MICROALGAE ARE SUITABLE PROTEIN FEEDS FOR LACTATING DAIRY COWS

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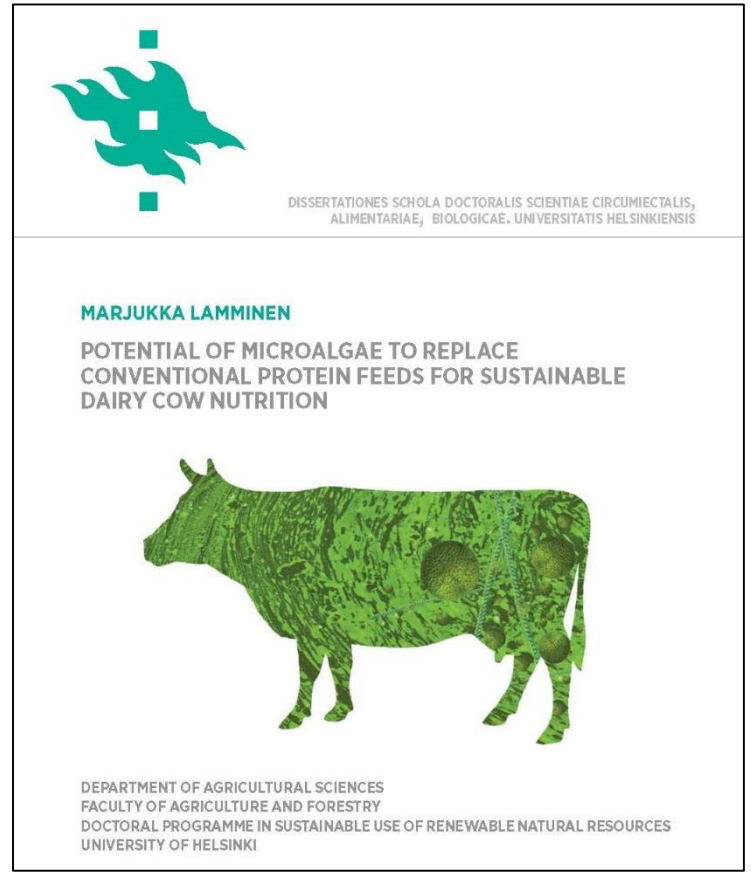
EAAP 2019, Ghent, Belgium
27.08.2019

PRESENTATION IS BASED ON THESE PUBLICATIONS

- Lamminen. 2019. Potential of microalgae to replace conventional protein feeds for sustainable dairy cow nutrition. Doctoral thesis. University of Helsinki. [LINK]
- Lamminen et al. 2019. The effect of partial substitution of rapeseed meal and faba beans by Spirulina platensis microalgae on milk production, nitrogen utilization, and amino acid metabolism of lactating dairy cows. *Journal of Dairy Science* 102: 7102-7117. [LINK]
- Lamminen et al. 2019. Different microalgae species as a substitutive protein feed for soya bean meal in grass silage based dairy cow diets. *Animal Feed Science and Technology* 247: 112-126. [LINK]
- Lamminen et al. 2017. Comparison of microalgae and rapeseed meal as supplementary protein in the grass silage based nutrition of dairy cows. *Animal Feed Science and Technology* 234: 295-311. [LINK]



4 EXPERIMENTS WITH DAIRY COWS - TREATMENTS

Objective: To study the effects of microalgae on milk production, nutrient and nitrogen utilisation and amino acid metabolism

1st Experiment	2nd Experiment	3rd Experiment	4th Experiment
a) Rapeseed supplement (RSS) b) Mixture of *Spirulina platensis* and *Chlorella vulgaris* (ALG) c) Mixture of RSS and ALG • 6 cows in late lactation • Separate feeding • Replicated 3×3 Latin square	a) No protein feed b) Rapeseed supplement *c) Spirulina platensis* d) Mixture of rapeseed and *Spirulina platensis* • 8 cows in late lactation • Separate feeding • Replicated, balanced 4×4 Latin square	a) Soya bean supplement *b) Spirulina platensis* *c) Chlorella vulgaris* d) Mixture of *Chlorella vulgaris* and *Nannochloropsis gaditana* • 4 cows in mid-lactation • Separate feeding • Balanced 4×4 Latin square	a) Rapeseed meal b) Mixture of rapeseed and *Spirulina platensis* c) Faba beans d) Mixture of faba beans and *Spirulina platensis* • 8 cows in mid-lactation • Total mixed ration • Replicated, balanced 4×4 Latin square

In all experiments: grass silage and cereals as a basal diet, isonitrogenous substitution of conv. protein feeds with microalgae

COMPOSITION OF MICROALGAE

	Dry matter, g/kg	Ash, g/kg DM	NDF, g/kg DM	Crude fat, g/kg DM	Crude protein, g/kg DM	Histidine, g/kg CP	Methionine, g/kg CP	Lysine, g/kg CP
Rapeseed supplement (exp. 1-2)	869	68	283	47	316	27	17	49
Rapeseed meal (exp. 4)	877	84	318	41	345	21	16	48
Soya bean supplement (exp. 3)	878	76	145	11	439	27	10	62
Faba beans (exp. 4)	872	43	158	15	310	23	5	56
Spirulina platensis (exp. 1-4)	942	70	0 / 87*	56	688	16	21	40
Chlorella vulgaris (exp. 1,3)	947	54	0 / 15*	109	597	18	20	54
Nannochloropsis gaditana (exp. 3)	962	158	77 / 219*	192	385	18	19	55

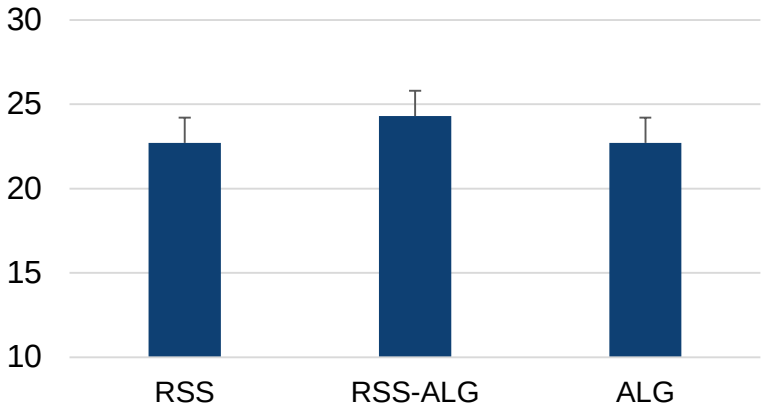
* Depending on the pore size of the NDF crucibles (40-100 µm vs. 16-40 µm)

MICROALGAE IS POORLY PALATABLE

- In separate feeding of concentrates and forages:
  - Cows decreased intake of microalgae concentrates and increased silage intake
  - No effect on total dry matter intake
- In total mixed ration:
  - Microalgae decreased total dry matter intake when cows were no longer able to avoid microalgae in diet
- Big individual differences between cows in palatability → large variation in results → difficulty to reach statistically significant differences

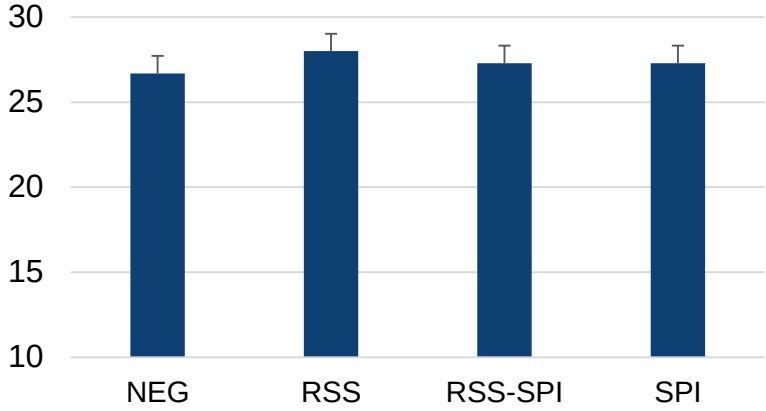
EFFECT OF MICROALGAE ON MILK YIELD (KG/D)

1: Microalgae mix (ALG) vs. rapeseed (RSS)



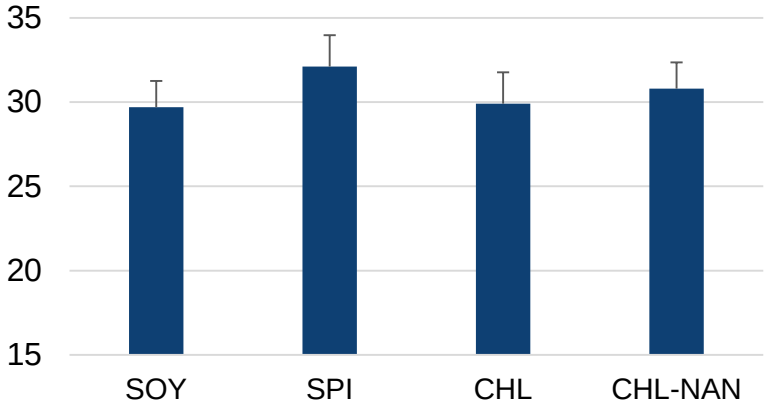
Significance:
Quadratic: P<0.10

2: Spirulina (SPI) vs. rapeseed (RSS)



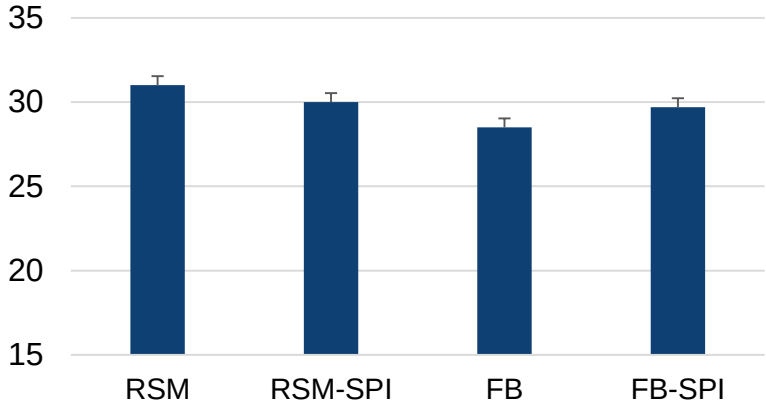
Significance:
None

3: Different microalgae vs. soya (SOY)



Significance:
None

4: Spirulina (SPI) vs. rapeseed (RSM) or faba beans (FB)



Significance:
RSM vs. FB: P<0.001

(RSM vs. FB) × SPI: P<0.01

EFFECT OF MICROALGAE ON MILK COMPOSITION AND NITROGEN UTILISATION

Experiment	Milk yield kg/d	Milk protein %	Milk fat %	Milk N:N intake	N excretion	Human-edible protein efficiency
1 Microalgae mix vs. rapeseed						
2 *Spirulina platensis* vs. rapeseed						
3 Different microalgae vs. soya						
4 *Spirulina platensis* rapeseed						
4 *Spirulina platensis* vs. faba beans						

CONCLUSIONS

- No biological or physiological constraints for protein feed use of microalgae in dairy cow nutrition
- Microalgae are high in methionine (+) but low in histidine (-)
  - Histidine is usually 1st limiting amino acid on grass silage and cereal based diets
- The palatability of microalgae for dairy cows needs to be improved
    - Processing?
- Microalgae are slightly inferior to rapeseed meal, but suit well to substitute soya and faba beans (milk yield, nitrogen utilisation)
    - Impact of poorer DMI or nutritive value or both?
- Some standard feed analysis methods (NDF, *in situ* nylon bag technic. etc.) are challenging with unicellular feed material

Leverage from the EU 2007–2013

European Union
European Regional Development Fund

Maa- ja metsätalousministeriö
Jord- och skogsbruksministeriet
Ministry of Agriculture and Forestry

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RAISIO

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