# Development of near infrared (NIR) spectroscopy techniques for analysing the nutritive value of fresh silage.

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## Abstract

Near infrared (NIR) spectroscopy has been used for several years in Victoria for commercial testing of feed quality, including silage. NIR is a rapid and convenient alternative to wet chemistry methods, which are time consuming and expensive. However, silage analysis by NIR has been limited to oven-dried samples. Volatile compounds are lost during the drying process. The development of NIR techniques for fresh silage will improve efficiency by eliminating the drying and grinding process as well as preventing volatile losses. Fresh and oven-dried silage samples were scanned using two NIR instruments. Both dried and ground samples were analysed for dry matter (DM), crude protein (CP), dry matter digestibility (DMD) and neutral detergent fibre (NDF) using standard analytical procedures. Total nitrogen and pH were also determined on the undried samples. This study will compare the accuracy of NIR calibrations developed on both fresh and dried silage and will examine the feasibility of predicting fermentation characteristics in fresh silage using NIR.

## Key Words

Near infrared (NIR) spectroscopy, nutritive value, fermentation characteristics, silage

## Introduction

The nutritive value of silage is most commonly assessed on dried, ground material but volatile compounds are lost during the drying process. High drying temperatures may cause protein denaturation (2) or non-enzymatic browning due to ‘Malliard’ reactions (5, cited in 2), which could affect the nutritive assessment. Commercial testing of silage quality currently involves drying (60-65?) and grinding a sub-sample, then scanning it with an NIR spectrophotometer and applying a calibration equation to the spectra in order to predict nutritive characteristics. The existing silage calibration used by the FEEDTEST laboratory at the Pastoral and Veterinary Institute (PVI) was derived from a broad range of silage samples. Wet chemistry analysis is conducted on selected samples to check the accuracy of the NIR predictions.

NIR analysis of fresh silage would avoid the need for drying and grinding, and overcome the problem of volatile losses. However, the high moisture content and heterogenous nature of fresh silage can result in reduced calibration accuracy compared to dried and ground silage.

## Methods

Perennial ryegrass (*Lolium perenne* L.) and tall fescue (*Festuca arundinacea* Schreb.) pasture was harvested from two experimental sites at the PVI, in 2000 and ensiled in pickling jars. Undried silage was scanned using a Foss-NIRSystems model 6500 spectrophotometer (spectral range 400-2500 nm). A sub-sample of dried (60?), ground material was also scanned using a Foss-NIRSystems model 5000 spectrophotometer (spectral range 1100-2500 nm). Silage DM, feed quality attributes determined by NIR (CP, NDF, DMD) and reference methods used for the NIR calibration were determined using standard analytical procedures (1, 3, 6). Fermentation characteristics including pH (3) and total nitrogen were determined on undried samples.

## Results and Discussion

Table 1 indicates the range in quality attributes for fresh and dried silages made from ryegrass and tall fescue. The NIR spectra for a fresh and dried sample of tall fescue silage harvested in the morning are illustrated in Fig.1 and Fig. 2 respectively. The prominent absorption peaks in Fig. 2 include water at 1940 and 1445 nm, aliphatic –CH peaks (lipids) at 2310, 1725, 1400 and 1210 nm, and –OH peaks (carbohydrates) around 2100 and 1600nm (4). The absorptions at 2180 and 2055 nm are due to amide structures present in protein (7). The stronger absorption peaks in Fig.1 emphasise the much higher moisture content in fresh silage and its masking effect on other spectral features.

**Table 1: Quality attributes of fresh and dried samples of perennial ryegrass and tall fescue silage (n=96)**

| | NIR-predicted values in dried silages | | | |
|---|---|---|---|---|
| Species | DM% | CP% | NDF | DDM |
| Lolium perenne L. | 16.6-23.4 | 8.2-11.5 | 52.7-73.6 | 62.0-70.0 |
| Festuca arundinacea Schreb | 16.2-23.5 | 11.6-19.4 | 49.4-74.8 | 61.6-71.0 |

| | pH and protein concentrations in fresh silages | | |
|---|---|---|---|
| | pH | CP (%FW) | CP (%DM) |
| Lolium perenne L. | 3.8-5.4 | 1.3-2.1 | 6.9-9.7 |
| Festuca arundinacea Schreb. | 3.9-8.1 | 1.5-3.6 | 8.2-19.6 |

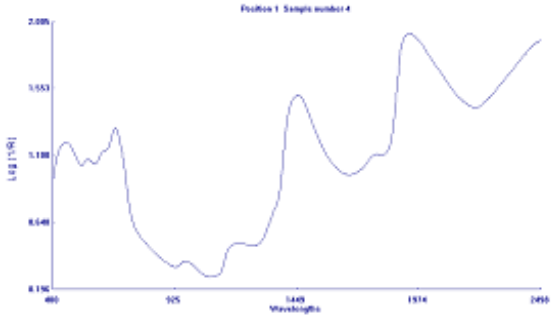

**Fig. 1 Fresh Silage NIR Spectra Fraydo AM cut)**

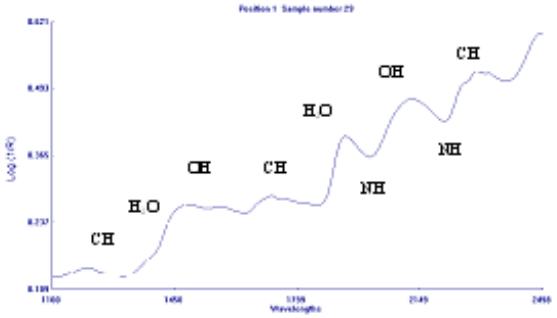


**Fig. 2 Dried Silage NIR Spectra (Fraydo AM cut)**

## Conclusion

The range of silage quality found in this study suggests that the data set is suitable for use in the development of an NIR calibration based on undried silage. This work is still in process.

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