

# Assessment of Feed Quality by Non-destructive Methods

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## Abstract

For the optimal optimization of feed ration, it is crucial to assess the quality of the forage feed to dairy cows. To have a good production of milk and meat on a cattle farm, the farmers must collaborate with the nutrition and feed control laboratories in order to formulate in a timely manner feed that is nutritionally sound. Non-destructive procedures provide benefits such as high sensitivity and minimal sample preparation. The portable instruments of near infrared spectroscopy can be utilized in "on line" and "offline" modes, removing the need for lengthy response times and allowing for fast intervention in the prevention and/or correction of disorders. When determining the feed ratio for dairy cows, one of the physical parameters that are considered is nitrogen, and implicitly the protein level, which can also be readily measured using the Dumas analysis method. The paper presents the analysis of the protein content of various vegetable substrates with that are fed to dairy cows, results obtained by applying both destructive and non-destructive techniques.

**Keywords:** dairy cows, feed ration, non-destructive methods, physico-chemical properties

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## 1. Introduction

Today's optical methods are reliable, quick, and non-destructive analytical tools that can be thought of as a good substitute for conventional chemical analysis.

The ability to assess a wide variety of agricultural product components, including those with both plant and animal origins, utilizing spectral approaches has been demonstrated in several studies over the past few decades.

There are numerous analyzers available right that make it possible to precisely ascertain the composition of the feed being studied both during sampling and in flow mode [1].

The rapid advancement of non-destructive techniques for assessing feed quality includes imaging-based, spectroscopy-based, and other pertinent applications including the electronic

tongue, electronic nose, and dielectric techniques [2]. Recently, the NIRS technique has become an extremely used and precise method for determining the quality of forage.

The quality of fodder is influenced by the climatic conditions of the respective year and the conservation methods. The Dumas method is another quick approach that is used for the quick analysis of the total nitrogen and protein content of vegetable substrates.

The Dumas method consists in burning the sample of known mass in a high-temperature range of 800 – 900 °C in the presence of oxygen, nitrogen, and helium.

Nondestructive methods have made progress, being useful for obtaining quantitative and qualitative data, destroying the sample, and offering several advantages, such as high sensitivity, adequate response time and minimal sample preparation [3].

The incorporation of IR analyzers into automated feed quality control methods may be an effective way to enhance product quality and streamline the

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entire feed process. Controlling the quality of farm animal feed is crucial for improving the farm's production operation [1]. Non-destructive methods have been developed to detect the physico-chemical composition of dry or fresh fodder by replacing traditional methods that are too expensive, unsafe, difficult, and tedious [4].

Non-destructive procedures make it possible to evaluate the characteristics and quality of food products without damaging them, even before they are harvested and throughout the distribution chain. Through the integration of numerous algorithm tools, the availability of dependable and quick non-destructive equipment delivers information based on the food quality directly with high accuracy [5]. The development of portable technologies for the detection of feed quality, particularly during postharvest processing, has moved the focus to non-destructive approaches. In this way, a portable device that can be utilized anywhere might help with quick decision-making based on the feed quality standards [5-7].

The paper presents the assessment of the protein content of various vegetable substrates that are fed

to dairy cows, results obtained by applying both destructive (Kjeldahl method) and non-destructive (FT-NIR and Dumatherm) techniques, and the advantages of its implementation in the animal husbandry industry.

## 2. Materials and methods

The NIR technique does not require the use of chemicals or any prior preparation of the samples, being considered "clean technology" in accordance with the requirements of sustainable agriculture. Materials the automatic analyzer FT NIR PERTEN Software Analyzer (Instruments DA 7200 Perten Disposable gloves Stove Laboratory mill Sifting system and analytical balance.

### *FT-NIR Perten Automatic Analyzer*

The sample submitted to analysis was very well homogenized and placed into the analysis tray. Subsequently, the tray with the sample was fixed in the apparatus and the analysis was carried out. The results were displayed on the screen about one minute after the sample scan (Figure 1).



a



b



Figure 1. Illustration of the PERTEN Analyzer

**Dumatherm Analyzer**

Evaluate protein content by the Dumas Method - The Dumas method consists in burning the sample of known mass in a high-temperature range of 800-900 °C in the presence of oxygen, nitrogen, and helium. The gases are then passed through special columns that absorb carbon dioxide and water. Preparation of the sample to be analyzed:

Weigh a maximum of 100 mg of the sample of feed on the analytical balance. Weighed samples are folded in tin foil and added to a numbered rotor (weigh 3-5 samples on average). After every 4 minutes, the result of each sample expressed in total nitrogen content is obtained, and by multiplying it with the correction factor 6.25, the protein content is obtained (Figure 2).

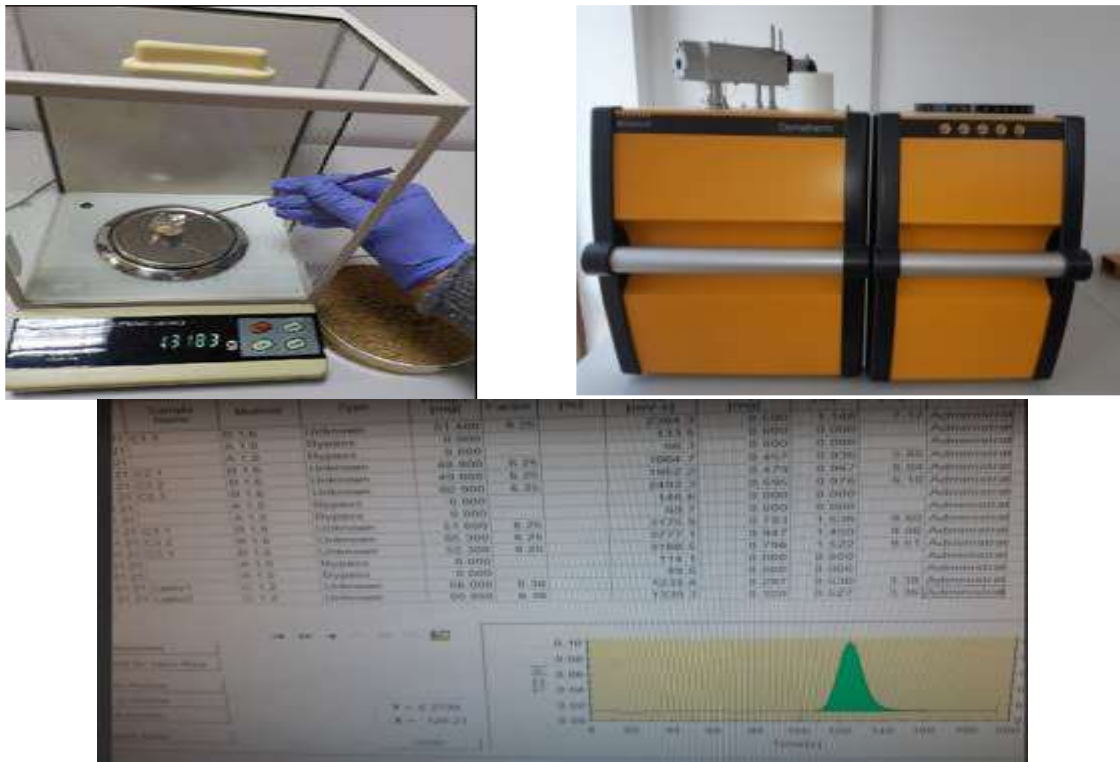


Figure 2. Illustration of the Dumatherm – Analyzer

### 3. Results and discussion

The protein content of the fodder that enters the feed of milk cows was analyzed by the destructive methods, as well as by the non-destructive methods.

As in the case of the Kjeldahl reference method, the total nitrogen content is multiplied by the value of 6.25 which represents the particular reference factor for feed.

This results in an expression of the total nitrogen

content for each tested sample as a percentage of the protein content.

The absorption of NIR by water strongly overlaps most of the NIR spectrum of biomolecules. In this regard, for a more accurate analysis of feed samples using NIRS in laboratory conditions, it is usually pre-dried and milled. The average value of the total nitrogen content and total protein content obtained using the three methods is shown in table 1.

**Table1.** The average value of the protein content of the samples evaluated by the three methods

Techniques/Methods	Samples	Total nitrogen content, %	Total protein content, %
Kjeldahl method (Gerhardt Systems)	Corn Grains	1.854	11.59
	Alfalfa Hay	3.392	21.2
	Lucerne silage	3.564	22.28
	Corn Silage	1.105	6.91
Dumas method (Dumatherm - Analyzer)	Corn Grains	1.923	12.02
	Alfalfa Hay	3.440	21.5
	Lucerne silage	3.568	22.30
	Corn Silage	1.113	6.96
FT-NIR spectrophotometric method (Perten Analyzer)	Corn Grains	1.928	12.05
	Alfalfa Hay	3.488	21.8
	Lucerne silage	3.580	22.38
	Corn Silage	1.120	7.00

The composition of the vegetable feed that makes up the diet of farm animals plays a significant role in the productivity of the dairy industry.

The concentration of crude protein (CP), lipids, neutral-detergent fiber (NDF), acid-detergent fiber (ADF), water-soluble carbohydrates (WSC), as well as total nitrogen (N), determines the energy value and digestibility of the feed that farm animals consume. A crucial component of feed quality is acid detergent fiber (ADF), which contains both cellulose and lignin.

The total nitrogen content and total protein content of the feed samples was determined by three methods the Kjeldahl method, the Meroda Dumas method, and infrared scanning with the Perten analyzer. As a quick approach for evaluating the feed's quantity, near-infrared spectroscopy (NIRS) is a non-destructive technique with applications in the food and agricultural industries.

Several physico-chemical parameters can be analyzed simultaneously using this technology, which also reduces toxicity and lab labor time.

Compared to the two presented methods, infrared scanning is considered fast, cheap and very accessible to farmers in establishing fodder

rations. The NIRS technique can be successfully applied for assessing the quality of plant

substrates, respectively for the determination of different physico chemical parameters.

The total nitrogen concentration can be calculated with this method far more quickly than the Kjeldahl method-in just a few minutes as opposed to 6 hours or even more with the Kjeldahl method. Also, it doesn't utilize catalysts or harmful chemicals.

### 4. Conclusions

Rapid non-destructive methods can be used for feed quality analysis provided they are properly calibrated and metrologically checked regularly against the reference method. The application of these quick analysis techniques leads to the efficiency of time of waiting for a result and low costs in dairy cow farms.

Processing huge amounts of data at a relatively rapid speed is now possible thanks to recent improvements in productivity and the cost of computing power.

In order to process IR spectroscopy data with high accuracy and speed, new chemometric mathematical models must be developed, and existing ones must be improved.

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