TREATMENT OF WHEAT STRAW BY HYDROLYSIS OF UREA AT LOW LEVEL OF WATER ADDITION

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Introduction

When straw is treated using urea as an ammonia source, a low level of water addition could facilitate treatment application. In these conditions however ureolysis can be poor (Williams et al., 1984). Consequently, the objective of this work was to determine the influence of a low moisture content in straw and of an added urease source on the extent of ureolysis and on the effectiveness of straw treatment.

Materials and Methods

Wheat straw (1 cm ground) was treated in low moisture conditions using 4 g urea per 100 g of 90% DM straw and a minimum amount of water to bring the moisture content of the treated material to 18% (M_{18}). Ground soybean (S) was added as an urease source (ureasic activity of 7.1 mg N/Min. g) at 0, 30, 90 mg/ml of urea solution (including straw water, S_0, S_{30}, S_{90}). These treatments were compared to other conditions: 1) urea treatment (4 and 6 g/100 g of 90% DM straw; U_4: U_6) in wetter conditions (30% moisture after treatment; M_{30}) with medium quantity of S (30 mg/ml urea solution; S_{30}); 2) anhydrous ammonia treatment 3.4 g per 100 g 90% DM straw (AA 3.4 = isonitrogenous with U_6), moistened at 15% (M_{15}). Urea treatments were made by thoroughly mixing products with 80 g straw and leaving the mixture in air tight 850 ml vessels during 3 months at 30°C. Anhydrous ammonia treatments were applied in similar conditions, but during 3 weeks only.

After opening, pH was taken on 1 g aliquotes to which 10 ml distilled water was added, and other samples were dried at 35°C. These samples and untreated (NT) straw samples were used for determination of dry matter (DM; 48 h at 103°C), total nitrogen (Kjeldahl N), urea (modified method of Michel, 1971) and organic matter digestibility estimated by densitometry at 280 nm (OMDd) (Besle et al., 1989). Nitrogen fixation on dried straw samples was calculated as: (total treated straw N) – (total untreated straw N) – (residual urea N) – (added soybean N).

Results and Discussion

Within low moisture urea treatments (table 1), straw N content was doubled or tripled and OMDd was quite highly increased by an average of 13.5 percentage units. Ureolysis was poor without soybean; it increased progressively up to completion with added soybean. Following urea transformation into ammonia, total N decreased, fixed N increased but OMDd increased only slightly.

In wetter conditions, ureolysis was only little better than U_4 S_{90} M_{18}, but there was a consi-

TABLE 1. CHARACTERISTICS OF UNTREATED AND TREATED STRAWS

Treatments	NT	M_{18}			M_{30}		M_{15}
		U_4S_0	U_4S_{30}	U_4S_{90}	U_4S_{30}	U_6S_{30}	$AA_{3.4}$
Ureolysis (%)		48.1^a	65.3^b	90.7^c	99.8^d	99.0^d	–
Total N (g/kg DM)	7.54^a	24.9^b	19.1^c	16.6^d	14.95^c	17.5^e	16.35^d
Fixed N (g/kg DM)	–	3.6^a	4.2^b	6.5^c	7.4^d	9.3^e	8.8^e
OMDd x 100	34.8^a	47.7^b	48.2^{bc}	48.8^c	54.8^{de}	55.1^e	53.75^d

See abbreviations in text. Data with same superscript are not significantly different ($P < 0.05$).

derable increase in fixed nitrogen (39.6% initial added N) and especially OMDd. It is likely that water enhanced hydrolysis of phenolic acid esters (Scalbert et al., 1986) by ammonia, and the opening of cell wall structure. When urea level increased to U_6, total and fixed N (33.2% initial added N) increased but by a lower proportion than the initially added N; OMDd was not significantly modified. The latter treatment gave slightly better results than AA treatment (fixed N = 31.2% initial added N) but after a longer period of time. After the same treatment duration as AA (3 weeks), urea of this U_6 treated straw was completely hydrolysed. Nevertheless U_6 treated straw had a lower OMDd (5 percentage units) and a lower pH (8.8 v.s. 9.2) than AA. This difference in alcalinity might stem from ammonium carbamate ions produced by urea hydrolysis, which could explain the lower increase in OMDd by urea than by AA treatments for the same treatment duration, even though moisture content was higher in urea treated straw.

It is concluded that urea treatment of straw can be achieved with a minimum addition of water. Nitrogen enrichment and improvement of OMDd of treated straw were fairly high. Added urease source enhanced ureolysis but had little effect on OMDd. Water addition appeared to be important especially to improve digestibility. Optimal results obtained by urea treatment were of similar magnitude as those obtained using anhydrous ammonia provided duration of treatment was higher than of ammonia treatment.

(Key Words: Wheat Straw, Urea)

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