

IMPROVEMENT IN THE DIGESTIBILITY OF BAGASSE PITH BY CHEMICAL TREATMENT

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SUMMARY: The dry matter digestibility of bagasse pith increased from 27.64 to 72.86 and 61.99 percent when it was treated with 3.5 per cent sodium hydroxide or 2.5 per cent calcium hydroxide respectively. The digestibility of the pith first treated with 8.5 per cent calcium hydroxide and subsequently with 5.8 per cent ammonia was 70.48 per cent. A three fold increase in non-protein nitrogen was also observed. Feeding trials on buffalo calves showed that digestibility of treated pith was equivalent to coarse grain. Average weight gain/head/day was 120 gm more than the calves maintained on standard ration. The cost of the ration was 46.4% less than standard feed.

Key Words: Digestibility, cellulose, lignin.

INTRODUCTION

Bagasse is the main by-product of sugar industry. It contains 60-70 % carbohydrates, mostly in the form of cell wall polysaccharides and is a potential source of dietary energy for cattle. The major limitation of bagasse pith as 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 (6,8,11) and biological (2,4,9) treatments have been reported for the delignification of crop residues. Alkali treatment is considered most promising for converting low quality roughages into nutritious feed for ruminants.

This study was undertaken to improve the nutritive value of bagasse pith separately by sodium hydroxide, calcium hydroxide or ammonia treatment or first with calcium hydroxide and then with ammonia.

MATERIALS AND METHODS

Bagasse pith was obtained from M/s. Crescent Sugar Mills, Faisalabad. It was treated different concentrations of commercial sodium hydroxide (1.5-4.5 % w / w) and calcium hydroxide (0.5-2.5

% w/w). The material was also treated either with ammonia (5% w/w) only or with ammonia after treatment with calcium hydroxide (0.5 % w/w) and was incubated at $55 \pm 5^\circ\text{C}$ for 15 days. Analytical methods were the same as reported elsewhere (1).

In vivo digestibility of the treated bagasse pith was estimated according to rumen techniques (7). The samples were infused in rumen of cow or buffalo and taken out after 48 hours. These were first washed with distilled water, followed by alcohol and finally with distilled water and dried at $100 \pm 5^\circ\text{C}$ to constant weight. The coefficient of digestibility was calculated according to the formula:

$$\text{Coeff. of digestibility} = \frac{\text{Wt. of sample infused} - \text{Wt. of sample left}}{\text{Wt. of sample infused}} \times 100$$

The results so obtained were analyzed statistically according to the sendicore. Rations containing wheat straw (R_1) or bagasse pith treated first with calcium hydroxide and then with ammonia were formulated and fed to buffalo calves for 90 days. The calves were weighed at the beginning, during and at the termination of the experiment to record average weight gained by the calves.

RESULTS AND DISCUSSIONS

A) Digestibility Studies

i. Bagasse pith treated with sodium hydroxide

Dry matter, organic matter, cellulose and mineral digestibility of untreated bagasse pith was 27.64, 25.34,

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Table 1: Rectuleo Rumen Digestibility of Bagasse Pith Treated with Different Concentrations of Sodium Hydroxide.

	Rectuleo Rumen Digestibility percentage after 48 hours			
	Dry Matter	Organic Matter	Cellulose	Minerals
Bagasse Pith	27.64 ± 4.0	25.34 ± 3.64	25.53 ± 3.86	57.12 ± 1.77
Bagasse Pith treated with 1.5 % Sodium Hydroxide	45.84 ± 4.24	44.75 ± 4.84	39.77 ± 6.16	61.14 ± 3.54
Bagasse Pith treated with 2.0 % Sodium Hydroxide	45.53 ± 2.09	43.41 ± 1.88	42.88 ± 3.36	66.99 ± 3.13
Bagasse Pith treated with 2.5 % Sodium Hydroxide	54.06 ± 6.95	47.24 ± 8.82	46.61 ± 13.33	75.00 ± 3.74
Bagasse Pith treated with 3.0 % Sodium Hydroxide	47.96 ± 5.18	48.92 ± 6.17	47.11 ± 8.70	74.99 ± 2.93
Bagasse Pith treated with 3.5 % Sodium Hydroxide	72.86 ± 1.06	70.12 ± 1.77	68.61 ± 1.58	84.62 ± 2.30
Bagasse Pith treated with 4.0 % Sodium Hydroxide	57.41 ± 2.29	51.96 ± 2.40	55.59 ± 7.38	83.46 ± 1.88

24.53 and 51.12 per cent respectively (Table 1). Treatment of bagasse pith with different concentration of sodium hydroxide ranging from 1.5 to 3.5 per cent progressively increased its digestibility. The maximum increase in dry matter, organic matter, cellulose and mineral digestibility after 3.5 per cent sodium hydroxide treatment was 72.86, 70.12, 68.16 and 84.62 percent, respectively. The increase in digestibility seems to be due to the breaking of bond between lignin and cellulose. A decrease in in vivo digestibility was observed when the level of sodium hydroxide was more than 3.5 per cent (Table 1). This decrease in in vivo digestibility at higher levels of sodium hydroxide appears to be due to alkaliosis caused by excess of unreacted alkali. These findings are in agreement with the findings of their workers (3, 10, 13, 15) who reported an improvement in the digestibility of various crop residues by alkali treatment and a decrease in digestibility due to alkaliosis.

ii. Bagasse pith successively treated with sodium hydroxide and ammonia

Treatment of bagasse pith with 5 per cent ammonia increased the digestibility of dry matter, organic matter,

cellulose and minerals to 46.71, 45.72, 39.05 and 71.03 per cent respectively (Table 2). There was a gradual increase in the digestibility of dry matter, organic, cellulose and minerals to 68.71, 65.37, 55.88 and 88.49 per cent, when the pith was successively treated with increasing concentration of sodium hydroxide (1.5 to 4.0 per cent) and 5.0 per cent ammonia (Table 2). Our results agree with the findings of Wainman and Blaxter (14) who reported an increase in digestibility of forages treated with calcium hydroxide.

iii. Bagasse pith treated with calcium hydroxide or ammonia

The dry matter digestibility of untreated bagasse pith was 27.64 per cent. Ammoniation (5 per cent w/w) of bagasse pith increased its dry matter, organic matter, cellulose and mineral digestibilities to 46.71, 45.72, 39.05 and 71.03 per cent respectively (Table 2). These results are supported by the findings of Hogan *et al.* (5) who reported that digestion coefficient of straw increased after ammonia treatment from 48 to 66 per cent. The dry matter digestibility of 0.5 per cent calcium hydroxide treated pith was 37.04 per cent as compared to the untreated bagasse pith

Table 2: Rectuleo Rumen Digestibility of Bagasse Pith Treated with Different Concentrations of Sodium Hydroxide and Ammonia.

Treatment of bagasse Pith	Rectuleo Rumen Digestibility percentage after 48 hours			
	Dry Matter	Organic Matter	Cellulose	Minerals
Bagasse Pith	27.64 ± 4.0	25.34 ± 1.64	24.53 ± 3.86	57.12 ± 1.37
5% Ammonia	46.71 ± 3.80	45.72 ± 1.78	39.05 ± 5.42	71.03 ± 4.23
1.5 % Sodium Hydroxide + 5 % Ammonia	45.11 ± 8.45	41.95 ± 9.16	42.92 ± 7.64	61.70 ± 9.85
2.0 % Sodium Hydroxide + 5 % Ammonia	53.48 ± 4.17	50.96 ± 5.94	43.19 ± 4.44	65.65 ± 4.77
2.5 % Sodium Hydroxide + 5 % Ammonia	62.24 ± 3.12	60.24 ± 2.86	48.68 ± 4.87	69.74 ± 3.24
3.0 % Sodium Hydroxide + 5 % Ammonia	62.42 ± 3.82	60.79 ± 2.33	50.62 ± 6.02	79.00 ± 1.25
3.5 % Sodium Hydroxide + 5 % Ammonia	63.91 ± 3.15	59.38 ± 3.58	50.29 ± 5.47	81.10 ± 1.40
4.0 % Sodium Hydroxide + 5 % Ammonia	68.74 ± 2.59	65.37 ± 2.89	56.38 ± 1.94	88.49 ± 1.40

Table 3: Rectuleo Rumen Digestibility of Bagasse Pith Treated with Calcium Hydroxide.

Treatment	Rectuleo Rumen Digestibility percentage after 48 hours			
	Dry Matter	Organic Matter	Cellulose	Minerals
Bagasse pith (as such)	27.64 ± 4.0	25.34 ± 1.64	24.53 ± 3.86	57.12 ± 1.37
0.5 % Calcium Hydroxide	37.04 ± 3.34	35.64 ± 3.46	38.85 ± 3.16	57.63 ± 2.04
1.0 % Calcium Hydroxide	49.56 ± 1.17	49.51 ± 0.49	54.26 ± 2.00	60.78 ± 7.13
1.5 % Calcium Hydroxide	50.53 ± 2.05	48.59 ± 2.10	48.74 ± 1.60	69.81 ± 2.07
2.0 % Calcium Hydroxide	38.84 ± 5.85	38.46 ± 1.85	39.59 ± 1.42	65.92 ± 1.60
2.5 % Calcium Hydroxide	61.99 ± 2.80	59.87 ± 3.04	62.57 ± 3.29	77.42 ± 2.38

Table 4: Rectuleo Rumen Digestibility of Bagasse Pith Treated with Calcium Hydroxide and Ammonia.

Treatment	Rectuleo Rumen Digestibility percentage after 48 hours			
	Dry Matter	Organic Matter	Cellulose	Minerals
Bagasse pith (as such)	27.64 ± 4.0	25.34 ± 1.64	24.53 ± 3.86	57.12 ± 1.37
5 % Ammonia	46.71 ± 3.80	45.72 ± 1.78	45.05 ± 5.42	71.03 ± 4.23
0.5 % Calcium Hydroxide + 5% Ammonia	70.48 ± 4.29	70.01 ± 4.39	69.15 ± 5.61	77.23 ± 3.14
1.0 % Calcium Hydroxide+ 5% Ammonia	71.54 ± 6.43	71.07 ± 6.64	69.17 ± 8.23	77.85 ± 3.66
1.5 % Calcium Hydroxide+ 5% Ammonia	42.11 ± 7.25	71.40 ± 7.49	70.11 ± 8.35	80.94 ± 4.95
2.0 % Calcium Hydroxide+ 5% Ammonia	71.77 ± 3.92	70.25 ± 4.06	66.48 ± 4.78	83.75 ± 2.99

(Table 3). An increase in the dry matter, organic matter, cellulose and mineral digestibility to 70.48, 70.01, 69.15 and 77.23 per cent was observed when bagasse pith was first treated with 0.5 per cent calcium hydroxide and subsequently with 5.0 per cent ammonia (Table 4). Bagasse pith after treatment with calcium hydroxide and ammonia becomes equivalent to good quality hay in its digestibility with an added advantage that nitrogen contents are roughly doubled and storage life is extended. Our results are supported by the finding of Shah *et al.* (12).

B) Feeding Trials

Composition of rations containing wheat straw (R₁) and bagasse pith treated with calcium hydroxide and ammonia (R₂) is given in Table 5, whereas that of the concentrate is given in Table 6.

The dry matter digestibility of ration R₁ was 47.63 ± 0.71 whereas that of R₂ 65.17 ± 0.50 (Table 7). This improvement in the digestibility was due to breaking up of ligno cellulose bonds by calcium hydroxide and ammonia treatment. Cellulose digestibility increased from 49.37 ± 4.25 to 75.15 ± 0.87.

Weight gained by buffalo calves is given in Table 7. It is evident that the average weight gain of the calves fed on wheat straw ration (R₁) was 56.75 kg/head whereas it was 67.50 kg/head in case of treated pith. Thus the ration con-

Table 5: Composition of the Feed.

No.	Ingredients	Ration 1%	Ration 2%
1.	Green Maize	53	53
2.	Concentrate	16	16
3.	Treated Bagasse Pith	-	31
4.	Wheat Straw	31	-
Total		100	100

Table 6: Composition of the Concentrate.

No.	Ingredients	Percentage
1.	Cotton Seed Cake	28
2.	Wheat Bran	28
3.	Toria Cake	10
4.	Grams	10
5.	Salt	1.0
6.	Molasses	22.0
7.	Di-cal-Phosphate	1.0
Total		100

taining pith (R₂) was nutritionally better than the standard feed (R₁). The average daily weight gain per head in case of treated pith was 0.75 kg as compared to 0.63 kg in case of wheat straw.

Table 7: Results of the Digestibility Trial

Material	Total weight 4 in (kg) of 90 animals in days	Average weight gain (kg)	Average daily/ weight day (kg)	Percentage digestibilities of		
				Dry Matter %	Cellulose %	Protein %
Wheat straw R ₁	270	56.75	0.63	47.63 ± 0.71	49.37 ± 4.25	30.75 ± 1.06
Bagasse pith Feed R ₂	270	67.50	0.75	65.17 ± 0.50	75.15 ± 0.87	62.35 ± 3.08

The cost of the feed R₂ was Rs. 66.70/100 kg whereas that of the standard ration R₁ was Rs. 125.00/kg- a saving of 46.4 %. Thus the rations containing treated bagasse will have the following advantages over standard ration.

1. Dry matter digestibility equivalent to coarse grain.
2. Cellulose digestibility improve by 52.2 %.
3. Digestibility of protein will be 62.35 % more.
4. Weight gain per head per day was 120 gm more.
5. The cost of the ration will be 46.4 % less.

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