000chf/y)
operational costs	*	**	*	***	**
	(300chf/y)	(4'500chf/y)	(700chf/y)	(11'000chf/y)	(2'000chf/y)
preliminary	no	yes	yes	no	yes

cheese whey as resource

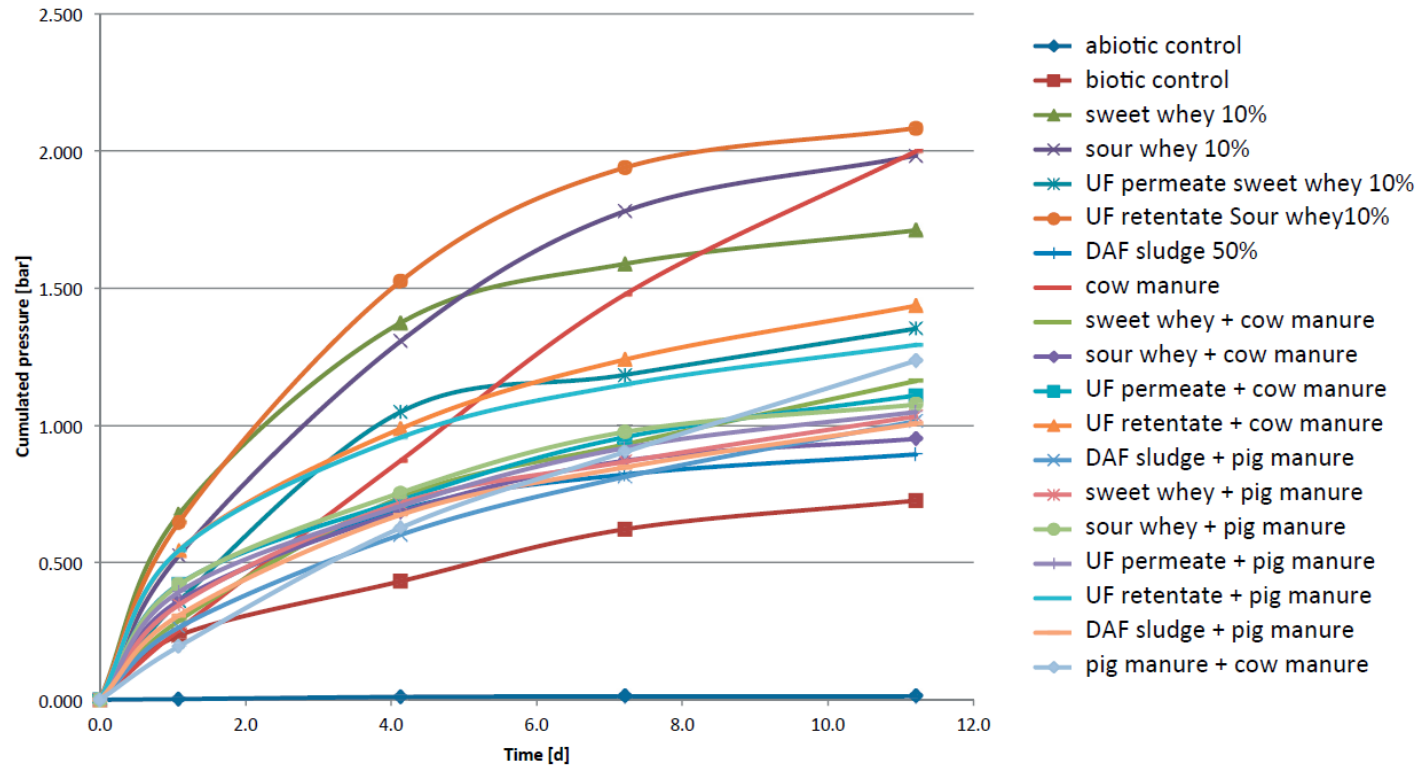
■ Chemical characteristics by literature data

Components	Sweet whey (g/L)	Acid whey (g/L)
Total solids	63–70	63–70
Lactose	46–52	44–46
Proteins	6–10	6–8
Calcium	0.4–0.6	1.2–1.6
Phosphate	1–3	2–4.5
Lactate	2	6.4
Chloride	1.1	1.1

Components	Value
BOD₅	40,000–60,000 ppm
	30,000–50,000 ppm
	>30,000 ppm
COD	50,000–80,000 ppm
	60,000–80,000 ppm
	60,000–100,000 ppm
	>60,000 ppm

Chatzipaschali, Aspasia A., and Anastassios G. Stamatis.
Energies 5.9 (2012): 3492-3525.

Codigestion tests with substrates in Piora



Comparative trends of different substrate in co-digestion processes

UF retentate of sour whey gave the maximum CH₄ daily with 0.7 g of CH₄ and max CH₄ production rate 0.4g CH₄ /L d.

Anaerobic digestion as feasible process to recover energy

- Substrate untapped biomasses
- Pretreatment increase the % of organic matter converted (lignocellulose)
- Process efficiency ($\text{CH}_4\%$ in biogas)
- Digested sludge fate (disposal costs and nutrient recovery)

1. substrate: whey

project SIERO



Cheese production in switzerland

potential energy content of whey

Total cheese production 2013:
182'705 tons

180'000 Tons of cheese

1Kg of cheese ~ 10L cheese whey

1'800'000'000 L whey

total organic matter (COD kg)

90'000'000Kg

methane produced

31'500'000 Nm³CH₄

0.35Nm³CH₄/KgCOD

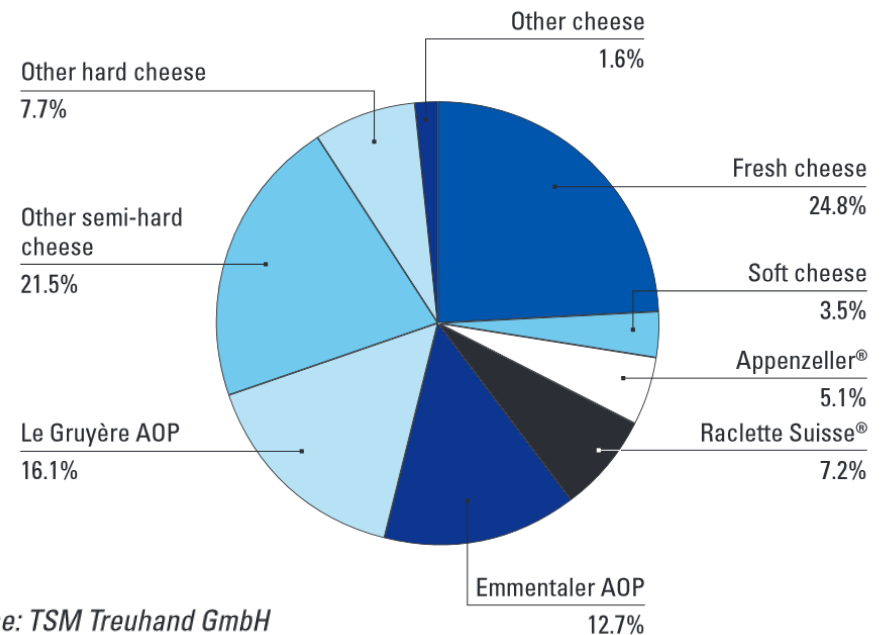
biogas produced

52'500'000 Nm³

1Nm³biogas ~2.1kWh_{el}

110'250'000 kWh_{el}

110'250MWh



Source: TSM Treuhand GmbH

good waste: characteristics

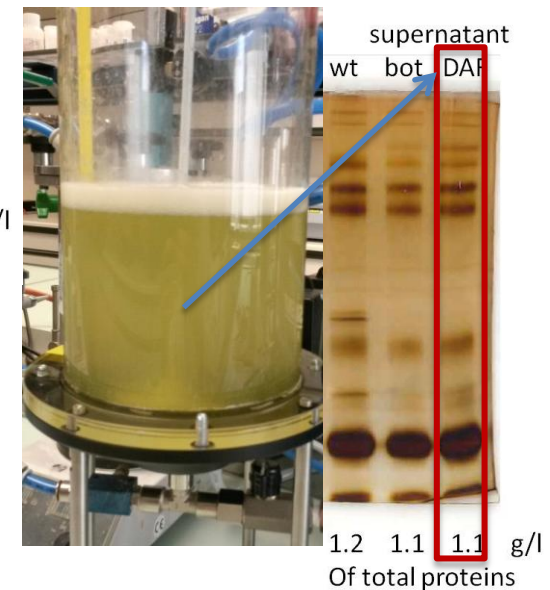
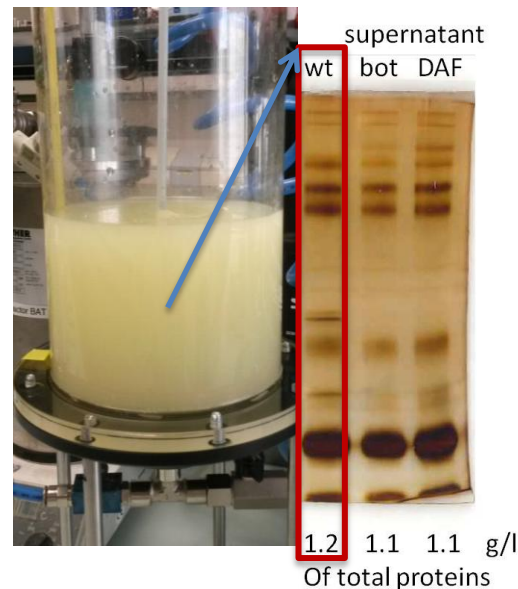
- waste *perceived as problem* with disposal cost
 - unexploited as resource locally and/or with low efficiency
 - locally relevant
 - high organic content
-
- Food sector by-products (exhausted coffee powder)
 - Pharmaceutical waste (yeast culture, bacteria culture)
 - Manure

Cheese whey pre-treatment complementary exploitation of phases: liquid as biogas and fat as other sectors

Fat separation: advantages

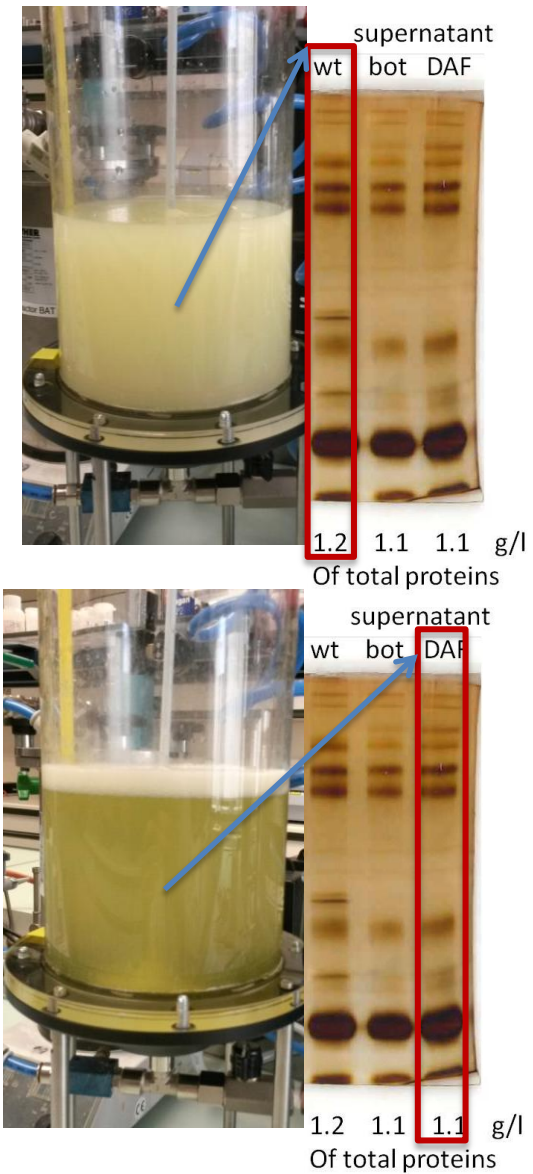
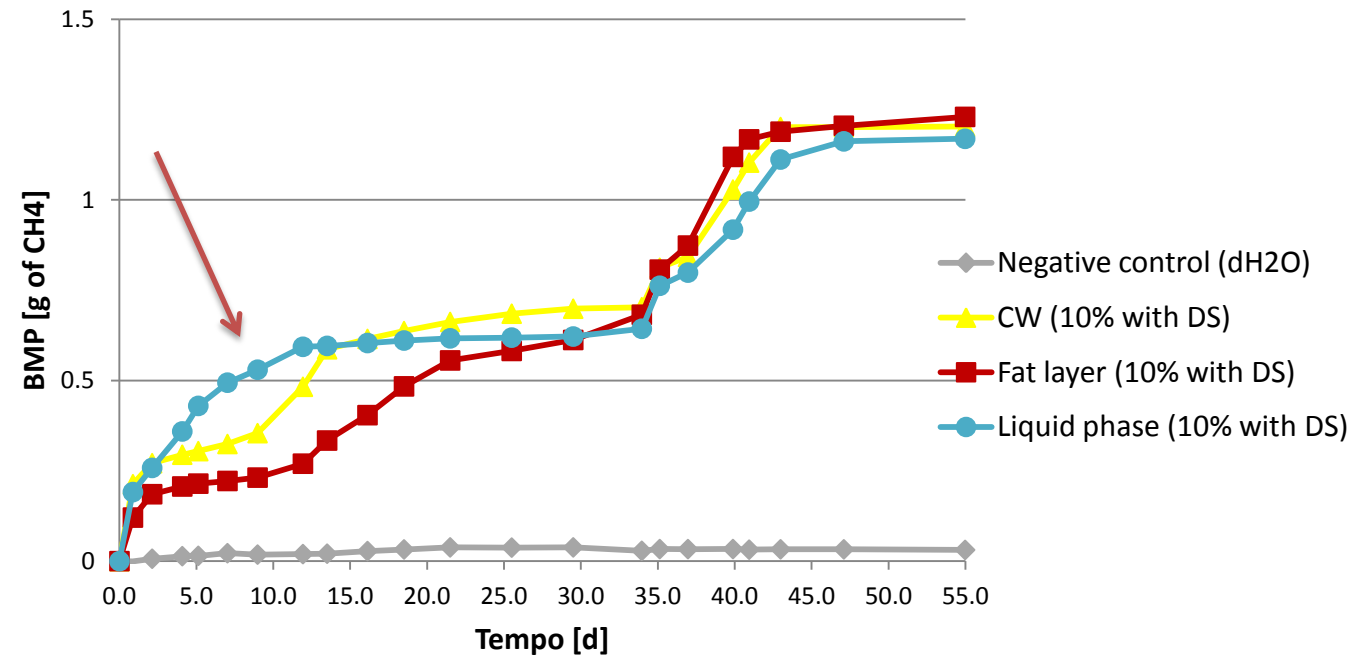
Cheese whey SIERO project characteristics

pH	4.5
COD	60 g/l
NH ₄ ⁺ -N	10.3 mg/l
NO ₃ ²⁻ -N	8.0 mg/l
PO ₃ ²⁻ -P	9.7 mg/l
Total solids	53.9 g/l
Total proteins	1.1 g/l
Fat content	1.0 %
Volatile fatty acids	1.7 g/l
Lactate	34.2 g/l
Acetate	0.5 g/l

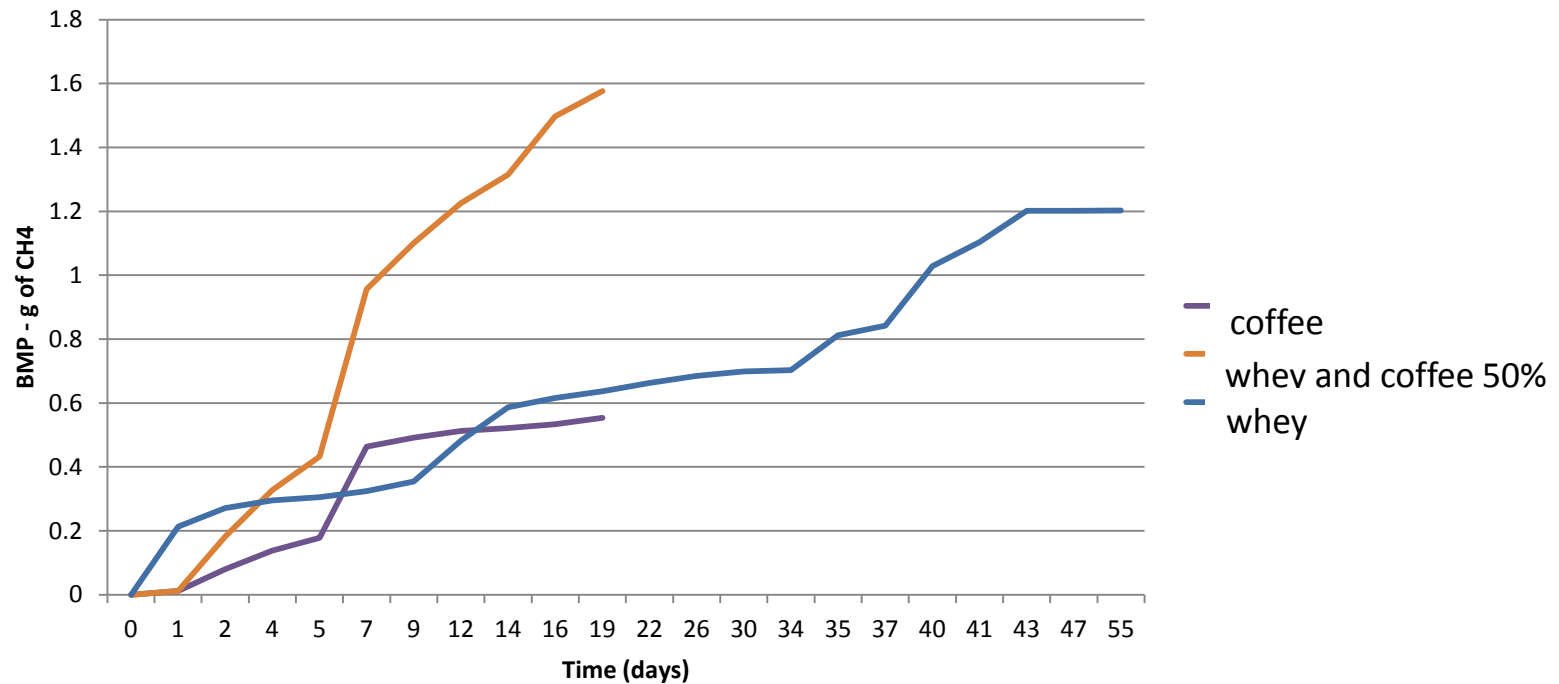


Cheese whey pre-treatment

Fat separation: advantages



Comparison Digestion and Co-digestion of cheese whey and coffee



Conclusions and next steps

Substrate

untapped biomasses

Exhausted coffee, pharma fermentation byproducts, soapstocks

Pretreatment

increase the % of organic matter converted (lignocellulose)

Process efficiency

(CH₄% in biogas)

separate bioreactors and biofilm methanogens

Digested sludge fate

(disposal costs and nutrient recovery)

Acknowledgement

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