The potential of low temperature steam treatment for improving the nutritional value of sugarcane pith

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Introduction The key to maximising the nutritional value of lignocellulosic materials is in disrupting the plant cell walls as to allow complete access to nutrients and not creating extra anti-nutritional factors. The disruption conditions of choice will always be a compromise between severe processes that achieve high levels of access, but simultaneously form anti-nutritional factors, and milder but less disruptive. Sugarcane pith is highly lignified by products of the sugar and paper industries. For treatments by steam and pressure alone, harsh conditions are needed (t>180°C). Under these conditions acetyl groups are released from the hemicellulose matrix and suitable levels of cell wall disruption are achieved, also result in formation of furfural by secondary dehydration reactions of hemicellulosic pentoses and soluble phenolic compounds. Both of them inhibit the activity of rumen microbes and cell-free enzymes. Using lower temperatures with an acid can achieve comparable cell wall disruption to steam treatment at high temperatures (Grohmann *et al*., 1985), and results lower amounts of toxic compounds. The objective of this experiment was to evaluate the effects of low temperature steam treatments with sulphuric acid (H^2S04) concentrations and reaction times on utilisation of sugarcane pith by rumen microbes.

Materials and methods Sulphuric acid solution was added to ground sugarcane pith (100 g; of about 92% DM) to obtain samples of approximately 30% dry mater (DM) content with 0, 0.6, 1.2 and 1.8% H_2SO_4 on a DM basis. Then, pith samples were autoclaved at 121°C and 134°C for 40, 80 and 120 min. The pressures at 121 and 134°C were 1.1 and 2.2 bar, respectively. The samples were oven-dried overnight at 55°C. Gas production (GP) was analyzed in triplicates by the Menke and Steingass (1988) technique using 100 ml glass syringes. Syringes were incubated in 39°Cand GP measured at 3, 6, 12, 24, 48, 72 and 96 h. The cumulative *in vitro* gas production data was fitted to the exponential equation $Y = b (1 - e^{-c.t})$.

Results *In vitro* gas production of steam treated sugarcane pith is shown in Table 1 and 2. The treatment conditions tested in this study, temperature, acid concentration and reaction time affected potential of gas production. Increased in amount of acid, temperature and reaction time resulted in a significant increase of GP ($P<0.05$). The most and the least amount of gas production (111±3 vs. 72±0.9 per 300 mg DM) was for highest and lowest amount of temperature (134 and 121 ℃), acid (%1.8 and 0 per DM) and reaction time (120 and 40min), respectively ($P<0.05$).

Table 1 Cumulative *in vitro* GP (ml per 300 mg DM) of steamed sugarcane pith (mean± s.e.)

Treatments condition		GP	Acid, % dry mater			
Temp,℃	time, min.		0	0.6	1.2	1.8
134	120	*b*	78.4±2	80.4±1.6	107±2.6	111±3
		c	0.06±0.001	0.03±0.001	0.04±0.002	0.04±0.008
134	80	*b*	74±0.1	84.6±3	92±1.4	107±5
		c	0.06±0.002	0.03±0.002	0.05±0.002	0.03±0.004
134	40	*b*	72.8±1	72.6±0.7	79.2±0.7	95.3±0.9
		c	0.07±0.002	0.02±0.004	0.05±0.003	0.06±0.002
121	120	*b*	77.5±3	77.9±3	82±1.5	99.2±4
		c	0.03±0.0	0.03±0.005	0.04±0.004	0.02±0.002
121	80	*b*	72.4±0.5	73.4±0.6	77.9±1.5	85.4±1.1
		c	0.05±0.002	0.04±0.002	0.04±0.004	0.04±0.003
121	40	*b*	72±0.9	74.8±2	80.4±0.5	86.5±1
		c	0.02±0.003	0.06±0.006	0.03±0.002	0.1±0.005

b= GP from fermentable fraction *c*= rate constant of GP

Table 2 The main effects of acid, temperature and reaction time on cumulative GP (ml per 300 mg) of sugarcane pith

	Acid, g/kg DM				s.e.m	temperature, ℃		s.e.m	Time, minute			s.e.m
	0.0	6	12	18		121	134		40	80	120	
GP	74.5^{c}	77.3^{c}	86.5^{b}	97.4^{a}	0.23	80^{b}	87.9^{a}	0.16	79.3^{b}	83.3^{b}	89.2^{a}	0.2

Conclusions The results of the present study demonstrate that treatments of acidified sugarcane pith with low temperature particular in hard condition (134 ℃ for 120 min. and 1.8% acid per DM) improved GP and therefore its utilisation for rumen micro organisms. Amount of GP in this condition is comparable with GP of the sugarcane pith treated in high-pressure (210 ℃, 3 min. 19 bar) (122.5 *vs.* 111) (observation of authors, unpublished data).

References

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