

EFFECTS OF HEATING ON DIETARY PROTEIN FRACTIONS OF SOME TROPICAL GRASS AND LEGUME SILAGES IN RUMINANT

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ABSTRACT

This study was conducted to estimate suitable methods to evaluate dietary protein fractions in forage in terms of meeting ruminant requirements, and to investigate the effects of heating by secondary fermentation after ensiling on the dietary protein fractions in some tropical legumes and grasses. Results were as follows. 1) When applying the methods in this study, dietary protein systems were distinguished between rumen degradable protein (nitrogen x 6.25) fractions that are quickly soluble and slowly degraded; and rumen undegradable protein fractions that are digestible and indigestible. 2) The *in situ* and *in vitro* methods were introduced to measure an indigestible nitrogen in ruminants, which is characterized as acid detergent insoluble nitrogen (ADIN). These two new methods were significantly ($p < 0.01$) correlated with ADIN and a reliable alternative to nitrogen after ADF analysis. 3) The dry matter digestibility and degraded protein fraction were decreased when silages were exposed to heating with moderate moisture during and after ensiling, while indigestible nitrogen content was remarkably increased.

KEYWORDS

Protein degradability, ruminant, heating, silage, tropical grass, tropical legume

INTRODUCTION

The efficient use of forage can only be achieved by understanding nutrient requirements and forage nutritive value in ruminants. Recent works for protein metabolism in rumen have quantified the degradation of forage protein within the rumen, the extent of microbial protein synthesis, and the associated changes in the quantity of amino acids absorbed from the small intestine, however, these quantitative concepts are sometimes theoretical and methods to estimate ruminal protein have not been established (Nocek, 1988; Nocek and Russell, 1988). There are few studies on it for tropical forages, especially tropical legumes. In the case of utilization of these forages, especially as silage, these forages are often subjected to heating under high air temperature.

The objectives of this study were to 1) estimate suitable methods to evaluate dietary protein fractions in forage in terms of meeting ruminant requirements, and 2) investigate the effects of heating by secondary fermentation after ensiling on the dietary protein fractions in some tropical legumes and grasses.

MATERIALS AND METHODS

Some tropical forage species were evaluated, which were grown for about two months at University Farm sited in south-east Japan. Forage species used were: *Macroptilium lathyroides* (Pb), *Desmodium intortum* var. Greenleaf (Gd), *Macroptilium atropurpureum* cv. Siratro (Si), *Neonotonia wightii* cv. Cooper (Gc) and *Neonotonia wightii* cv. Tinaroo (Gt) as tropical legumes and *Pennisetum purpureum* (Ne) as tropical grass. These forages were ensiled with average moisture content of 79.9% and about 60 days regrowth period and were ensiled in poly-ethylene bags immediately after cutting to a 5cm particle size. All the bagged silage was stored at 25°C for 30 days after sealing with a vacuum sealer. After opening the silos, all the samples were freeze-dried and ground at 1mm and

analyzed. One part of samples were exposed to heating (70°C, two days period) methods with some water added.

When applying the methods in this study, dietary protein systems were distinguished with one partition of rumen degradable protein (nitrogen x 6.25) divided into quickly soluble (soluble protein) and slowly degraded fractions, and the other partition of rumen undegradable protein divided into digestible and indigestible fractions (indigestible protein).

To evaluate soluble protein, borate-phosphate buffer (BP) solution (Krishnamoorthy *et al.*, 1982) was used. The *in situ* nylon bag technique (Crawford, *et al.*, 1978) was used to determine the extent of ruminal protein degradation. Two rumen-fistulated Holstein steers with about 800kg were maintained on a diet of 90% grass hay and 10% concentrate on dry matter basis throughout the experimental period. Bags, placed in the ventral portion of the rumen, were taken at intervals of 6, 12 and 24 hours after incubation, respectively. For comparative evaluation of indigestible protein fractions, acid detergent insoluble nitrogen (ADIN), pepsin-insoluble nitrogen after 24 hours rumen incubation (RPIN) and pepsin-cellulase *in vitro* assay (Goto and Minson, 1977) insoluble nitrogen (IVDMDIN) were measured.

RESULTS AND DISCUSSION

Fermentative quality of ensiled forages was good under pH 3.9-4.8, but low lactic acid fermentation was showed with legumes except Pb.

The association between ADIN and RPIN or IVDMDIN, which were considered to be fractionated into undigestible nitrogen (protein), was represented as a highly significant ($p < 0.01$) relationship as presented in Fig.1. From the result, estimates of undigestible protein were obtained from RPIN in this study.

Dry matter disappearance in the rumen increased slowly until 24 hours incubation. Heat treated forage legume silages experienced a lower transition in dry matter disappearance as compared with the, whereas this tendency was not observed with Ne. Protein (or nitrogen) solubility with all silages increased rapidly until 6 hours later, and slightly from this time until 24 hours later. Protein degradability with Si, Gc and Pb than Gd and Ne in control, which values were within 63 to 72%, decreased to within 51 to 58% in heat treated forage, and decreased from 41% to 33% for Gd and 48% to 14% for Ne.

The dietary forage protein were fractionated as shown in Fig. 2 by respective nitrogen extract methods mentioned above. The rumen undegradable protein fraction with all species were increased by ensiling, and further increased with heat treatment to silage. Therefore, exposing silage to high temperatures caused an increase in content of rumen undegradable protein and also undigestible protein obtained from RPIN which included an undegradable fraction. It is well known that exposure of silage to air after opening silos often causes heating by aerobic deterioration (Middleton and Thomas, 1983). Furthermore, it is satisfactory to consider the results of

exposing silage to high temperature even during ensiling in a tropical area. As Van Soest (1965) found the concentration of N insoluble in ADIN, the same tendencies were shown in this study. This study suggests heating increases undegradable protein fractions (i. e. bypass protein), and simultaneously increases undigestible protein. Further study is needed to determine a protein fraction effective in digestive organs after rumen.

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Figure 1

Relationship between rumen-pepsin insoluble nitrogen (RPIN) pepsin-cellulase undegradable nitrogen (IVDMDIN) and acid detergent insoluble nitrogen (ADIN), respectively.

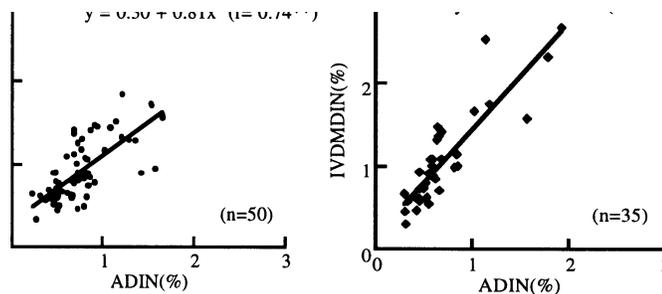


Figure 2

Dietary protein fractions in silages applied to heating.

