Animal Feed Science and Technology 151 (2009) 291–298

Contents lists available at ScienceDirect

Animal Feed Science and Technology

journal homepage: www.elsevier.com/locate/anifeedsci

The response of rice straw varieties to urea treatment

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ARTICLE INFO

Article history:
Received 22 March 2005
Received in revised form 12 February 2009
Accepted 10 March 2009

Keywords:
Whole rice straw
Stem
Leaf sheath
Leaf blade
Urea treatment

ABSTRACT

Sixteen rice straw varieties comprising 6 single-crop and 10 double-crop varieties were treated with 40 g/l urea solution (50 g straw per 200 ml of solution) for 21 days at 27 °C and total and insoluble ash, crude protein, neutral detergent fibre and *in vitro* digestibility (IVD) were measured after samples were dried at 60 °C to constant weight. The mean IVD values across treatments for the single-crop varieties were 0.500, 0.480, 0.418 and 0.499 for all fractions (whole straw, stem, leaf sheath, and leaf blade), corresponding values for the double-crop varieties were higher, 0.560, 0.598, 0.542 and 0.627, respectively. The untreated IVD values across varieties were 0.496, 0.497, 0.404 and 0.462 for whole straw, stem, leaf sheath, and leaf blade; and for urea treated, 0.564, 0.581, 0.556 and 0.665, respectively. Urea treatment caused a decrease in neutral detergent fibre exclusive of residual ash (NDFom) and in increase in IVD of all fractions ($P<0.001$). Single-crop fractions were all lower in IVD ($P<0.001$), and all fractions except whole straw were higher in NDFom ($P<0.05$) than double-crop varieties. Based on criterion variables selected from step-wise discriminant analysis, single- and double-crop varieties clustered separately before but together after urea treatment which may be important in selecting genetic varieties. Regression analysis showed, in general, fractions with a lower IVD intercept responded better to urea treatment evaluated by relatively higher regression coefficients of 0.39, 0.67, 0.79 and 0.80, respectively for whole straw, stem, leaf sheath, and leaf blade. The effect of the untreated stem, leaf sheath, and leaf blade IVD on the

Abbreviations: Totash, total ash; CP, crude protein; NDFom, neutral detergent fibre exclusive of residual ash; Inash, ash insoluble in neutral detergent solution; IVD*in vitro*, dry matter digestibility.

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[1] In memory of James Vadiveloo, a respected friend and colleague.

0377-8401/$ – see front matter. Published by Elsevier B.V.
doi:10.1016/j.anifeedsci.2009.03.003

IVD of untreated and urea-treated whole straw was described by single and multiple regressions where the most important fraction was the leaf blade IVD for urea-treated whole straw IVD and the leaf sheath IVD for the untreated whole straw IVD. Multiple regressions, although they had higher R^2, did not show any fraction to be more important than found in the simple regressions. It is concluded that although urea-treatment may result in a better response in poorer quality straws, rice straw varieties with a high leaf sheath IVD would improve the quality and utilisation of whole straw without urea treatment whereas high leaf blade IVD would improve the quality and utilisation of whole straw with urea treatment.

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1. Introduction

In Malaysia, rice varieties belong to the cultivated diploid subspecies, *O. sativa indica* and comprise single and double-crop varieties. However, only the double-crop varieties are commercially cultivated, the single-crop varieties serving as an important source of germ-plasma in rice breeding programmes.

Single-crop varieties have a higher stem proportion, lower *in vitro* dry matter digestibility and degradability but higher protein content than double-crop varieties (Vadiveloo, 2003a,b), although differences in leaf-stem proportion, chemical composition and *in vitro* or in sacco dry matter and fibre digestibility have also been reported between double-crop varieties (Vadiveloo, 1995; Williams et al., 1996; Abou-El-Enin et al., 1999; Agbagla-Dohnani et al., 2001). Environmental factors such as weather, soil type and altitude may also contribute to these differences (Shen et al., 1998a; Vadiveloo and Phang, 1996; Williams et al., 1996).

All rice straw varieties however remain poor in nutritive value, the limiting high lignocellulose and low protein contents have to be addressed before rice straw can be used in productive rations. Of the chemical treatment procedures available generally for improving cereal straws (Chaudhry, 1998), urea treatment is popular because it is non-hazardous, it can serve as a delignification agent through ammoniation and it is a source of nitrogen. In addition, urea removes the silica polymerised with cuticle waxes from the leaf blade and leaf sheath (Shen et al., 1999) and exposes the underlying tissues to bacterial colonisation (Bae et al., 1997). Silica is distributed unevenly over the leaf and stem fractions of rice straw, being present on the inner and outer surfaces of the leaf blade, the outer surface of the leaf sheath and absent in stem (Shen et al., 1999).

A limited study with whole straw comparing the response of single- and double-crop rice varieties to urea treatment showed that the former of lower initial digestibility and degradability responded better to urea treatment (Vadiveloo, 2003a,b). The objective of the present study was to confirm these results with a larger number of single- and double-crop varieties and to extend the investigation to include the response of the leaf and stem fractions.

2. Materials and methods

2.1. Rice straw and urea treatment

Sixteen rice straw varieties comprising 6 single-crop varieties (Serendah A, Padi Meai, Radin Ebos, Serendah B, Seraub, and Naga) and 10 double-crop varieties (MR 219, MR 185, MR 211, MR 84, MR 167, MR 220, MR 221, MR 229, MR 239, and Padi Batu) were hand-harvested about 30 cm above the ground in March 2002 and field-dried. The ranges in the agronomic characteristics of the varieties were: days to maturity, 100–160 days; culm height, 61–128 cm; grain yield, 1000–10,000 kg/ha; leaf blade, 200–340 g/kg; leaf sheath, 190–340 g/kg; and stem, 360–470 g/kg. The proportions of leaf blade, leaf sheath, and stem were done with field dried straw. Whole straw, leaf sheath, leaf blade and stem were ground (1 mm size) and either untreated or treated with a 40 g/l urea solution in the ratio of 50 g straw to 200 ml of solution. Samples were stored at 27 °C for 21 days and then dried at 60 °C to constant weight.

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