NUTRITIVE EVALUATION OF SAGO FIBRE

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Summary

Nutrient evaluation of sago fibre showed that the fibre has potential and could be utilized as feed for ruminants. However, as a source of nutrients, it has limitations arising from low intake, digestibility, crude protein and minerals content.

The present study showed that the sago fibre is low in crude protein (3.3%) and high in neutral detergent fibre (72.5%) and acid detergent lignin (25.8%) contents. Treatment of sago fibre with urea increased the crude protein content from 3.3 to 16.7%. Both urea and sodium hydroxide treatment decreased the neutral detergent fibre level from 72.5 to 59 and 56.6%, respectively.

Rumen degradation of sago fibre by nylon bag showed that both urea and sodium hydroxide treatments increased dry matter and organic matter disappearance of the fibre significantly. In vivo digestibility of 2% urea treated sago fibre was 47.5% and intake of the fibre was 1.57% of body weight of the lamb.

(Key Words: Sago Fibre, Digestibility, Alkali Treatment, Ensiling, Nutrient Composition)

Introduction

Feeding systems utilizing agro-industrial by-products could serve two useful purposes, viz reducing the rate of pollution and providing new sources of feedingstuffs for livestock. More than 47,000 tonnes of sago fibre is produced annually in Malaysia. The sago fibre, a by-product from the extraction of sago starch, has not been used as animal feed. However, Jalaludin (1987) suggested that sago fibre might be utilized as feeds for ruminants.

Like many other agricultural by-products, sago fibre is high in lignified fibre and low in other essential nutrients (Jalaludin et al., 1970). Evidence indicates that the major component of this by-product is cell wall polysaccharides which are not well utilized by the animal. Methods which increase the utilization of this component would certainly increase the nutritive value of this resi-

due. Like other fibrous residues, pretreatment with chemical may improve its nutritive value (Ibrahim, 1983). Sodium hydroxide and urea are the most common chemicals used for improving the feeding values of fibrous feed (Doyle et al., 1986).

This study is aimed a) determine the nutrient composition, degradability and digestibility of sago fibre and b) assess the effect of alkali pretreatment on the nutritive value of sago fibre.

Materials and Methods

Sago Fibre

Six kg sun dried sago fibre was allocated to each of the following treatments: 2, 5 and 6 g Urea/100 g DM fibre. Each group of sago fibre was sprayed with a urea solution using a garden watering can (1:1 w/v) and then ensiled in double plastic bags for 1, 2, 3 and 4 weeks for each treatment. Similar procedure was applied for sodium hydroxide treatment, where the sago fibre was sprayed with NaOH solution of 2, 4 and 6 g NaOH/100 g DM fibre, and then ensiled in doubled plastic bags for 1, 2, 3 and 4 weeks for each treatment. The "control" treatment were untreated sago fibre, sprayed with water 1:1 (w/v).

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Analytical Methods

At the end of the ensiled period, the treated fibre was immediately analysed for crude protein (CP) by micro-kjeldahl method. All chemical analyses were carried out in duplicates. The samples were dried in forced air oven at 60 °C till constant weight, ground and stored for analysis. Dry matter (DM) was determined in forced air oven at 105°C overnight. Ashing was carried out at 550°C overnight.

Neutral detergent fibre (NDF), acid detergent fibre (ADF), cellulose, hemicellulose, silica and acid detergent lignin were determined by the method described by Goering and Van Soest (1970). Ether extract was analysed by refluxing with petroleum ether. Calcium (Ca), copper (Cu) and magnesium (Mg) was determined by atomic absorption spectrophotometer and phosphorus by a single-beam spectrophotometer. Gross calorific value (GE) of sago fibre was determined using an Adiabatic Bomb Calorimeter. All methods for analyses were those recommended by the A.O.A.C. (1980).

Nylon bag technique

The method used was essentially that of Mehrez and Orskov (1977). Three grammes of sample were placed in nylon bags (9 × 15 cm) and suspended in the rumen of 3 cannulated sheep fed with a basal ration of sago fibre supplemented with 200 g corn, 50 g fish meal and 20 g mineral mix. For each sample, two successive incubation of 48 h were carried out in 3 sheep to give 6 measurements for each sample. After incubation in the rumen for 48 h, the contents of the nylon bags were washed and dried at 60°C till constant weight. The residues in the bags were transferred into porcelain crucible and ashed at 550°C overnight. The proportion of DM and OM which had disappeared, were determined from the difference between amount before and after incubation.

In vivo digestibility

Four male sheep (20-23 kg liveweight) of Malin × Dorsett crossbred were housed in individual metabolic crates and had continuous access to water. Prior to the commencement of the experiment, sheep were treated with antihelmintics and allowed 3 weeks adaptation period to the experimental diet.

The sheep were given a basal diet of sago fibre treated with 2% urea, ensiled for 2 weeks, 50 g molasses and 20 g mineral premix (Lazuli Co. Ltd., Kuala Lumpur) *ad libitum*. The sheep were fed once daily at 09:00 h, the amount offered was at least 20% in excess of the previous days intake. The voluntary feed intake and total faecal output were measured over the last 10 days. Samples of feed offered and refused were collected, weighed and sub-sampled daily and 10% were kept for DM and OM determinations.

The DM and OM digestibility (DMD, OMD), and intake (DMI, OMI) was calculated from the DM and OM of sago fibre eaten and excreted by the animal (Minson, 1981).

The analysis of variance (Steel and Torrie, 1960) was carried out using the Statistical Analysis System (SAS) installed on micro computer.

Results and Discussion

The chemical composition of sago fibre is shown in table 1. Sago fibre was low in CP (2.9%) and high in NDF (72.8%) content. The fibre was also fairly high in ADF (38.7%), ADL (25.7%), and low in Ca (0.2%) and P (0.1%). The chemical composition of sago fibre was comparable to other fibrous agricultural by-products such as rice straw and palm press fibre (PPF). Rice straw contained CP (3-6%), NDF (61-86%) ADF (41-63%) and ADL (4-10%) (Doyle et al., 1986). PPF also contained CP (4%) and NDF (75.4%) as mentioned by Devendra (1978), were similar to sago fibre.

The urea and sodium hydroxide treatments had significant effect on NDF and CP content of the sago fibre (table 2 & 3). Urea treatment decreased the NDF content of the fibre with increasing length of ensiling period. This was probably because of time taken in converting urea to ammonium hydroxide (Sundstol et al., 1978; Jayasuriya and Pearce, 1983; Wanapat, 1985). The NDF content of sago fibre was also decreased with increasing level of alkali used (Jackson, 1977; Chairatanayuth and Wannamolee, 1987).

Urea treatment increased the CP content of sago fibre significantly due to the N from urea. The concentration of N also increased with the strength of urea used (table 3). Similar results had been reported by many workers with straws where 0.3-4.2% N increased over untreated straw

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TABLE 1. THE CHEMICAL COMPOSITION OF UNTREATED SAGO FIBRE

	Range	Mean	S.E.
Moisture (%)	45.5 — 73.5		
Ash (% DM)	8.5 — 9.2	8.8	0.20
CP (% DM)	2.6 — 3.2	2.9	0.30
Ether Extract (% DM)	3.4 — 3.7	3.5	0.90
Gross Energy (MJ/kg DM)	12.3 — 15.9	13.7	1.10
NDF (% DM)	69.3 — 74.5	72.8	0.30
ADF (% DM)	37.0 — 41.7	38.7	1.49
Cellulose (% DM)	4.9 — 6.0	5.3	0.36
Hemicellulose (% DM)	32.3 — 36.1	33.7	1.18
Silica (% DM)	5.7 — 7.8	6.8	0.61
ADL (% DM)	23.8 — 27.7	25.7	1.11
Ca (mg/g DM)	1.7 — 2.8	2.2	0.31
P (mg/g DM)	1.2 — 1.5	1.3	0.10
Mg (mg/g DM)	0.3 — 0.7	0.5	0.11
Cu (μ g/g DM)	0.3 — 0.5	0.4	0.06

TABLE 2. EFFECT OF ENSILING PERIOD ON NDF CONTENT (g/110 g DM) OF UNTREATED, UREA AND SODIUM HYDROXIDE TREATED SAGO FIBRE

Chemical	Level (%)	Ensiling Period (wks)				Significance	S.E.
		1	2	3	4		
Sago Fibre (control)	—	72.8	72.7	72.5	72.3	NS	0.2
Urea	2	66.8	62.6	61.7	61.6	***	0.6
	4	65.1	61.8	61.6	60.4	***	0.5
	6	64.5	60.4	59.3	58.9	***	0.6
NaOH	2	61.8	61.2	60.6	60.5	NS	0.2
	4	59.7	59.5	59.0	58.9	NS	0.3
	6	57.9	57.2	57.1	56.6	NS	0.3

TABLE 3. EFFECT OF ENSILING PERIOD ON CP CONTENT (g/100 g DM) OF UNTREATED, UREA AND SODIUM HYDROXIDE TREATED SAGO FIBRE

Chemical	Level (%)	Ensiling Period (wks)				Significance	S.E.
		1	2	3	4		
Sago Fibre (control)	—	3.2	3.2	3.2	3.2	NS	0.03
Urea	2	10.4	10.5	10.3	10.4	NS	0.05
	4	13.2	13.5	13.3	13.4	NS	0.08
	6	16.5	16.5	16.8	16.9	NS	0.08
NaOH	2	3.0	2.7	3.0	2.8	NS	0.06
	4	2.9	3.0	2.7	2.8	NS	0.06
	6	2.9	2.8	2.9	2.9	NS	0.06

when urea was applied at the level of 1-20 g/100 g DM (Ambar and Djajanegara, 1982; Schiere et al., 1988). Sodium hydroxide treatment resulted in reduced CP content relative to untreated fibre, was probably due to chemical degradation of the protein into volatile compounds (Vijchulata et al., 1985). Ensiling period did not effect the CP content of the fibre.

Both urea and sodium hydroxide treatments increased the DM and OM disappearance from the nylon bag of sago fibre significantly with increasing level of chemical (table 4 & 5). This result was similar to results of treating straws, where there was an increase of 5-15 units of DM and OM disappearance from nylon bag when 1-20 g alkali per 100 g DM straw was used (Chandra and Jackson, 1971; Ambar and Djajanegara, 1982). The effect of ensiling period was significant in urea treated fibre because of time

taken for converting urea to ammonium hydroxide. During the ensiling of fibre with urea, it is believed that ammonia released from urea forms ammonium hydroxide and this alkali breaks down ligno-cellulose bonds (Jackson, 1977; Chesson, 1981) resulting the fibre more susceptible to digestion by microbial enzymes.

The result of urea treatment on chemical composition and nylon bag degradation showed that 2% urea treated sago fibre, ensiled for 2 weeks was equally good in terms of chemical composition and nylon bag degradability. Thus, 2% urea treated fibre was further tested for *in vivo* digestibility. The urea treatment has the added advantage in that it also increased the N content thus stimulating rumen fermentation and providing the additional protein required by the animal. Urea improves feeding quality of the fibrous material without loading the feed with

TABLE 4. EFFECT OF ENSILING PERIOD ON DM DISAPPEARANCE (g/100 g DM) OF UNTREATED, UREA AND SODIUM HYDROXIDE TREATED SAGO FIBRE

Chemical	Level (%)	Ensiling Period (wks)				Significance	S.E.
		1	2	3	4		
Sago Fibre (control)	—	51.3	51.3	51.5	51.2	NS	0.3
Urea	2	56.8	59.4	60.0	60.2	*	0.4
	4	60.6	61.4	62.7	63.6	**	0.4
	6	62.3	64.2	64.7	65.2	*	0.4
NaOH	2	61.1	60.9	61.8	61.8	NS	0.3
	4	62.5	63.7	63.8	64.1	NS	0.3
	6	64.8	65.7	66.8	66.8	NS	0.5

TABLE 5. EFFECT OF ENSILING PERIOD ON OM DISAPPEARANCE (g/100 g OM) OF UNTREATED, UREA AND SODIUM HYDROXIDE TREATED SAGO FIBRE

Chemical	Level (%)	Ensiling Period (wks)				Significance	S.E.
		1	2	3	4		
Sago Fibre (control)	—	54.7	54.7	54.7	54.4	NS	0.2
Urea	2	58.7	61.7	62.8	63.2	**	0.6
	4	63.3	63.7	65.4	66.0	*	0.4
	6	64.9	66.0	67.7	68.9	**	0.5
NaOH	2	64.3	63.3	63.6	63.8	NS	0.3
	4	65.2	65.3	65.7	66.1	NS	0.3
	6	67.2	67.2	68.3	68.8	NS	0.4

excess sodium (as in the case of NaOH), is economical, easily available and safe to handle (Horton, 1979; Schiere and Ibrahim, 1985).

The *in vivo* digestibility and intake of the treated fibre are shown in table 6. The mean DM digestibility was 575 g/kg which is only sufficient to maintain ruminant (Doyle, 1982). Associated with this low digestibility was a low DM intake (1.48% of liveweight, LW) possibly due to a slow

digestibility of the cell mass. The low intake associated with the low dry matter digestibility meant that insufficient nutrients were absorbed to prevent the sheep losing weight during the *in vivo* trial.

Conclusions

The result of the study suggests that sago fibre

TABLE 6. INTAKE AND DIGESTIBILITY OF 2% UREA TREATED SAGO FIBRE ENSILED FOR 2 WEEKS BY SHEEP

Parameter	Mean	S.E.
No. of sheep	4	
Initial M (kg)	20.93	
Final M (kg)	20.45	
Liveweight change (kg)	-0.48	
Fibre offered (g DM/d)	491.5	
Fibre refused (g DM/d)	186.1	
% of offered	37.95	
Fibre DM intake		
(g DM/d)	305.4	20.44
(g DM/kg M.d)	14.7	0.73
(g DM/kg M0.75d)	31.4	1.69
Fibre DM digestibility		
(g/kg feed)	575.2	9.01

can be used as a maintenance feed for ruminant provided that is treated with urea to increase intake and digestibility. Protein and energy supplements appear to be required if animals fed treated sago fibre are required to grow.

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