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Editorial

Use of detergent system terminology and criteria for submission of manuscripts on new, or revised, analytical methods as well as descriptive information on feed analysis and/or variability

Abstract

This editorial discusses development of the detergent system of feed analysis, suggests detergent system terminology for articles to be published in Animal Feed Science and Technology, provides guidelines for submission of manuscripts that describe new and revised analytical methods, including near infrared reflectance spectroscopy, and descriptive information on feed analysis and/or variability.

Keywords: Terminology; Detergent system

1. Introduction

Analytical methods are extremely important in nutritional research as they form the basis for interpreting data. Without reliable and nutritionally significant methods, scientific advances are impeded. One of the most important sets of feed assays in ruminant nutrition research (and, increasingly, non-ruminant research) is the detergent analysis system. However, terminology used within this system is confused and often used incorrectly, which can lead to misunderstandings among scientists relative to the meaning of these feed assays. Indeed, since feed analysis itself is an extremely important subject of animal nutrition research, it is a basic subject of Animal Feed Science and Technology. Unfortunately research in this area is often neglected and rarely highlighted in animal nutrition publications.

Abbreviations: ADF, acid detergent fibre; AFST, Animal Feed Science and Technology; AOAC, Association of Official Analytical Chemists; CF, crude fibre; NIRS, near infrared reflectance spectroscopy; NDF, neutral detergent fibre; NDIN, neutral detergent insoluble N; NDS, neutral detergent solubles; USDA, United States Department of Agriculture

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The objective of this editorial is to outline detergent system terminology suitable for articles published in Animal Feed Science and Technology, as well as providing guidelines for submission of manuscripts that describe new and revised analytical methods, including near infrared reflectance spectroscopy (NIRS) as well as descriptive information on feed analysis and/or variability.

2. The detergent fibre story

The poor state of feed analysis in the 1960s triggered the research program of Peter Van Soest at the United States Department of Agriculture (USDA) unit in Beltsville (MD, USA) and later at Cornell University in Ithaca (NY, USA), which led to the detergent system of feed analysis. Over a number of years, Van Soest convinced the scientific community to replace the Weende, or Proximate, analysis system with his detergent system. Replacing crude fibre (CF) and N-free extract with neutral detergent solubles (NDS), neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin made it possible to explain nutritional responses in terms of feed digestibility and intake.

The nutritional rationale of the detergent system was based on assaying for the feed fractions defined as NDS, NDF and lignin. In this system, NDS constitutes the completely digestible fractions of carbohydrate and protein, as well as lipid and some ash, whereas NDF represents the structural fibre, which is only partially digestible, and lignin is the fraction of NDF that is totally indigestible. The method for acid detergent fibre (ADF), published in 1963 (Van Soest, 1963), was actually the first publication in the series that completely described the detergent analysis system, although the system continues to change as new challenges and methodologies become available. ADF rapidly replaced CF in many parts of the world, as the method for ADF was both simpler than for CF and also gave similar values in many forages. The ADF procedure was approved by the Association of Official Analytical Chemists without major difficulty, as it was not difficult to standardize among laboratories.

As with the CF procedure, ADF isolates mainly cellulose and lignin, but not hemicellulose, the characteristic that made ADF unsuitable as a measure of total structural fibre. Thus, when the NDF analysis procedure was first published (Van Soest and Wine, 1967), ADF analysis became less interesting for feed formulation and began a slow but steady decline in global use, although it remains commonly used in many areas of the world. The main use of ADF today, for which it was developed, should be to prepare a low-protein residue for subsequent analysis of lignin.

The USDA pamphlet published by Goering and Van Soest (1970) was a major accomplishment, as it contained the first detailed description of the NDF method for laboratory use. This was necessary as, unlike ADF, there were several alternative procedures, as well as persistent filtration problems with some types of samples. This publication was, some 10 years later, followed by a chapter in 'The Analysis of Dietary Fibre in Food' (Robertson and Van Soest, 1981), where a number of variants of NDF analysis were introduced, including the use of amylase. Ten years later, a third publication (Van Soest et al., 1991) presented additional recommendations and changes, but no single method for all feed samples was recommended.

While NDF had largely replaced CF among scientists, CF was by no means an obsolete analysis. As NDF was not a governmentally–approved method for legal trade, CF continued

to be used in many countries. In the 1980s, David Mertens (a former PhD student of Peter Van Soest) started efforts to standardize NDF analysis among laboratories in the USA. He realized that the only way to reduce error among laboratories was, essentially, to prescribe a single analytical method for all types of feeds. Merten's efforts resulted in recommendations that all feeds be amylase treated (i.e., 'a'), that sodium sulphite be used and that NDF be reported on an ash-free basis (i.e., 'om'), which would be designated aNDFom. The only methodological variation considered was that feeds with greater than 100 g fat/kg be pre-extracted with a suitable solvent. Approval of the NDF method by the AOAC was a protracted process, but finally happened in 2002 (Mertens, 2002). However, this publication actually describes several variants of the NDF procedure, with or without the use of a heat stable amylase and with or without expression of NDF on an ash-free basis.

While it is unlikely that all scientists will rigorously adhere to the Mertens (2002) protocols, the editors of AFST recommend the use of this publication as the main reference for NDF analysis. For the ADF analysis, we recommend referencing the current AOAC handbook (Official Methods of Analysis of AOAC International) with the correct procedure ID number specified. The most common lignin analyses, performed on ADF residues, are the direct sulphuric acid method and the indirect permanganate method. The best reference for these lignin methods are in Robertson and Van Soest (1981).

Animal Feed Science and Technology asks authors to use the following definitions for NDF, ADF and lignin expressions:

aNDFom	–NDF assayed with a heat stable amylase and expressed exclusive of residual ash
NDFom	–NDF not assayed with a heat stable amylase and expressed exclusive of residual ash.
aNDF	–NDF assayed with a heat stable amylase and expressed inclusive of residual ash
NDF	–NDF assayed without a heat stable amylase and expressed inclusive of residual ash
ADFom	–ADF expressed exclusive of residual ash
ADF	–ADF expressed inclusive of residual ash
Lignin (sa)	–Lignin determined by solubilization of cellulose with sulphuric acid
Lignin (pm)	–Lignin determined by oxidation of lignin with permanganate

While expressions of NDF and ADF inclusive of residual ash will continue to be acceptable (i.e., the terms aNDF, NDF and ADF above), we highly recommend reporting all fibre values, including digestibilities, on an OM basis. Silica is partially soluble in ND, is quantitatively recovered in AD, and so may contribute to the 'fibre' values and to subsequent digestibility coefficients. Tannins and Maillard products also interfere with fibre analysis and can significantly increase lignin values. Correction for these interferences can be made, even though no absolute method is recommended.

If modifications are made to any procedure, there is an absolute requirement that they be reported in the text and the departure from the procedure is justified. The most notable modification would likely be the absence of sodium sulphite when analyzing for neutral detergent insoluble N (NDIN). However, calculation of aNDFom values by assaying without sodium sulphite and 'correcting' by deducting assayed N by 6.25 is strongly discouraged.

3. Submissions on new or modified analytical methods

Animal Feed Science and Technology has always welcomed manuscripts on analytical methods. Unfortunately, the number of manuscripts submitted in this area is small, which reflects the poor funding situation for research in methodology on a worldwide basis. While it is common that graduate students develop analytical methods, or modifications, in their thesis research, these procedures are often embedded in the submitted articles and may not attract the attention of the scientific community.

The editors of AFST respectfully point out to potential authors that good methodology papers have an excellent chance of becoming most cited publications, along with review articles which actually have a considerably shorter shelf life. However, presenting analytical protocols in a manuscript is often a challenge. The primary rule is that any laboratory should be able to reproduce a published analytical procedure. For this to be possible, the protocol must be very clear, the method description must contain all necessary details and units must be unambiguous. After describing apparatus and reagents, a very effective way of writing an analytical protocol is to use the same style as in a cookbook, such as: weigh P g of chemical Q into an R ml beaker. Slowly add S ml of chemical T while slowly agitating. If a method has been previously published, useful modifications may be worthy of publication as, for example, short communications. Prerequisites for both original and modified procedures are that the suggested procedure or modification be based on a wide range of the feeds for which the procedure/modification is designed, and that sufficient assays be completed to enable a supportable statistical analysis.

Animal Feed Science and Technology encourages submission of both original and modified analytical procedures that have interpretive feed value. Indeed the Journal contains a section entitled 'Methodologies' specifically for this purpose.

4. Submissions on near-infrared spectroscopy (NIRS)

Papers based on NIRS measurements constitute a special situation to reviewers and editors as they contain highly specialized technical, statistical and mathematical details. These details often leave the average reader, and reviewer, confused at best and bewildered at worst. Often the details reported in the 'Materials and Methods' sections of these manuscripts were not created by the authors, but taken directly from the software package provided by the manufacturer of the NIRS hardware. Thus, the criteria for acceptance of NIRS papers are not easy to define but, as for all papers intended for AFST, they must pro-

vide new knowledge that will be of interest to an international readership. In this context, new calibration equations do not equate with new analytical methods, nor are predictions of a set of feeds collected in a limited geographical area, often using standard NIRS methodology, adequate for publication. However, more accurate, precise or robust equations may be suitable, and mathematical, technical and statistical advancements may constitute the foundation for acceptance.

The Editors-in-chief of AFST have struggled with the issue of obtaining scientifically valid reviews of NIRS submissions for some time. In the past, reviews were often inconsistent between and within laboratories due to different philosophies of reviewers, and Editors-in-Chief, relative to NIRS. In an attempt to eliminate these problems, AFST has designated Dr. Peter Udén as the Editor-in-Chief that will handle all NIRS submissions, with a small group of primary reviewers to provide review consistency.

5. Submissions on feedstuff composition

Data on feedstuff composition are very valuable in ration formulation, to understand physiological responses of plants, and assess effects of various processing and preservation methods on nutritive value. However, finding scientific journals that will consider such manuscripts has been daunting, and has led to a lack of information on chemical composition, and variability in chemical composition, in refereed publications.

Animal Feed Science and Technology welcomes such submissions when published and/or accepted analytical procedures have been employed. However, unusual feedstuffs and/or a wide range of data are prerequisites. Often several years, seasons, varieties, growing conditions, or locations are required for publication, unless the feedstuff is so unusual that only limited information exists in the literature. However, submissions that only report chemical analytical components are unlikely to be accepted as the Editors-in-Chief feel that a clear link to the target animal species is required. This link can consist of in vivo, in vitro or in situ studies, but these data must follow the same guidelines as outlined above for the chemical components.

6. Conclusions

Animal Feed Science and Technology is a scientific journal with a wide international readership. Thus it is important that terminology used in AFST be clear and unambiguous. Ambiguity has been a hallmark of the terminology used within the detergent fibre system, and the guidelines outlined here are designed to assist in this regard.

It is a fundamental scientific tenet that true understanding follows advances in analytical methodology. Unfortunately, our science seems to put more emphasis on using feed analysis than in developing it. AFST welcomes submissions on feed assay method development, and modifications of existing published procedures, as well as submissions in the area of feedstuff composition and variation.

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