Amazing Grazing: feed wedge and cutting window for grazing systems with high levels of supplementation

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Keywords: Amazing Grazing, feed wedge, cutting window, grass utilisation, feed supplementation

Introduction

In the Netherlands, many dairy systems are characterised by alternating use of grassland for grazing and fodder production and high levels of feed supplementation during the grazing season. A planning tool 'Grip op Gras' was developed to optimise on-farm fresh grass utilisation for these systems.

Materials and methods

'Grip op Gras' combines a feed wedge and cutting window and is based upon estimates of the DM yield of all on-farm grassland paddocks. The feed wedge in 'Grip op Gras', unlike existing feed wedges (Anonymous, 2009), varies the size of the grazing platform while target yield and target residual are fixed. So it can be decided which paddocks to use for grazing or fodder production, or to adjust the level of supplementation. Paddocks planned to be used for fodder production are moved from the feed wedge to the cutting window where information is provided to determine the best time for cutting. The default expected grass growth (kg DM ha^{-1} day^{-1}) can be adjusted by the user. 'Grip op Gras' was tested in practice by ten dairy farmers and advisors between April and July 2017. Half of them were familiar with estimating DM yield and the use of a feed wedge (group A), while the other half were not (group B). During the test period, participants provided weekly feedback.

Results and discussion

The use of data and tools in grassland management is not common practice in the Netherlands. Therefore, it was difficult to identify farmers and advisors willing to measure DM yield of all on-farm paddocks on a weekly basis and to use 'Grip op Gras'. Finally, only group A used 'Grip op Gras' weekly in their grassland management. The participants found that user-friendliness could be improved, especially in relation to input of data. The default expected grass growth was highly appreciated by the participants since it clarified the effect of time on grass availability for cutting and grazing. Utility and user-friendliness of 'Grip op Gras' was dependent on whether the user was familiar with the use of tools and data in grassland management; the more experienced had fewer problems than the less experienced.

Conclusion

The concept of the feed wedge and cutting window in 'Grip op Gras' was considered to be appropriate and satisfactory by the test panel of dairy farmers and advisors. A next step would be to improve the user-friendliness of the program.

References

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Optimising grass silage quality for green biorefineries

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Abstract

A pilot scale ensiling study was conducted to establish if liquid-solid separation of timothy and red clover silages could be improved by additive treatments. The treatments were controlled without additive, a formic acid based additive, a fibrolytic enzyme and a combination of formic acid and enzyme. Fibrolytic enzyme resulted in improved outcomes in this experiment. Furthermore, the results provided quantitative estimates of liquid yield and quality of liquid-solid separation of grass silages, useful for biorefinery pre-processing.

Keywords: additive, formic acid, enzyme, liquid-solid separation, timothy, red clover

Introduction

Grass provides a versatile raw material for green biorefineries and effectively converts solar radiation into chemical forms of energy. If preserved as silage, it can be used as feedstock all year round and existing technology is available for its cultivation, harvesting and ensiling (Wilkinson and Rinne, 2017). Ensiling converts water soluble carbohydrates into lactic acid and volatile fatty acids and protein is degraded to a varying extent. These changes may reduce the value of biomass entering a green biorefinery. However, ensiling may also serve as a pre-treatment for biorefining, thus indicating a potential trade-off. The objective of the current experiment was to evaluate how two forage species (timothy (*Phleum pratense*) vs red clover (*Trifolium pratense*)) and silage additive treatments (no additive, formic acid and fibrolytic enzymes) affect silage quality for biorefining. Yield from physical liquid-solid separation was used as an indicator as it is typically the first step of a green biorefinery.

Materials and methods

The experimental grass silages were produced at Jokioinen, Finland (60°48'N, 23°29'E) on 24 August 2016. The silages were second cut from pure stands of timothy and red clover. Both swards were harvested with a precision chopper without wilting and ensiled immediately in pilot scale silos, using three replicates per treatment. The treatments were controlled without additive (C), formic acid based additive (FA; AIV2 Plus, Eastman Chemical Company, Oulu, Finland at a rate of 5 l ton^{-1} fresh matter), a fibrolytic enzyme (E; Flashzyme Plus containing cellulase and hemicellulase activities, Roal Ltd., Rajamäki, Finland at a rate of 0.5 ml kg^{-1} DM) and a combination of FA and E (FA+E; first FA and then E from separate bottles). The silos were stored at room temperature with protection from light and opened after an ensiling period of 92 days. The liquid-solid separation was performed using two different laboratory scale methods: a double screw press (DS; Angel Juicer Ltd., Busan, South Korea) and a pneumatic press (PP; in-house built equipment, Luke, Jokioinen, Finland). The silage and respective juice fractions were analysed for chemical composition using routine methods, as described by Seppälä *et al.* (2016). Statistical analyses were performed using SAS GLM procedure separately for both species, and differences between treatment means were evaluated using the Tukey test.

Results and discussion

The chemical composition of the raw materials was not optimal because of exceptionally low crude protein (CP) concentration of timothy and DM concentration of red clover (Table 1). The plots were not fertilised after the first cut, which explains the low CP and ash concentrations of timothy. The humid weather around the second cut was reflected as low DM concentration of the ensiled materials. This resulted in poor quality of C silages, particularly in red clover (Table 2). The FA treatment effectively restricted fermentation and improved the fermentation quality and positive responses were also found with treatment E, particularly in red clover. The liquid yields were 0.661 and 0.420 (averaged over both species and all additive treatments) for DS and PP, respectively, showing a clear difference in the effectiveness of the liquid-solid separation methods (Table 2). The DM concentrations of the liquids were 68 and 49 g kg^{-1} for DS and PP, respectively, and lower than in our previous experiments (Rinne *et al.,* 2017), probably due to the low DM concentration of the original silages. The red clover liquid had 28% lower DM concentration but 44 and 39% higher ash and CP concentrations, respectively, than the timothy liquid, reflecting the silage composition. Although the results were not totally consistent, it seems that application of E could improve the amount of DM retained in the liquid fraction in mechanical separation of silage, which is consistent with Rinne *et al.* (2017).

Table 1. Description of the original silages.

	Timothy	Red clover
Dry matter (DM), g kg^{-1}	210	129
Buffering capacity, g lactic acid100 g^{-1} DM	4.4	11.2
In vitro organic matter digestibility	0.628	0.599
In DM, g kg^{-1}		
Ash	59	89
Crude protein	78	176
Water soluble carbohydrates	170	60
Neutral detergent fibre	592	485

Conclusion

The use of a fibrolytic enzyme and/or formic acid as a silage additive impacted (mostly marginally) on various characteristics likely to be relevant to biorefinery. Furthermore, the results provide quantitative estimates of liquid yield and quality of liquid-solid separation of grass silages for a biorefinery process.

References

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Table 2. Composition of the silages preserved using different additives[1] and subsequent liquid characteristics after mechanical separation.

	Timothy				SEM[2]	*P*-value[3]	Red clover				SEM	*P*-value
	C	FA	E	E+FA			C	FA	E	E+FA		
Dry matter (DM), g kg^{-1}	211	208	211	206	5.8	0.843	138	140	139	137	0.9	0.297
pH	3.77^{b}	3.93^{a}	3.78^{b}	3.85^{ab}	0.017	<0.001	5.49^{a}	4.07^{c}	4.36^{b}	3.95^{c}	0.027	<0.001
Ammonium N, g kg^{-1}N	60^{b}	84^{a}	63^{b}	82^{a}	3.4	0.002	113^{a}	95^{b}	94^{b}	83^{b}	3.0	0.001
Chemical composition, g kg^{-1} DM												
Ash	69	69	70	69	0.9	0.72	101^{a}	88^{b}	96^{a}	90^{b}	1.2	<0.001
Crude protein (CP)	84	93	89	92	2.8	0.175	191^{a}	181^{b}	192^{a}	182^{b}	1.8	0.005
Water soluble carbohydrates	33.3^{a}	17.6^{b}	30.1^{ab}	16.9^{b}	3.02	0.009	3.0^{c}	14.0^{b}	2.6^{c}	16.4^{a}	0.46	<0.001
Ethanol	49.8^{b}	61.4^{ab}	58.7^{ab}	71.6^{a}	4.15	0.036	39.8^{a}	12.0^{c}	12.7^{c}	17.6^{b}	0.81	<0.001
Formic acid	0.1^{b}	12.3^{a}	0.2^{b}	10.0^{a}	0.57	<0.001	4.5^{b}	33.7^{a}	1.1^{b}	31.7^{a}	1.48	<0.001
Lactic acid	105^{a}	53^{b}	100^{a}	60^{b}	4.4	<0.001	2^{b}	21^{ab}	56^{a}	21^{ab}	10.8	0.041
Acetic acid	19.5	20.0	17.3	20.4	1.55	0.515	70.1^{a}	17.4^{c}	60.8^{b}	17.5^{c}	0.51	<0.001
Propionic acid	0.5^{b}	1.0^{a}	0.5^{b}	1.0^{a}	0.016	<0.001	6.3^{b}	1.4^{c}	9.1^{a}	1^{c}	0.28	<0.001
Butyric acid	0	0	0	0	-	-	1.7	1.4	0.2	0	0.57	0.170
Liquid characteristics												
Proportion of fresh matter (DS[4])	0.623	0.610	0.637	0.643	0.0096	0.145	0.700	0.697	0.671	0.707	0.0081	0.061
Proportion of fresh matter (PP[5])	0.355	0.336	0.362	0.384	0.0107	0.071	0.479	0.488	0.467	0.492	0.0154	0.678
DM, g kg^{-1} (DS)	78.4	70.8	78.5	71.5	2.39	0.087	51.5^{a}	61.8^{b}	63.0^{bc}	64.8^{c}	0.63	<0.001
DM, g kg^{-1} (PP)	58.9	52.8	57.3	55.8	1.39	0.068	33.5^{a}	41.4^{b}	42.8^{b}	48.4^{c}	0.87	<0.001
DM retained in liquid (DS)	0.261^{ab}	0.232^{a}	0.292^{b}	0.259^{ab}	0.0119	0.045	0.279^{a}	0.330^{a}	0.322^{a}	0.362^{b}	0.0120	0.008
DM retained in liquid (DS)	0.100	0.092	0.112	0.122	0.0082	0.128	0.115^{a}	0.142^{ab}	0.130^{ab}	0.181^{b}	0.0133	0.041
Ash, g kg^{-1}DM (DS)	117	148	169	179	18.2	0.158	243	227	195	179	16.8	0.098
Ash, g kg^{-1}DM (PP)	147	169	150	155	10.1	0.441	282^{a}	175^{b}	254^{a}	221^{ab}	18.1	0.015
CP, g kg^{-1}DM (DS)	112	117	119	118	3.4	0.499	186^{a}	158^{b}	188^{a}	162^{b}	3.1	<0.001
CP, g kg^{-1}DM (PP)	84	85	87	84	2.8	0.785	121^{a}	98^{a}	110^{c}	99^{b}	1.1	<0.001

[1] C = control without additive, FA = formic acid based additive, E = fibrolytic enzyme, FA + E = FA and E combined.
[2] SEM = Standard error of the mean.
[3] Statisical significance between treatments. The treatment means were further separated using Tukey's test and means with different superscripts differ at $P < 0.05$.
[4] DS = Double screw juicer.
[5] PP = Pneumatic press.