Nitrogen Fixation and *In Situ* Dry Matter and Fibre Constituents Disappearance of Wheat Straw Treated with Urea and Boric Acid in Murrah Buffaloes

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ABSTRACT : Wheat straw was treated with 4 per cent urea at a moisture level of 50 per cent alongwith different levels of boric acid viz. 1, 2, 3 and 4 per cent, under laboratory conditions to know the impact of boric acid on ammonia-N fixation in the straw. Murrah buffaloes were used for determining the disappearance of dry matter, CP and fibre constituents by nylon bag technique. Ammoniation increased CP content of wheat straw, which increased further due to addition of boric acid. Low level of boric acid (1%) had no adverse effect on fibre constituents disappearance but at higher levels there was a depressioon in the disappearance of fibre coonstituents. It can be concluded that low level of boric acid was sufficient to trap the excess ammonia released during urea ammoniation of wheat straw without affecting other constituents and their disappearance in the rumen of buffaloes. (*Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 8 : 1133-1136*)

Key Words : Wheat Straw, Urea, Boric Acid, Nitrogen, Ammoniation, Murrah Buffaloes

INTRODUCTION

Crop residues, which are the backbone of livestock industry in almost all the third world countries are not only deficient in essential nutrients but also have poor digestibility. Various workers (Klopfenstein and Bolson, 1971; Oji and Mowat, 1978; Maeng and Chung, 1989; Kumar et al., 1991; Badurdeen et al., 1994) have used physical and chemical methods to improve their nutritive value. Among the various chemicals employed for the treatment of crop residues, ammonia, an alkali has given good results, but ammoniation of straw using gaseous or aqueous ammonia have their inherent problem of being costly and tedious to transport. Urea, a cheap source of ammonia after hydrolysis has given satisfactory results as for as the improvement in nutritive value of crop residues is concerned, but this also has certain limitations as the ammonia liberated from urea as a result of action of ureolytic organism is not fully fixed in the straw and about 60-70 per cent goes to atmosphere, which is not only a significant loss of nitrogen but also ammonia escaped to the atmosphere causes pollution. Therefore, some research workers have tried to fix the excess ammonia in the straw spraying with some organic acids like formic and acetic acid (Borhami et al., 1982) or inorganic acids like sulphuric and hydrochloric acid (Cloette and Kritzinger, 1984; Yadav and Virk, 1994a, b) with different degree of ammonia fixation. In the present study, different levels of boric acid were used to fix the excess ammonia of the urea present in the straw.

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MATERIALS AND METHODS

Wheat straw was treated on laboratory scale with fertilizer grade urea (4 per cent) at a moisture level of 50 per cent. Boric acid (1-4 per cent) was also added simultaneously to trap the excess free ammonia evolved from urea. Treated samples (T_1-T_6) were kept in polythene bags, which were sealed to maintain the anaerobic conditions. These bags were opened after 4 weeks. All the treated samples were air dried and milled to pass through 1 mm sieve before determining their chemical composition using methods recommended by AOAC (1985) and cell wall constituents (Van Soest et al., 1991). Hemicellulose and cellulose were calculated as NDF-ADF and ADF-ADL respectively. The *in sacco* degradability of dry matter, crude protein and cell wall constituents was determined by the polyester bag technique (size of bag 9 cm×13 cm, pore 44 μm) with 5 g of dry sample (Mehrez and Ørskov, 1977). Three rumen fistulated buffalo bulls (3.5 years of age, 400 kg body weight) fed on ammoniated wheat straw and concentrate mixture (containing equal parts of ground nut cake, maize and wheat bran alongwith salt, mineral mixture and vitablend (a source of vitamin A and D_3) as per their requirements as specified by Kearl (1982) were used for this study and 3 bags for each animal/treatment were hanged for 48 hours in the rumen of each animal (i.e. 9 bags for each sample). Analysis of variance was performed as per Snedecor and Cochran (1967) and when significant F value was detected, means were separated using Duncan's multiple range test.

Table 1. Chemical composition (%) of wheat straw treated with urea and boric acid

Treatment	Crude protein	Netural detergent fibre	Acid detergent fibre	Cellulose	Hemi cellulose	Lignin
Untreated wheat straw (T1)	3.7	83.4	54.4	36.2	28.9	10.4
Ammoniated wheat straw (T2)	7.9	77.2	50.6	40.3	26.6	6.5
AWS+1% boric acid (T3)	13.8	73.6	48.5	38.5	25.1	6.2
AWS+2% boric acid (T4)	14.3	72.3	46.9	37.0	25.5	6.2
AWS+3% boric acid (T5)	14.3	73.3	49.1	38.2	24.2	6.5
AWS+4% boric acid (T6)	16.1	72.2	38.2	36.8	23.6	6.2

AWS: Ammoniated wheat straw.

Table 2. Disappearance of dry matter, crude protein and fibre constituents from wheat straw treated with urea and boric acid after 48 hours *in situ* incubation

Treatment	Dry matter	Crude protein	Netural detergent fibre	Acid detergent fibre	Cellulose	Hemi cellulose
Untreated wheat straw (T1)	42.5 ± 1.2^{c}	-	44.1 ± 2.6^{c}	44.2 ± 2.4^{c}	44.0 ± 2.6^{d}	44.0 ± 2.5^{c}
Ammoniated wheat straw (T2)	56.4 ± 2.3^{a}	54.9 ± 2.6^{b}	54.9 ± 2.1^{a}	56.2 ± 1.9^{a}	55.4 ± 1.7^{a}	57.8 ± 1.9^{a}
AWS+1% boric acid (T3)	54.4 ± 1.9^{a}	73.0 ± 1.7^{a}	51.7 ± 2.3^{a}	51.1 ± 2.1^{a}	60.0 ± 1.7^{a}	52.9 ± 2.1^{a}
AWS+2% boric acid (T4)	51.9 ± 2.4^{b}	72.7 ± 1.8^{a}	49.4 ± 1.9^{b}	48.3 ± 2.6^{b}	58.8 ± 1.5^{b}	51.6 ± 1.7^{b}
AWS+3% boric acid (T5)	52.0 ± 2.3^{b}	68.8 ± 2.4^{ab}	49.9 ± 1.8^{b}	50.5 ± 2.1^{b}	58.2 ± 1.9^{b}	48.7 ± 1.7^{b}
AWS+4% boric acid (T6)	49.8 ± 2.5^{b}	70.9 ± 2.4^{a}	45.6 ± 1.8^{c}	46.5 ± 1.7^{b}	55.3 ± 1.9^{c}	43.0 ± 1.4^{c}

[a,b,c] Columns having different superscripts differ significantly ($p<0.01$).

RESULTS

The chemical composition of untreated, urea treated and urea+boric acid treated samples is given in table 1. Ammoniation of wheat straw increased the crude protein contents to 7.9 per cent from 3.7 per cent in the untreated straw. Additioon of boric acid increased the CP content further. There was a substantial increase in CP content of ammoniated wheat straw even at the lowest level (1 per cent) of boric acid. Though there was a decrease in fibre constituents in the treated samples where boric acid was added, but it was not substantial indicating that addition of boric acid had a significant increase in CP content without having any positive or negative effect on the fibre constituents of the samples.

There was a significant ($p<0.01$) increase in dry matter, NDF, ADF, Cellulose and hemicellulose disappearance due to ammoniation of straw (table 2). There was a significant ($p<0.01$) decrease in DM disappearance due to higher levels of boric acid but at 1% boric acid no effect was noticed. *In sacco* disappearance of crude protein was significantly more ($p<0.01$) in wheat straw samples where boric acid was added as compared to urea treated wheat straw. Results revealed no significant effect on these fibre constituents as a result of boric acid treatment at 1 per cent level. Higher levels of boric acid had a depressing effect on the disappearance of these fibre constituents indicating that 1 per cent boric acid was sufficient to trap the excess ammonia released during urea ammoniation.

DISCUSSION

Urea ammoniation of wheat straw increased the crude protein content from 3.7 per cent (T1) to 7.9 per cent (T2). This is in agreement with the observations of earlier workers (Jayasuriya and Perrera, 1982; Jai Kishan et al., 1986; Dass et al., 1993a, b). There was a significant ($p<0.01$) increase in CP content in wheat straw treated with urea and boric acid (T_3-T_6) than ammoniated wheat straw (T_2). Crude protein content in the ammoniated straw increased to 16.1 per cent at 4 per cent boric acid level and it was significantly ($p<0.01$) more than ammoniated straw even at 1 per cent boric acid level (13.1 per cent). This may be due to the formation of ammonium borate. Similarly, higher CP value in ammoniated straw was reported earlier by different workers who trapped the excess free ammonia by spraying organic acids (Borhami et al., 1982) or inorganic acids (Cloette and Kritzinger, 1984; Yadav and Virk, 1994a, b; Mandal et al., 1995; Taiwo et al., 1995). Urea-ammoniation of straw decreased the cell wall constituents i.e. NDF, ADF cellulose and hemicellulose. The decline in cell wall constituents in urea-ammoniated straw over control has also been reported earlier (Reddy and Reddy, 1984; Yadav and Yadav, 1986; Reddy et al., 1989). Decreasing trend of NDF, ADF, cellulose and lignin might be due to the solubilization of cell wall constituents. Addition of boric acid at four different levels did not show any positive negative effect on the cell wall constituents. This was contrary to the earlier reports where mineral acids were used (Cloette and Kritzinger, 1984; Yadav and Virk, 1994a). They observed a proportional decrease in NDF, ADF and cellulose with the increase in level of acids used for fixing the free ammonia.

In sacco disappearance of dry matter of wheat straw increased significantly ($p<0.01$) due to ammoniation and has also been documented earlier (Horton, 1978; Schneider and Flachowsky, 1990; Caneque et al., 1998). Similarly, there was a significant increase in CP, NDF, ADF, Cellulose and hemicellulose disappearance due to ammoniation of straw. These results are also in line with earlier observations (Dass et al., 1993a, b). Addition of more than 1% boric acid had a negative effect on the disappearance of dry matter, NDF, ADF, cellulose and hemicellulose but the results were similar to urea treatment alone where 1% boric acid was added. The disappearance of crude protein was significantly ($p<0.01$) more in all the boric acid treated samples (T_3-T_6) as compared to urea treated straw only. This may be due to the better utilization of compounds formed due to boric acid treatment by the rumen microbes. However, further studies are needed to test the palatability of ammoniated straw treated with boric acid.

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