Biochemical methane potential of timothy, tall fescue and red clover silages harvested at different stages of maturity


MTT Agrifood Research Finland
Background:

• In Finland grass silage is one optional raw material for biogas production

• The production costs of grass silage should be covered by the price of methane, not yet economically feasible

• Is there any possibilities to cut down the production costs of grass silage?
• machinery costs make up one third of the silage production costs (Peltonen, 2010).

• Typically dairy farms have effective machinery to harvest the silage as optimal harvest time is only one week in first cut.
• One possibility to reduce machinery cost is to divide the capital cost over a larger amount of silage harvested. If the optimal harvest time for a biogas plant differs from the optimum of a dairy herd, the same machinery could be utilized for both purposes.

• Is it possible to delay the harvest? How rapidly does biochemical methane potential (BMP) drop when grass matures?
Quite much research work is already done related to relationship between digestibility, grass maturity and the weather conditions, but there is not data available how these are reflected to BMP of the harvested grass silage.
Materials and methods:

- **12 frozen silage samples** collected in earlier experiments as time series of harvest times
  - 6 samples silages from *grass species*, primary growth:
    - mixture sward timothy/meadow fescue (*Phleum pratense / Festuca pratensis*)
    - tall fescue monoculture (*Festuca arundinacea*)
    both harvested at three different stages of maturity
  - 6 samples, silages **red clover** (*Trifolium pratense*) monoculture: two primary growth and four regrowth silages

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Materials and methods:

- In vivo digestibility measured in digestibility trial using sheep
- In vitro digestibility measured using sellulase method
- Indigestible NDF content of the silages measured using nylon bag technique as 12 days incubation in rumen
- Dry matter, ash, crude protein, ash, NDF, ADF, lignin

-Biochemical methane potential (BMP) measured using the automated methane potential test system (Bioprocess Control AB, Sweden)
- BMP measured as three replicates – only 12 samples could be measured at the same time
Which of the parameters are able to explain differences in BMP potential?

A regression model $Y_{ijk} = A_i + B_j \cdot X + e_{ijk}$ was fitted to the data separately for each independent continuous numeric variable, using REG procedure of SAS.

Units are presented on DM bases as this is the practice of the D-value predicting services available at the moment in Finland.
Results:

- **Grass silages**
  BMP was 344 l CH$_4$ kg$^{-1}$ VS and BMP decreased with increasing maturity.

- *in vitro* digestibility predicted the BMP with a high coefficient of determination ($R^2 = 0.79$).

- In spite of the high correlation, the slope between BMP and D-value had a small value.

![Graph](attachment:image.png)

\[ y = 0.1782x + 200.52 \]

\[ R^2 = 0.789 \]

- red clover, 1.cut
- red clover, 2.cut
- cut grass species, 1.cut
- cut grass species, 2.cut
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![Graph showing some more samples]
• The practical value of the result:

It seems that BMP of the grass primary growth can be predicted using the same system developed for milk production.

However, when D-value changed from 700 to 600 g kg$^{-1}$ DM, the BMP decreased only 5 %.
• **Red clover**

The average BMP of clover silages was 291 l CH$_4$ kg$^{-1}$ VS.

• Unlike grass silages, the differences in chemical composition or digestibility of the clover silages did not explain the differences in BMP results in this data.
Results:

- **Red clover**

  The average BMP of clover silages was $291 \text{ l CH}_4 \text{ kg}^{-1} \text{ VS}$.

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The combined effects of changes in grass maturity and yield on total methane yield were demonstrated assuming that the start of harvest of primary growth varied.

- Weather data from 2010 and
- Finnish forage yield and quality models

- Timing of first cut was restricted so that digestible organic matter was 570 – 730 g kg\(^{-1}\) DM
- and the start of the second cut started 30 days after the finish of first cut but not earlier than 30\(^{th}\) July.
When combined with the yield accumulation data, it is concluded that towards the end of June the yield increases rapidly compared to the decrease in BMP. Based on these calculations, postponing the first harvest appears to be beneficial for a biogas plant.
In the calendar of contractor:

- Work for the whole summer, better summer job for good drivers
- Easier to invest to good machinery

Benefit for both dairy herd and biogas plant:
Possibly more efficient system is reflected as lower harvesting cost
Conclusions

Increasing maturity reduces specific BMP of harvested grass silages. Our results suggest, however, that postponing the first harvest appears to be beneficial for a biogas plant as the increase in yield exceeds the reduction in specific BMP. This result is important on areas where dairy herds and biogas plants would be using the same harvest machinery.

Thank You! Kiitos!

Silage harvested in the midnight sun in Jokioinen, in Southern Finland