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EFFECT OF UREA TREATMENT AND POST-TREATMENT STORAGE ON DIGESTIBILITY OF WHEAT STRAW

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Chopped wheat straw was treated with simple water or aqueous solution of urea at various concentrations to keep the urea level at 1, 2, 3, 4, 5 or 6% of the wheat straw and a moisture level of 50% in all the straw samples. Each of these samples was stored anaerobically for a period of 2, 4 or 6 weeks at room temperature. Nylon bag digestibility was determined for dry matter (DM), organic matter (OM) and crude fibre (CF). Urea treatment of the straw beyond 3% level improved ($P<0.05$) by increases in the time during which the treated straw could be stored without spoiling. The improvement in CF digestibility of the straw was associated more with the urea treatment than with the storage time.

Key words: Urea, Wheat straw, Digestibility.

Introduction

More than 14.62 million tonnes of wheat straw which is considered to be a potential source of energy for ruminants is produced annually in Pakistan [1]. Although, low levels of soluble cell contents and nitrogen matter make it nutritionally poor, wheat straw forms a significant part of ruminant rations as a dry roughage mixed with fresh green fodder and as a sole roughage during lean periods of the year. High proportions of cell wall, mainly, cellulose, hemicellulose and lignin present in the straw decrease the organic matter digestibility [2] and as a result a major part of the gross energy is not utilized by the animals. Various attempts have been made to improve the nutritional value of straw by chemical, physical, and microbiological methods. Urea treatment of the straw has been shown to increase the nutritive value by incorporation of nitrogen into straw to better meet the crude protein requirement of the animals and by improving feed intake and digestibility [3-6]. When urea is hydrolyzed, the ammonia liberated acts on the lignocellulosic complex of the straw making the cellulose and hemicellulose content of straw more available to the rumen microflora. Ammonia treatment also solublizes some of the lignin and hemicellulose, increases the swelling action of fibre and induces structural changes in cellulose fibre, [7] which ultimately increases the digestibility of the straw.

The study was conducted to determine the effect of different levels of urea treatment and post-treatment storage time on nylon bag digestibility of wheat straw.

Materials and Method

Chopped wheat straw was treated with simple water or aqueous solutions of urea at various concentrations to keep the urea level at 1, 2, 3, 4, 5, or 6% of the wheat straw and a moisture level of 50% in all the straw samples. These samples were stored anaerobically in polythene bags for a period of 2, 4 or 6 weeks at room temperature. After specified periods, the straw containing bags were opened and the straw was exposed to remove excessive ammonia. The samples were dried to constant weight at 100° and then ground to pass 1 mm mesh screen prior to analysis.

Nylon bag digestibility was determined by the method described by Van keuren and Heinemann [8]. For this purpose, 5 gm of ground straw samples were placed in 7x18 cm bags of pure nylon cloth, having 31 thread counts per cm. Glass pebbles weighing 20-25 gm were put into each bag to keep it suspended in the rumen. The mouth of each bag was fastened tightly with nylon fishing cord to prevent exit or entry of any particles. The bags were placed in the ventral sac of the rumen and the free end of the long nylon cord was tied to fistula cap. The bags were removed from the rumen after 36 hrs (prior determination of time to suspend the sample bags in rumen showed almost straight line of digestibility till 36 hrs, so this time period was selected for all subsequent determinations). Immediately after removal, the bags were washed thoroughly with running tap water and then put in an oven at 75° for a period of 36 hrs. The loss in weight was assumed to determine the digestibility of dry matter, organic matter and crude fibre [9].

The data thus collected on various parameters were subjected to statistical analysis, using analysis of variance technique, to determine significant differences among treatment means [14]).

Results and Discussion

Dry matter digestibility (DMD). The data on DMD coefficients of straw treated with various levels of urea at 50% moisture level in straw and stored for different time periods are shown in Table 1.

Fifty percent moisture treatment of straw without urea treatment resulted in a descrease in the digestibility of dry matter from 29.51 to 15.31, 13.00 and 7.70% when stored under anaerobic conditions or a period of 2.4 and 6 weeks, respectively. Similar decreases in digestibility of straw were recorded following treatment of straw with 1% urea. It was observed that these treatment of straw samples were heavily

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infested with fungus. So, the fall in DMD may be attributed to the toxins produced by the fungi which might have caused enzyme inhibition through lethal enzyme binding.

The DMD digestibility of freshly treated wheat straw improved, although non-significant with an increase in the urea level. However, significant increase in DMD was recorded in urea treated wheat straw when stored for 2, 4 or 6 weeks. The improvement was significant upto the urea level of 3% while higher levels of urea had no additional effect on DMD coefficients. This increase in DMD is similar to the findings of some earlier workers [6,10,11], and may be attributed to greater availability of cellulose for microbial digestion due to ammoniation of straw following urea treatment.

It may be seen from Fig. 1 that DMD decreased significantly ($p<0.05$) when stored for 2, 4 or 6 weeks without and with 1% urea treatment of the straw. When straw was treated with 2% urea differences in DMD until 4 weeks of storage were non-significant but following 6 weeks storage, the digestibility improved significantly. Between 3 to 6% levels of urea treatment, the differences in DMD of straw were non-significant on 0, 2 or 4 weeks storage. However, significant increase was found at 6 weeks storage in all the cases. At 6 weeks storage, 3 to 6% urea treated straw had significantly higher DMD than that treated with 2% urea. Higher digestibility values at longer storage time may be due to a higher degree of solublization of hemicellulose and increased swelling action of fibre portion as reported by Singh and Gupta [7].

Organic matter digestibility (OMD). The coefficients of OMD of straw treated without or with varying levels of urea and stored for different time periods are shown in Table 2.

Nylon bag digestibility trials revealed that untreated straw had 30.76% OMD which increased significantly that according to data in Table 2 with an increase in the ureas level upto 3%. Beyond this level the differences in OMD coefficients of straw were non-significant.

When untreated straw samples with 50% moisture level were stored anaerobically for 2, 4 or 6 weeks, the digestibility decreased from 30.79 to 16.49, 13.61 and 9.32%, respectively. Similar results were recorded with 1% urea treatment of straw as in case of DMD.

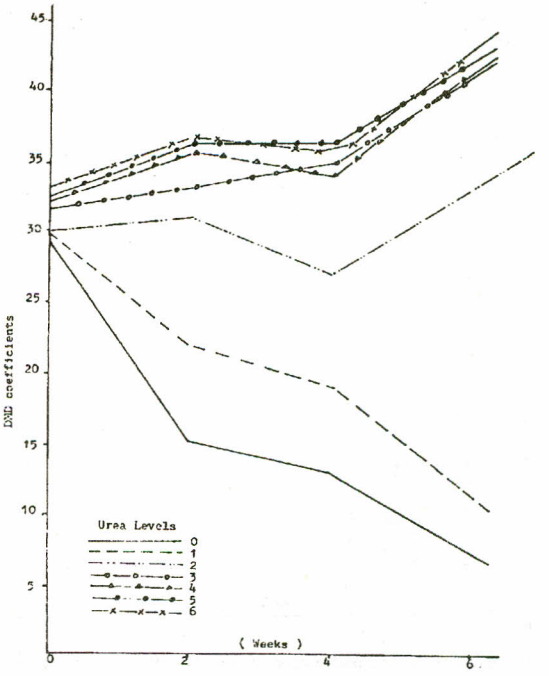

Fig. 1. Treatment time interaction of DMD coefficients of wheat straw.

TABLE 1. DRY MATTER DIGESTIBILITY COEFFICIENTS OF WHEAT STRAW AS AFFECTED BY VARYING LEVELS OF UREA AT DIFFERENT STORAGE PERIODS.

Urea level (%)	Control (0 week)	Storage period (weeks)		
		2	4	6
	A a	A b	A b	A c
Control	29.51	15.31	13.00	7.70
	A a	B b	B b	B c
1	29.74	22.20	19.32	11.72
	A b	C b	C B	C a
2	30.04	31.04	27.55	36.39
	A b	C D b	D b	D a
3	31.78	33.70	34.95	41.39
	A b	CD b	D b	D a
4	32.00	35.71	34.43	41.66
	A b	D b	D b	D a
5	32.11	36.24	35.92	42.11
	A b	D b	D b	D a
6	32.79	36.29	35.22	43.01

Same superscripts on means in a column (capital letter) for treatment or row (small letter) for storage periods show non- significant differences.

TABLE 2. ORGANIC MATTER DIGESTIBILITY COEFFICIENT OF WHEAT STRAW AS AFFECTED BY DIFFERENT LEVELS OF UREA AT DIFFERENT STORAGE PERIODS.

Urea level (%)	Control (0 week)	Storage period (weeks)		
		2	4	6
	A a	A b	A bc	A c
Control	30.76	16.49	13.61	9.32
	A a	B b	B b	B c
1	32.02	23.43	20.90	12.84
	A b	C b	C b	C a
2	31.53	32.28	28.52	37.51
	A b	C b	D b	D a
3	33.95	34.34	36.12	42.63
	A b	C b	D b	D a
4	33.36	37.04	35.97	42.50
	A b	C b	D b	D a
5	33.87	37.47	36.95	43.50
	A b	C b	D b	D a
6	34.49	37.33	36.21	43.86

Same superscripts on means in a column (capital letter) for treatment and row (small letter) for storage periods show non- significant differences.

It may be noted that without and with 1% urea treatment of the straw. OMD decreased significantly, on 2 and 4 weeks of storage. The digestibility again decreased significantly, at 6 weeks in case of 1% urea level whereas in case of non-urea treated straw, it did not vary between samples stored for 4 and 6 weeks. In straw treated with 2% urea level, there was a non-significant difference in OMD until 4 weeks of storage while at 6 weeks of storage, the digestibility was significantly higher. From 3 to 6% urea treatment, the differences in digestibility were non-significant at 0, 2 or 4 weeks and significantly higher at 6 weeks of storage in all cases. At 6 weeks of storage 3 to 6% urea treated straw had significantly higher OMD than at 2% urea level. Jayasuriya and pearce [12] and kumase *et al.* [13] also reported an increase in OMD with increase in urea or ammonia levels. The trend of OMD of straw at various levels of urea treatment as influenced by storage time observed in the present study, have been shown graphically in Fig 2.

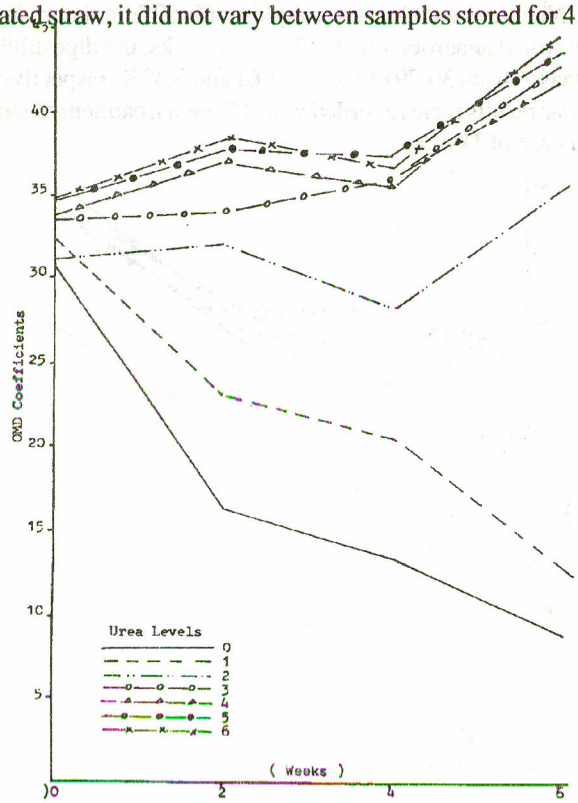

Fig. 2 Treatment X time interaction of OMD coefficients of wheat straw.

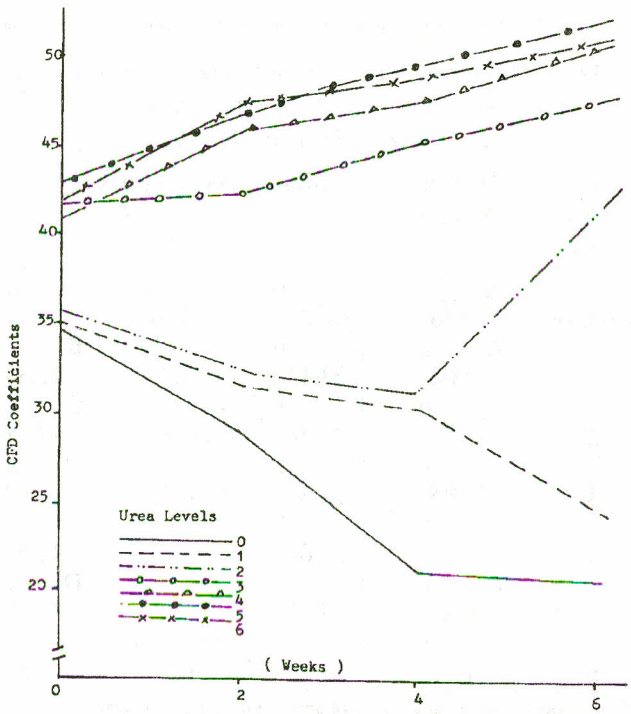

Fig. 3. Treatment X time interaction of CFD coefficients of wheat straw.

Crude fibre digestibility (CFD). The crude fibre digestibility of straw was also affected significantly by urea treatment and storage time post-treatment. The result have been summarized in Table 3.

It is evident from Table 3, that CFD of the straw, without urea treatment, decreased significantly with storage time. However, after 4 weeks of storage the decrease in digestibility was non-significant. In case of 1% urea treated straw, CFD did not vary significantly during the first 4 weeks of storage. Beyond this period it decreased significantly. This was the result of severe fungal attack on these straw samples.

Three and five percent levels of urea treatment of straw revealed non-significant differences in crude fibre digestibility with storage time. At 4 and 6% urea level. CFD did not vary significantly at 4 weeks of storage. At 6 weeks of storage the digestibility was significantly higher but differed non- significantly from 2 and 4 weeks stored samples.

The results of the present study indicated that urea treatment of straw increased the CFD more than storage time. A

TABLE 3. CRUDE FIBRE DIGESTIBILITY COEFFICIENTS OF WHEAT STRAW AS AFFECTED BY VARYING LEVELS OF UREA AT DIFFERENT STORAGE PERIODS.

Urea level (%)	Control (0 week)	Storage period (weeks)		
		2	4	6
Control	A a 35.540	A b 29.157	A bc 22.480	A c 21.033
1	A a 34.770	A a 31.579	B ab 30.387	A b 24.037
2	A b 34.813	A b 31.721	B b 31.127	B a 44.873
3	A a 41.593	B a 42.469	C a 45.093	B a 47.553
4	B b 40.810	B ab 46.007	C a 47.240	B a 51.190
5	B a 43.380	B a 46.810	C a 49.523	B a 51.870
6	B b 41.310	B ab 46.879	C ab 48.860	B a 51.220

Same superscripts on means in a column (capital letter) for treatment and row (small letter) for storage periods show non- significant differences.

similar improvement in the CFD in ammoniated straw have been reported by kumase *et al.* [13] and Singh and Gupta[7]. The trend of CFD of straw at various levels of urea treatment as influenced by storage time have been depicted graphically in Fig. 3.

It may be inferred from the results of the present study that the treatment of wheat straw at 4% level of urea with 50% moisture and four weeks of storage gives maximum benefit in terms of improved digestibility.

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