CALCIUM HYDROXIDE TREATMENT OF MILLET STRAW TO IMPROVE ITS RUMEN DIGESTIBILITY

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SUMMARY

The straw of Bajra, a millet, *(Pennisetum typhodium*), was ground and sieved and treated with 10 g $Ca(OH)_2$/100 g dry biomass at 100^{0}C for 2 hours to increase the rate and extent of dry matter digestibility. Samples were placed in fine mesh nylon bags and placed in the rumen of a cannulated steer. The bags were removed at intervals and analyzed for dry matter digestibility, neutral-detergent fibre and acid-detergent fibre. The digestibility of the straw was increased from 45% in its untreated state, to 90% after the $Ca(OH)_2$ treatment, making it an effective method to improve the nutritional value of agricultural residues. It is suitable for small scale farmers and has a tremendous potential in developing nations, such as India.

Keywords : millet straw, treatment, rumen, digestibility

INTRODUCTION

There is much interest in chemically treating agricultural residues to increase digestibility (Sundstol and Owen 1984). The digestion of agricultural residues by ruminants is limited by cellulose crystallinity and the close physical association between structural carbohydrates and lignin (Morris and Bacon 1977; Scalbert *et al.* 1985). In addition, acetyl groups on hemicellulose are an important factor limiting enzymatic carbohydrate hydrolysis (Gould 1984; Kong *et al.* 1992). Chemical treatments such as sodium hydroxide (Jackson 1977; Meeske et al. 1993), ammonia (Mann *et al.* 1988) and urea (Wrathall *et al.* 1989) improve the nutritive value of cereal straws. However, few studies have been performed with $Ca(OH)_2$ (Owen *et al.* 1984). There is no adverse effect on the animal from feeding $Ca(OH)_2$ treated straw because most of the additional calcium is excreted in the faeces (Djajanegara *et al.* 1984).

MATERIALS AND METHODS

Lime treatment

Straw of Bajra, a millet *(Pennisetum typhodium)* was ground and sieved to ~20 mesh. The treatment was 10 g $Ca(OH)_2$ and 9 mL water/100 g dry biomass at a temperature of 100^{o}C for two hours. The product was extensively washed after treatment and air dried.

In situ digestibility was measured by placing known weights (~2g) of untreated and treated samples into numerous tared, 50 µm pore size nylon bags (Ankom Technology Corp., NY, USA). The small nylon bags were placed in larger porous bags which were then secured with a cord and placed in the rumen. There were 5 large bags. Each large bag, containing 4 smaller bags each of treated or untreated straw corresponded to a time interval. After 0, 12, 24, 48 and 96 hours, one large bag was retrieved. For 0-hour digestion, the large bag containing the samples was actually held in the rumen for one minute. All bags were thoroughly washed until the water running out was clear. They were dried at 60^{0}C for 24 hours, cooled in a dessicator and weighed.

Fibre analysis

Neutral detergent fibre (NDF) and acid detergent fibre were determined using the methods of Goering and Van Soest (1970). 'Solubles' were estimated as the difference between DM and NDF, 'hemicellulose' was estimated as the difference between NDF and ADF and 'cellulose + lignin' was estimated as ADF. The initial DM, NDF and ADF contents of raw and treated samples were determined in triplicate and also determined for rumen digested samples after the samples were taken out at various intervals.

RESULTS

Figures 1a and 1b show the DM, NDF and ADF of raw and calcium hydroxide treated Bajra as a function of time. Figures 1c and 1d show the solubles, hemicellulose and cellulose + lignin content of raw and calcium

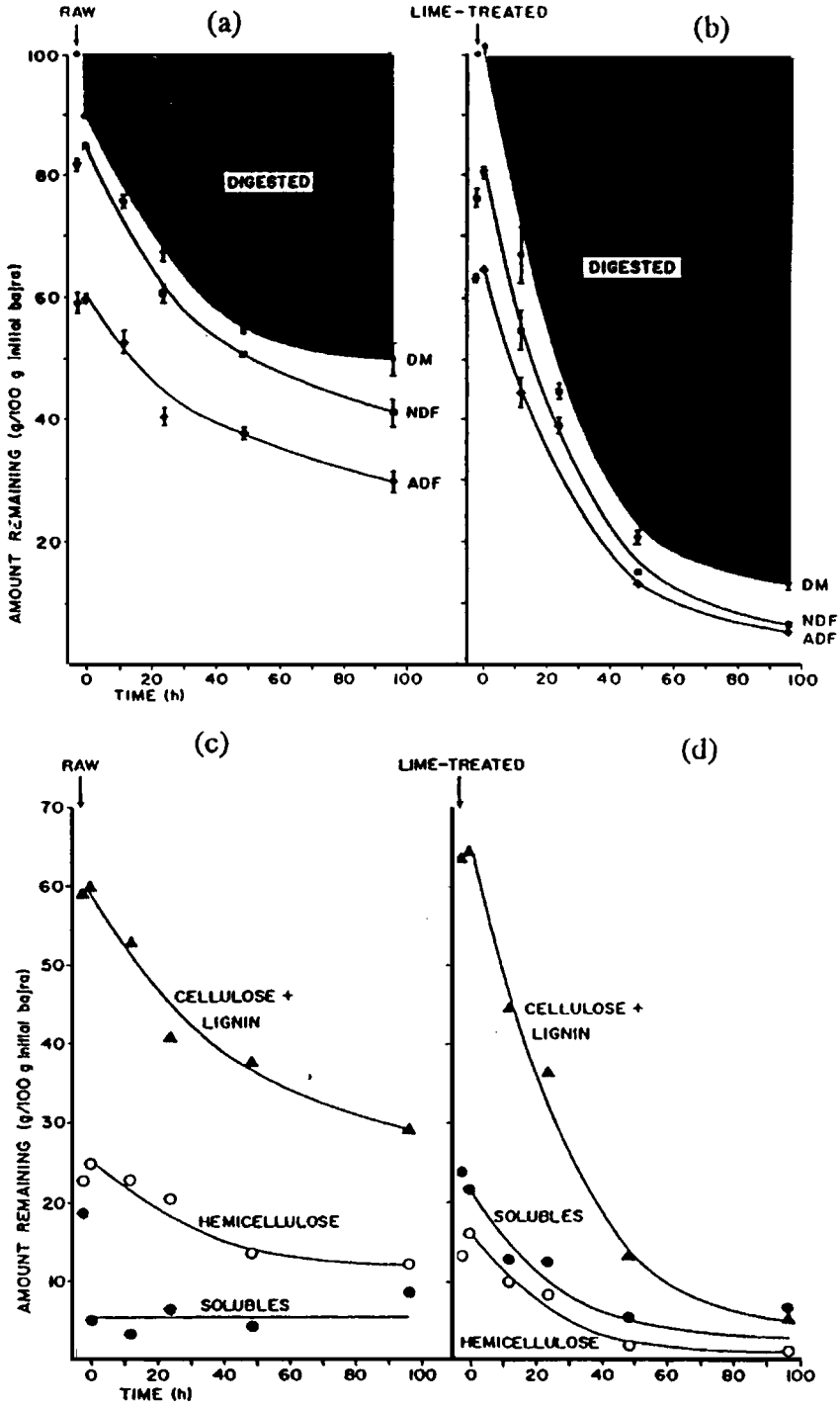

Figure 1. In situ digestion of Bajra millet straw in cattle rumen: (a & c) raw and (b & d) calcium hydroxide treated. DM = dry matter, NDF = neutral detergent fibre, and ADF = acid detergent fibre. Error bars ± 1 standard deviation.

hydroxide treated Bajra. With raw Bajra, the solubles were used almost instantly whereas with $Ca(OH)_2$ treated Bajra, the solubles took time to be digested. Calcium hydroxide treatment increased the digestibility of all components equally.

DISCUSSION

There have been many reports of improvements in the digestibility of straws and other low quality fodder achieved by various treatments. When bagasse was treated with 9 g NaOH/100 g at room temperature for 8 days, in vitro DM digestibility increased from 19.7% t0 60.1% (Playne 1984). Ammoniation of barley straw for 4 weeks using 3.5 g NH_3/100 g at ambient temperature increased the in situ digestibility from 49.1% to 74.5% (Silva and Orskov 1988).

Straws of Jowar *(Sorghum vulgare)*, another millet which is widely grown in India and stalks of tobacco were also individually treated by us with calcium hydroxide and their rumen digestibilities were determined along with Bajra straw as described earlier. The digestibility of Jowar straw was increased from 54% in its untreated state to 83 % after $Ca(OH)_2$ treatment and the increase in digestibility of stalks of tobacco was 68% treated vs. 34% untreated. $Ca(OH)_2$, unlike NaOH, has the advantage of being cheap, being safer to handle for unskilled workers and being easily recoverable. It is also environmentally less damaging. Its use to improve the nutritive value of crop residues has a vast potential in developing countries. This is especially so in India which does not have enough land mass to grow fodder for cattle, where many regions have erratic rainfall, and droughts are a regular phenomenon.

In an industrial setting, the straw is ground and washed to remove water soluble components. Then the insoluble fibre is treated with calcium hydroxide which solubilises some additional components. The wash water in this step contains both $Ca(OH)_2$ and calcium hydroxide-soluble organics. By bubbling this wash water with carbon dioxide, excess calcium hydroxide is precipitated as calcium carbonate which can be sent to a kiln for conversion into calcium oxide (quick lime). The $Ca(OH)_2$ treated fibre can be consumed by cattle. The wash water containing water soluble and calcium hydroxide-soluble components may also be fed to ruminants as a source of highly available nutrients.

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