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Freshwater microalgae as a strategy for methane mitigation in ruminant animals: a pilot study in rumen fermentation

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Introduction

Microalgae is a sustainable animal feed supplement:

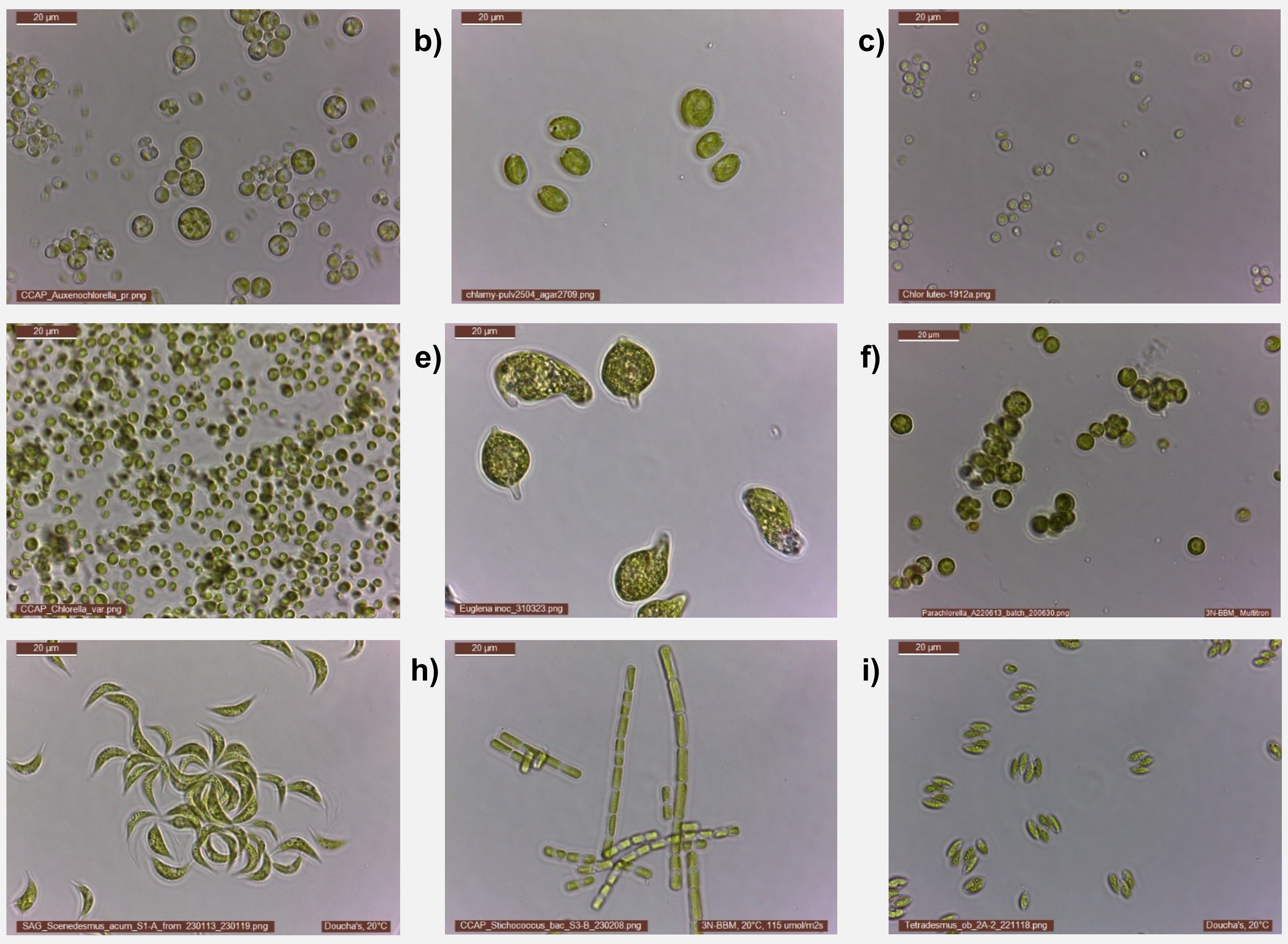
- Converts sunlight and carbon dioxide (CO_2) into biomass.
- Does not require arable land.
- Rich source of lipids, protein, vitamins and antioxidants.

Objective: investigate the potential of freshwater microalgae as ruminal methane (CH_4) mitigating nutritional supplement.

Method Overview

- Grow 10 microalgae species
- Assess nutrient profile

Figure 1. Microalgae cultures in Erlenmeyer flasks growing in the CO_2 incubator, light at 115 μmol/m2.s in a 16h:8h day/night photoperiod cycle at optimal temperature, shaken at 110 rpm.



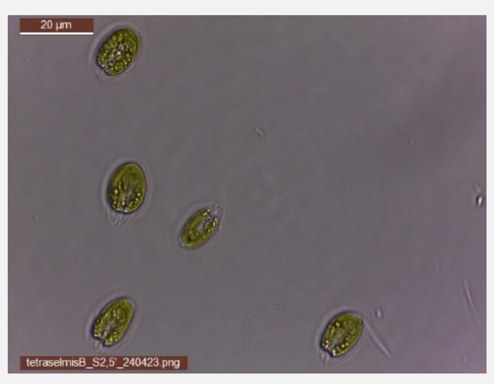


Figure 2. Morphology of microalgae under light microscopy. Magnification: 100 ×. a) *Auxenochlorella protothecoides* (Ap), b) *Chlamydomonas pulvinate* (Cp), c) *Chlorella luteoviridis* (Cl), d) *Chlorella variabilis* (Cv), e) *Euglena mutabilis* (Em), f) *Parachlorella kessleri* (Pk), g) *Tetradesmus acuminatus* (Ta), h) *Stichococcus bacillaris* (Sb), i) *Tetradesmus obliquus* (To), j) *Tetraselmis gracilis* (Tg).

- Test in Hohenheim Gas Test (HGT) according to Menke and Steingass (1988), Soliva and Hess (2007).
- Basal diet (**CON**): 40% grass silage, 40% maize silage, 15% hay, 5% concentrate (DM)
- Treatment: 15% replacement

Figure 3. Hohenheim Gas Test System

Table 1. ***In vitro*** **dietary nutritional profile**

%	CON	Ap	Cp	Cl	Cv	Em	Pk	Sb	Ta	To	Tg
DM	93.6	94.3	93.3	93.7	93.9	93.9	93.6	94.0	94.0	94.1	92.7
OM	92.8	91.5	91.5	92.1	91.7	89.9	92.1	91.9	92.1	92.8	87.7
Ash	6.80	7.86	6.90	6.76	7.34	9.14	6.60	7.21	7.06	6.43	10.2
CP	12.7	13.4	17.4	17.7	18.1	17.5	17.4	16.5	16.8	19.6	15.4
CF	20.9	18.0	18.0	ND	ND	18.3	18.2	ND	ND	17.9	18.0
EE	3.47	4.46	4.57	4.40	4.43	5.53	4.85	4.52	4.48	4.85	4.61
PUFA	0.496	1.38	1.05	1.52	1.04	1.61	1.50	1.24	1.08	1.05	0.834

DM = dry matter; OM = organic matter; CP = crude protein; CF = crude fibre; EE = ether extract; PUFA = polyunsaturated fatty acid; ND = not determined.

Results and Discussion

Table 2. ***In vitro*** **fermentation characteristics**

	LSM											SE	*P*
	CON	Ap	Cp	Cl	Cv	Em	Pk	Sb	Ta	To	Tg		
pH	6.77	6.77	6.80	6.77	6.78	6.78	6.79	6.78	6.80	6.76	6.81	0.03	<0.01
NH_3, mM	11.4	12.8	**16.0**	**14.7**	**17.8**	**19.1**	14.1	**15.4**	**14.1**	**16.2**	**14.1**	3.02	<0.01
IVOMD, %	68.3	**64.8**	**63.2**	**63.1**	**64.8**	**65.6**	**62.9**	**63.4**	**65.5**	**65.4**	**65.1**	1.64	<0.01
Total VFA, mM	54.3	53.4	55.5	53.5	54.2	52.8	54.4	54.6	53.8	53.4	53.6	2.19	0.08

LSM = least squares means; IVOMD = *in vitro* organic matter digestibility; VFA = volatile fatty acids. Numbers in bold and green: *P-value* of the contrast between microalgae vs. control <0.05.

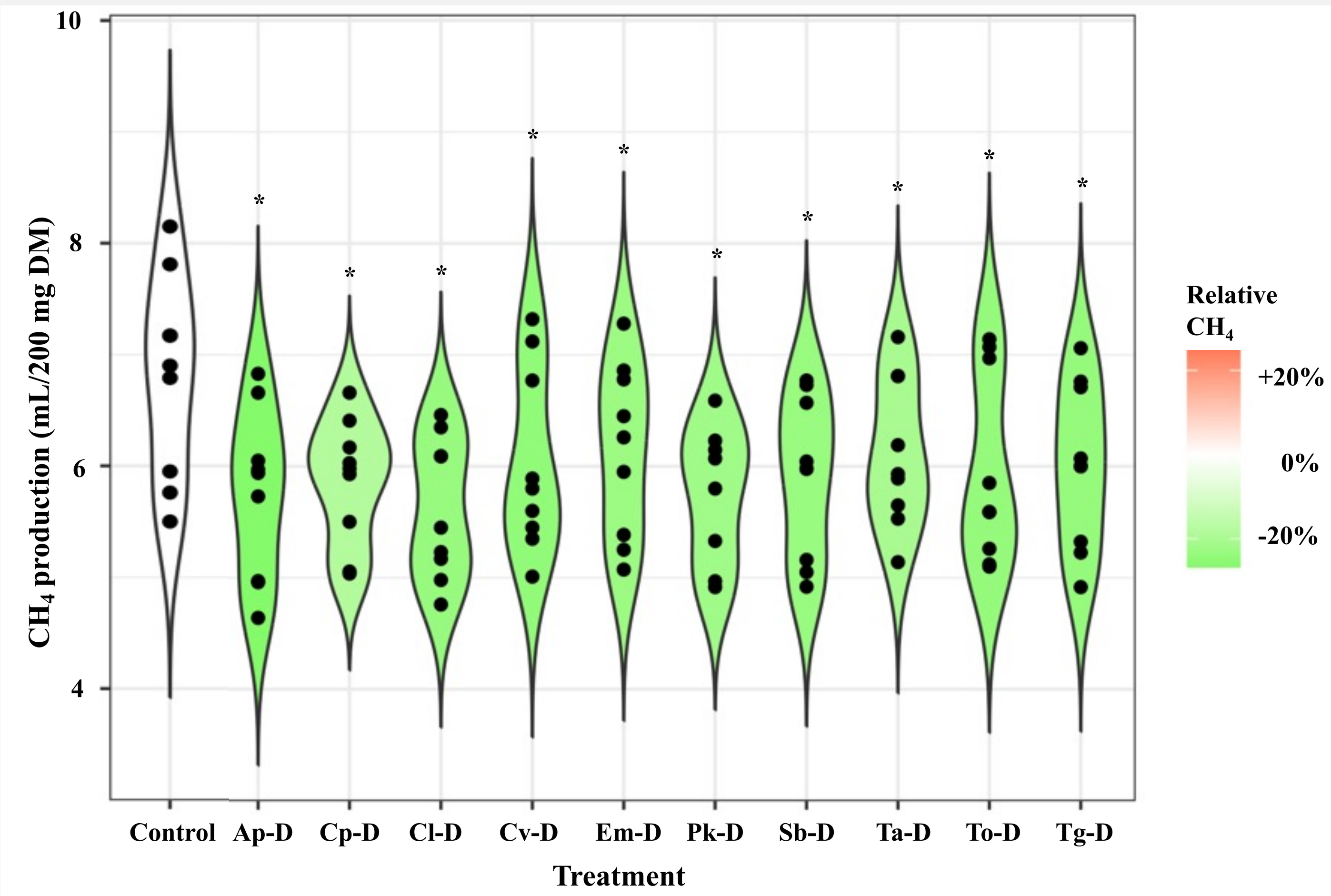


Figure 4. ***In vitro*** ***CH_4*** ***production capability*** **in microalgae containing diets.** **P-value* of the contrast between microalgae vs. control < 0.05

Conclusion

The supplementation of selected microalgae containing diets reduced IVOMD by 4.0 – 7.9%, but also reduced ruminal CH_4 production by 9.7 – 17.4%. Incorporation of high protein microalgae such as *Tetraselmis obliquus* as animal feed supplement could provide both nutritional benefit and increase environmental sustainability.

References

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2. Soliva, C. R., & Hess, H. D. (2007). *Measuring methane emission of ruminants by in vitro and in vivo techniques.* https://doi.org/10.1007/978-1-4020-6133-2_2

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