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EFFECT OF SODIUM HYDROXIDE AND AQUEOUS AMMONIA ON THE *IN VIVO* DIGESTIBILITY OF WHEAT STRAW

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Dry matter digestibility of straw increased to 73.04 % after treatment with sodium hydroxide (5 % w/w) and screw pressing. It was 55.9 % in case of ammoniated straw (5 % w/w). The digestibility increased to 77.72 % when 5.5 % sodium hydroxide treated straw was ammoniated. The bulk density of the straw increased from 71.2 mg/ml. to 362.0 mg/ml when it was screw pressed after sodium hydroxide treatment.

INTRODUCTION

The major limitation of wheat straw as animal feed is its low digestibility which is due to association of lignin with cellulose and hemicellulose. Lignin reduces the digestibility of cellulose and hemicellulose by physically protecting them against enzyme degradation. To overcome this difficulty a number of chemical [1–4] and biological [5–7] treatments have been reported for the delignificantion of crop residues. sodium hydroxide and ammonia treatments are considered most promising for converting low quality roughages into nutritious feed for ruminants.

This study was undertaken to improve the nutritive value of wheat straw by sodium hydroxide and ammonia treatments.

MATERIALS AND METHODS

Wheat straw was purchased from the local market and was ground to 20 mesh size. It was treated with different concentrations of commercial sodium hydroxide (3.5 – 5.5 % w/w) and then passed through an electrically operated screw press. The material was also treated with ammonia (5% w/w) and was incubated at 55 ± 5° for 15 days. Analytical methods were the same as reported elsewhere [8].

In vivo digestibility of the treated straw was estimated according to the rumen techniques [9]. The samples were infused in rumen of cow or buffalo and taken out after 12 hr upto 48 hrs. They were washed with distilled water followed by alcohol and finally with distilled water, and then dried at 100±5° to constant weight.

RESULTS AND DISCUSSIONS

Dry Matter Digestibility of Wheat Straw. Maximum increase in the dry matter digestibility was observed in case of straw which was screw pressed after sodium hydroxide treatment (5 % w/w) (Table 1). Improvement in digestibility of ligno cellulosic materials by alkali treatment has also been observed by other workers [10,11]. The digestibility in cow or buffalo rumen was almost the same. A further increase in the amount of sodium hydroxide resulted in a decrease in the digestibility which appeared to be due to alkaliosis. Similar findings have been reported by other workers as well [12].

Treatment of straw with 5.0 % ammonia increased the dry matter digestibility upto 55.89 %. Maximum increase in dry matter digestibility was 77.72 when 5.0 % ammonia was sprayed on 5.5 % sodium hydroxide treated straw. Increase in *in vitro* dgestibility of barely straw by aqueous ammonia treatment was observed by Hartley and Jones [13], and in rice straw by Waiss *et al.* [14].

Nitrogen Digestibility of Wheat Straw. Effect of sodium hydroxide on nitrogen digestibility of unpressed and screw pressed straw in the rumen of buffalo and cow are given in Table 2. Maximum increase in nitrogen digestibility in cow and buffalo rumen was 51.69 and 61.38 % respectively when 5.5 % alkali treated straw, after screw pressing, was incubated for 48 hr.

The nitrogen digestibility was however, increased to 70.30 % by the treatment of wheat straw with 5.0 % aqueous ammonia. The nitrogen digestibility was further increased to 86.57 % when the straw was successively treated with 5 % ammonia and 4.5 % sodium hydroxide.

Table 1. Effect of sodium hydroxide treatment on dry matter digestibility of wheat straw.

Treatment	Cow								Buffalo							
	Un-pressed Hours				Screw pressed Hours				Un-pressed Hours				Screw pressed Hours			
	12	24	36	48	12	24	36	48	12	24	36	48	12	24	36	48
Wheat straw as such	15.2	31.88	34.43	42.60	15.20	31.88	34.43	42.60	18.82	28.49	39.26	43.75	18.82	28.49	39.26	43.75
3.5 % Sodium hyroxide	44.81	46.59	63.27	65.29	33.67	46.24	46.97	49.09	36.78	46.91	60.30	56.69	32.41	42.62	49.53	59.13
4.0 % Sodium hydroxide	36.85	46.43	56.04	–	37.78	43.61	53.59	40.70	40.99	42.52	48.55	56.63	37.92	50.81	53.97	59.29
4.5 % Sodium hydroxide	32.42	42.39	55.45	58.23	29.36	47.45	51.92	–	32.92	40.39	52.89	55.17	35.45	45.51	53.97	51.09
5.0 % Sodium hydroxide	31.29	45.24	61.17	57.27	45.93	71.14	70.89	73.04	38.59	56.18	52.22	62.16	52.72	71.82	75.87	72.30
5.5 % Sodium hydroxide	35.43	43.62	51.89	57.09	47.74	61.99	66.09	67.25	30.86	43.44	46.98	50.89	49.18	60.48	61.35	68.46

Table 2. Effect of sodium hydroxide treatment on nitrogen digestibility of wheat straw.

Treatment	Cow								Buffalo							
	Un-pressed Hours				Screw pressed Hours				Un-pressed Hours				Screw pressed Hours			
	12	24	36	48	12	24	36	48	12	24	36	48	12	24	36	48
Wheat straw as such	9.73	11.28	16.76	21.78	10.88	14.44	22.36	25.59	8.88	10.76	17.38	19.88	11.78	13.73	17.55	21.76
3.5 % Sodium hydorxide	11.29	18.48	28.82	37.18	18.35	16.22	26.55	35.82	18.39	28.53	39.67	39.95	20.74	35.15	39.61	34.12
4.0 % Sodium hydroxide	19.51	30.00	45.23	47.29	17.84	24.93	32.83	38.24	33.33	34.21	36.11	42.10	16.89	30.25	36.89	40.24
4.5 % Sodium hydroxide	22.00	33.33	42.11	42.11	18.89	28.37	38.75	40.63	37.78	44.44	46.35	46.54	19.27	36.23	48.62	47.38
5.0 % Sodium hydroxide	16.22	30.62	34.29	40.64	15.52	30.24	42.69	49.02	20.27	22.38	39.89	45.81	18.69	35.10	59.12	59.12
5.5 % Sodium hydroxide,	16.04	38.00	43.62	47.89	16.41	31.38	45.62	51.69	10.00	30.96	33.22	47.54	17.82	35.19	58.12	61.72

Table 3. Effect of sodium hydroxide treatment on cellulose digestibility of wheat straw.

Treatment	Cow								Buffalo							
	Un-pressed Hours				Screw pressed Hours				Un-pressed Hours				Screw pressed Hours			
	12	24	36	48	12	24	36	48	12	24	36	48	12	24	36	48
Wheat straw as such	8.67	20.27	28.88	27.68	11.29	18.89	30.64	28.66	17.68	19.98	29.65	28.88	22.02	39.65	42.38	41.65
3.5 % Sodium hydroxide	12.89	27.10	36.66	62.96	6.97	28.25	52.21	64.19	3.00	48.77	62.36	61.26	16.13	45.72	58.01	79.81
4.0 % Sodium hydroxide	20.08	26.61	39.57	42.36	12.74	25.92	48.37	55.92	15.71	22.98	34.25	34.24	23.70	29.94	56.79	78.31
4.5 % Sodium hyroxide	19.75	21.01	24.01	47.12	13.89	30.24	42.85	51.93	10.12	19.88	42.48	42.31	20.86	42.84	48.89	72.39
5.0 % Sodium hydroxide	5.76	10.56	41.91	38.29	11.67	30.69	32.53	43.33	8.32	27.82	34.65	43.53	21.69	30.24	36.78	51.16
5.5 % Sodium hydroxide	4.71	15.56	27.04	34.02	13.68	30.97	36.64	51.69	3.11	27.82	27.36	34.65	14.02	32.00	38.42	55.62

Table 4. Effect of sodium hydroxide treatment on mineral digestibility of wheat straw.

Treatment	Cow								Buffalo							
	Un-pressed Hours				Screw pressed Hours				Un-pressed Hours				Screw pressed Hours			
	12	24	36	48	12	24	36	48	12	24	36	48	12	24	36	48
Wheat straw as such	26.66	29.95	32.57	40.00	35.35	39.65	44.12	44.12	23.39	28.88	32.25	39.98	38.54	27.21	45.62	50.79
3.5 % Sodium hydroxide	60.06	67.21	68.88	70.12	49.66	55.66	57.80	61.42	59.49	68.85	88.57	75.00	52.35	52.59	62.77	62.87
4.0 % Sodium hydroxide	53.57	57.32	79.02	80.12	41.31	53.38	61.05	62.99	60.00	61.43	61.97	62.50	41.47	54.68	70.69	73.62
4.5 % Sodium hydroxide	60.83	64.50	66.66	67.79	58.26	71.61	74.79	51.69	56.74	64.11	65.49	67.03	73.33	74.21	73.78	79.52
5.0 % Sodium hydroxide	48.44	59.58	66.95	67.79	45.79	28.57	29.17	86.50	39.23	67.24	55.49	70.47	54.00	70.30	76.33	92.35
5.5 % Sodium hydroxide	57.74	66.12	70.56	74.73	62.26	86.16	33.77	79.31	39.88	60.28	62.43	66.40	56.28	85.14	80.40	85.35

Cellulose Digestibility of Wheat Straw. The digestibility of cellulose, in general improved by treatment with different concentration of sodium hydroxide and screw pressing (Table 3). Maximum increase in cellulose digestibility was 79.81 and 64.91 % in case of buffalo and cow's rumen respectively when 3.5 % sodium hydroxide treated straw was subjected to screw pressing. However, the cellulose digestibility decreased, both in pressed and unpressed wheat straw, when the amount of sodium hydroxide wa 3.5 %.

Cellulose digestibility did not impro oy simple ammoniation of straw. It however, increased to 72.09 % when the straw was successively treated with 5.5 % sodium hydroxide and 5.0 % ammonia.

Mineral Digestibility of Wheat Straw. Improvement in mineral digestibility of wheat straw resulted by sodium hydroxide and screw pressing treatment in the rumen of cow and buffalo (Table 4). Increase in the amount of sodium hydroxide from 3.5 to 5.0% (w/w) and screw pressing increased digestibility of minerals from 62.87 to 92.4 % in the buffalo rumen after 48 hr. Similarly increase in the digestibility of minerals in cow's rumen was 86.5 % at 5.0 % sodium hydroxide, followed by screw pressing.

The digestibility of minerals also increased to 65.13 % by ammoniation (5 % w/w), and was further improved to 90. 44 % when 5.5 % sodium hydroxide treated straw was sprayed with ammonium hydroxide (5 % w/w).

Fibre Digestibility of Wheat Straw. Effect of sodium hydroxide on the *in vivo* digestibility of fibre of unpressed and screw pressed straw after different intervals of time (12 to 48 hrs) is given in Table 5. Maximum increase in fibre digestibility was 56.78 and 55.02 % in case of buffalo and cow rumen respectively with 3.5 % sodium hydroxide treated and screw pressed straw.

Further increase in the amount of alkali resulted in a decrease in the digestibility of fibre probably due to the inhibitory effect of excess of unreacted alkali on the growth of rumen microorganisms. Similar results have been reported by Negi and Kehar [15].

Treatment with ammonia alone showed no improvement in the digestibility of fibre which was increased to 59.93 % when 4.5 % alkali treated straw was ammoniated with 5 percent aqueous ammonia. However, the digestibility of fibre was not further increased when the amount of sodium hydroxide, before ammoniation was gradually increased from 4.5 – 5.5 % (w/w). This clearly shows that pH of the rumen was disturbed due to the presence of excess of unreacted alkali in the straw.

Bulk Density. The bulk density of unreacted wheat straw was 71.2 mg/ml which increased to 362.0 mg/ml

Table 5. Effect of sodium hydroxide treatment on fibre digestibility of wheat straw.

Treatment	Cow								Buffalo							
	Un-pressed Hours				Screw pressed Hours				Un-pressed Hours				Screw pressed Hours			
	12	24	36	48	12	24	36	48	12	24	36	48	12	24	36	48
Wheat straw as such	8.88	10.78	15.55	22.76	15.33	17.01	19.78	23.78	7.69	11.11	15.78	20.00	10.25	15.03	17.36	25.78
3.5 % Sodium hydroxide	9.15	21.20	27.39	31.56	27.26	35.26	46.67	55.02	10.83	20.82	33.87	47.99	25.11	35.26	40.33	58.78
4.0 % Sodium hydroxide	29.69	38.38	44.08	34.65	21.96	29.21	45.35	50.68	24.48	39.79	35.50	48.44	26.00	40.35	39.91	50.61
4.5 % Sodium hydroxide	20.50	23.05	33.98	38.96	23.69	27.50	39.55	48.70	27.65	32.15	32.22	41.13	24.75	33.50	44.27	43.72
5.0 % Sodium hydroxide	3.25	9.17	37.17	30.75	35.69	50.30	51.97	50.62	4.62	26.91	21.75	37.20	20.28	53.57	52.61	54.49
5.5 % Sodium hydroxide	7.33	8.84	20.11	32.04	19.92	30.72	49.28	51.72	5.68	27.83	31.75	38.44	23.87	21.26	28.88	38.58

after treatment with sodium hydroxide (5.5 %) and screw pressing.

From these findings it is concluded that the bulk density and the digestibility of the straw increased by alkali treatment and screw pressing. Thus easily digestible animal feed with high bulk density can be prepared. The improvement in the nutritive value and storage properties will make the feed economical at commercial level.

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