the production responses (Puhakka et al., 2016). This study investigated how the partial replacement of grass silage by FB silage in FB seed supplemented dairy cow feeding affects animal performance and nitrogen metabolism. Furthermore, it was investigated whether a rumen-protected methionine (RP-Met) supplement could improve the utilisation of FB protein in milk production. We hypothesised that (1) nitrogen utilisation is better on grass than on FB silage containing diets but (2) the nitrogen utilisation of FB can be improved by RP-Met supplement.

Material and Methods

The experiment was conducted at the University of Helsinki (Finland) and designed as a replicated 4 × 4 Latin Square with 21 day periods and 2 × 2 factorial arrangement of treatments. The first factor was forage species in total mixed ration (TMR) and the second factor RP-Met supplement. There were 4 primiparous and 4 multiparous (averaging 31 and 181 days in milk, respectively) Nordic Red dairy cows in this study. Forage was either pure grass silage (*Phleum pratense* and *Schedonorus pratensis*, D-value 664 g/kg dry matter (DM)) or a silage mixture where two thirds of grass silage DM was replaced by FB silage (D-value 593 g/kg DM). Concentrate (400 g/kg of TMR DM) contained barley, oats and FB seeds as protein source (311 g/kg of concentrate DM). Experimental TMRs were offered ad libitum. RP-Met (Smartamine M, Kemin Europa, Herentals, Belgium; 20 g/day digestible Met) was offered with 1 kg/day molassed sugar beet pulp during milkings. Chemical analysis were conducted as described by Puhakka et al. (2016). The data were statistically analysed by ANOVA. The orthogonal contrasts were used to compare the effects of (1) forage species, (2) RP-Met and (3) their interaction.

Results and Discussion

Replacing part of grass silage with FB silage in the dairy cow diet increased DM intake (21.2 vs. 22.6; $P < 0.01$) in line with results reported using whole-crop and legume silages (Jaakkola et al., 2009; Steinshamn, 2010). Furthermore, crude protein (CP) intake and the intake of all essential amino acids (AA) were higher ($P < 0.01$) on diets based on a mixture of FB and grass silage relative to grass silage only. FB silage increased ($P = 0.05$) plasma leucine and decreased ($P \leq 0.02$) methionine and threonine concentrations compared with grass silage. RP-Met increased ($P \leq 0.04$) plasma arginine, lysine and methionine concentrations (21.0 vs. 47.3 μmol/l) as well as AA (cystine and taurine) that can be metabolised from methionine. Forage species had no effect on the proportion on N excreted in urine or feces (averaging 45 and 38 %, respectively), but FB silage increased ($P < 0.01$) the amount of N excreted in urine by 24 % and in feces by 26 %. The increase in excretion is in line with the higher CP intake, when forage contained FB silage. Interestingly, RP-Met supplementation decreased energy corrected milk yield and protein yield when the forage was purely grass silage, but increased them when FB silage was dominating the forage ($P \leq 0.03$ for interaction). It seems that mammary gland methionine supply was limiting milk protein synthesis, when the diet contained a large proportion of FB. Furthermore, the utilisation of feed protein to milk protein was decreased by RP-Met on the grass silage based diet (289 vs. 276 g/kg) but improved, when forage contained also FB silage (234 vs. 249 g/kg), without reaching the level of grass silage diets. Milk urea concentration was lower ($P < 0.01$) on grass silage based diets compared with FB silage containing diets (27.2 vs. 33.5 mg/dl).

Conclusion and Implications

Nitrogen utilisation was higher on diets based on pure grass silage compared with FB silage containing forage mixture. RP-Met improved energy corrected milk yield, milk protein yield and nitrogen utilisation, when the dairy cow diet contained FB both as protein feed and as a major part of forage. However, RP-Met supplementation was ineffective on diets based on grass silage only.

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O119 Effect of different ensiling treatments of *Alaria esculenta* on *in vitro* ruminal fermentation

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Introduction

Recently the interest in seaweeds as alternative animal feed has increased due to their high concentration in bioactive compounds, minerals and macronutrients, as well as their potential ability to reduce enteric CH_4 emissions. However, their high water content limits stor-

Table 1
Fermentation parameters after 24 h of *in vitro* incubation of *Saccharina latissima* and different silages using rumen inoculum from goats.

Sample		Fresh	Control	FA	ALB	30ALB	*P*	SEM
Gas (ml/g DM)		90.0[2]	84.4[1]	98.3[3]	90.7[2]	94.9[3]	[b]	1.148
Total VFA (mmol/g DM)		2.43	2.45	2.55	2.44	2.42	-	0.055
Molar proportions (mol/100 mol)	Acetate	64.3[1]	70.9[3]	68.0[23]	66.6[2]	69.0[23]	[c]	0.23
	Propionate	24.5[3]	15.5[1]	19.8[2]	20.7[2]	17.2[1]	[c]	0.287
	Butyrate	6.12[1]	7.21[2]	6.39[1]	6.59[1]	7.51[2]	[c]	0.042
	Minor	5.12[1]	6.43[3]	5.79[2]	6.11[2]	6.30[23]	[c]	0.023
Acetate/Propionate (mol/mol)		2.66[1]	4.60[3]	3.44[2]	3.24[2]	4.05[3]	[h]	0.014
NH3-N (mg/100 ml)		13.3[1]	18.6[3]	15.1[12]	16.3[2]	15.0[12]	[c]	0.773
CH4 (ml/g DM)		7.10[1]	7.97[12]	9.94[3]	8.58[2]	9.71[3]	[c]	0.405
CH4/VFA (ml/mmol)		2.92[1]	3.36[2]	4.07[3]	3.64[2]	4.05[3]	[b]	0.221

[a] $P < 0.05$.
[b] $P < 0.01$.
[c] $P < 0.001$.
[1-3] For each parameter, average values not sharing the same superscript differ ($P < 0.05$). FA, formic acid; ALB, acid lactic bacteria.

age and handling, and consequently procedures for their conservation are needed. Ensiling is one of the most used methods to preserve forages and high-moisture feeds and could be an alternative for seaweeds preservation (Novoa-Garrido et al., 2020). Therefore, the aim of this study was to analyze the chemical composition and *in vitro* ruminal incubation of fresh and different silages of *Alaria esculenta* as a potential feed for ruminants.

Material and Methods

Samples of *A. esculenta* were collected at the coast of Bodø (Norway) and chopped. Four types of silage were assessed: no additives (CONS) or with formic acid (FAS; 4ml/kg), lactic bacteria (LBS), and seaweed pre-wilted to 30% dry matter (DM) before adding lactic bacteria (PLBS). Silages were prepared in duplicate in 1kg vacuum bags as described by Yen et al. (2022), and were stored for 90 days at 16°C before being opened, freeze-dried and ground (1mm screen). Fresh seaweed and silages were analyzed for chemical composition (AOAC, 2005) and incubated *in vitro* with ruminal fluid from sheep (4 replicates/sample) as described by De Evan et al. (2020). After 24h of incubation, final pH, production of volatile fatty acid (VFA) and CH_4, and NH_3-N concentrations were measured. The data were analyzed with PROC MIXED of the SAS using a mixed model in which the effect of the seaweed treatment was considered fixed and that of the ruminal inoculum was considered random.

Results and Discussion

Ensiling did not affect ($P > 0.05$) the crude protein content of *A. esculenta* (16.3-17.5 g/kg DM), but the content of NDF and ADF in fresh seaweed (385 and 253 g/kg DM, respectively) was greater than that in the silages (265 and 206 g/kg DM; averaged values for all silages), indicating a degradation of fiber compounds during ensiling. As shown in Table 1, total VFA production was greater ($P < 0.05$) for all silages, being PLBS the silage with the greatest total production, which agrees with their lower pH compared with the fresh seaweed and suggests that ensiling increased the rumen degradability of *A. esculenta*. Molar proportion of individual VFA differed ($P < 0.001$) among samples. The greatest proportion of acetate was observed for the fresh seaweed and FAS silage, whereas PLSB showed the lowest propionate proportion, the highest butyrate and minor VFA proportions, and the highest acetate/propionate ratio. All silages produced greater amounts of NH_3-N, indicating that protein degradation was produced during ensiling. However, all silages increased CH_4 production compared with the fresh seaweed, which could be related to the increased fermentation of the silages, as there were no differences ($P = 0.338$) among samples in the CH_4/VFA ratio.

Conclusion and Implications

Ensiling *Alaria esculenta* improved its ruminal degradation, resulting in greater VFA production and lower ruminal pH. Pre-wilting the seaweed to 30% DM before ensiling with lactic bacteria as additive was the most effective method to increase ruminal degradability.

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