UNIVERSITI PUTRA MALAYSIA

NUTRITIVE EVALUATION OF SAGO FIBRE AS FEEDSTUFF FOR SHEEP

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By

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This thesis is dedicated to:

my parents and friends

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LIST OF ABBREVIATIONS

NDF	Neutral Detergent Fibre
ADF	Acid Detergent Fibre
ADL	Acid Detergent Lignin
DM	Dry Matter
DOM	Digestible Organic Matter
MJ	Megajoules
LWG	Live Weight Gain
L	Litres
OM	Organic Matter
OMD	Organic Matter Digestibility
OML	Organic Matter Loss/Disappearance (g/100 g OM)
$R\text{-}NH_3$	Rumen Ammonia
LW	Live Weight
CP	Crude Protein
MR	Malaysian Ringgit
TVFA	Total Volatile Fatty Acids
GE	Gross Energy

Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of **Master of Science.**

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Faculty : Veterinary Medicine and Animal Sciences

Nutrient evaluation of sago fibre showed that the fibre has some 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 essential minerals content.

The present study showed that sago fibre was low in crude protein (CP) (3.3%) and high in neutral detergent fibre (NDF) (72.5%) and acid detergent lignin (ADL) (25.8%) con tent. Treatment of sago fibre with 0, 2, 4 and 6% urea increased the CP content of the fibre from 3.3 to 10.4, 13.4 and 16.7% and decreased the NDF content (%) from 72.5 to 63.2, 62.3 and 60.8, respectively. Sodium hydroxide treatment of sago fibre decreased the NDF content, and also resulted in reduced CP content (2.9%), may be due to chemical degradation

of the protein into volatile compounds. Both urea and sodium hydroxide treatment had no effect on other cell wall component.

Rumen degradation of sago fibre determined by nylon bag technique showed that both urea and sodium hydroxide treatments increased DM and OM disappearance of sago fibre significantly. Increasing the strength of chemical used also increased DM and OM disappearance. The DM and OM disappearance of 2% urea treated fibre ensiled for 2 weeks increased from 51.4% (control) to 59.4% and from 54.7% (control) to 61.8% respectively.

Growing lambs fed urea treated sago fibre mixed with corn at 1.5:1 ratio (sago fibre + corn) and supplemented with fishmeal at 0, 50, 100 and 150 g DM, gained 68.6, 139.6, 158.6 and 166.3 g/d, respectively. A simple cost analysis indicated that supplementary fishmeal at 50 g DM/d could be an efficient and economic diet for sheep. The result showed that energy and protein supplements are necessary for reasonable performance of the sheep fed on sago fibre diet.

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia bagi memenuhi syarat keperluan penganugerahan ijazah Master Sains.

PENILAIAN NUTRIEN GENTIAN SAGU SEBAGAI
BAHAN MAKANAN UNTUK BIRI-BIRI

Oleh

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Penilaian nutrien terhadap gentian sagu telah menunjukkan bahawa gentian ini mempunyai potensi untuk digunakan sebagai makanan ruminan. Walaubagaimanapun, sebagai satu sumber makanan ianya terhad dari segi pengambilan makanan, dayacerna dan kandungan protein kasar dan mineral.

Kajian ini telah menunjukkan bahawa gentian sagu mempunyai nilai protein kasar yang rendah (CP) (3.3%) manakala nilai gentian neutral detergen (NDF) (72.5%) dan gentian asid detergen (ADL) (25.8%).adalah tinggi. Gentian sagu yang dirawat dengan 0, 2, 4 dan 6% urea telah meningkatkan kandungan protein kasar dari 3.3 kepada 10.4, 13.4 dan 16.7% dan telah mengurangkan kandungan gentian neutral detergen daripada 72.5 kepada 63.2, 62.3 dan 60.8. Gentian sagu yang dirawat dengan natrium hidroxida telah mengurangkan kandungan gentian neutral detergen dan kandungan

protein kasar (2.9%) juga telah menurun dan ini mungkin kurang penguraian protein kepada sebatian meruap. Rawatan dengan urea dan natrium hidroxida tidak membawa kesan ke atas komponen dinding sel yang lain.

Penguraian gentian sagu dalam rumen dengan menggunakan kaedah beg nilon telah menunjukkan bahawa rawatan dengan urea dan natrium hidroxida telah meningkatkan kehilangan bahan kering (DM) dan bahan organik (OM) secara ketara. Peningkatan kepekatan bahan kimia yang digunakan telah menunjukkan kenaikan nilai kehilangan bahan kering (DM) dan bahan organik (OM). Nilai kehilangan bahan kering (DM) dan bahan organik (OM) gentian sagu yang dirawat dengan 2% urea dan dieram selama 2 minggu telah meningkat dari 51.4% (kawalan) kepada 59.4% untuk bahan kering dan 54.7% (kawalan) kepada 61.8% untuk bahan organik.

Biri-biri membesar yang telah diberi makanan campuran gentian sagu yang telah dirawat dan jagung pada nisbah 1.5:1 (gentian sagu + jagung) dan ditambah dengan tepung ikan pada 0, 50, 100 dan 150 g bahan kering telah menambahkan berat badan sebanyak 68.6, 158.6 dan 166 g/sehari. Satu analisis kos ringkas telah menunjukkan bahawa penambahan tepung ikan pada kadar 50 g DM/sehari adalah ransum yang ekonomi dan cekap untuk biri-biri. Keputusan ini telah menunjukkan bahawa penambahan tenaga dan protein adalah perlu untuk prestasi biri-biri yang diberi makan gentian sagu.

CHAPTER I

GENERAL INTRODUCTION

Fibrous by-products from agricultural crops and agro-industries serve as the main ingredient of the diet of ruminant animals in Asia for at least part of the year. These by-products are inevitably produced during the production of the main commodities. It is also inevitable that this will continue in the future since cereals and other crops will be needed for human consumption. In recent years, there has been an increased interest in maximizing the use of low quality by-products as feed for ruminants. The reasons for this increased interest vary from location to location and range from problems of disposal and pollution to realization of the potential nutritive value of the resources. Feeding systems utilizing agro-industrial by-products will also reduce the cost of animal production.

Malaysia continues to import most of the concentrates used in animal rations except for small amounts available locally. The amount of animal feed required is expected to increase with the increasing rate of population growth and consequently increasing demands in livestock products. There is no natural pasture land in Malaysia other than small and scattered areas of mixed grasses and weeds on wasteland, road shoulders, fringes of rubber, coconut and oil palm estates and abandoned padi lands (Mustaffa Babjee, 1987). Furthermore, the prospect for increasing areas sown to improved pastures is rather limited because of the high investment cost and slow returns. Clearly, inadequate supply of good quality feed is one of the main constraints to ruminant production in Malaysia.

Several alternatives are available to Malaysia in her efforts to overcome this constraint. One is to utilise the undergrowth that are present under tree crops such as rubber, oil palm and coconut, of which Malaysia has an estimated 2.8 million ha Experiences at Rubber Research Institute (Tan and Abraham, 1981; Arope et al., 1985), Sime Darby Plantations (Pillai et al., 1985) and Guthrie Plantations (Wan Mohamed et al., 1987) have shown this to be a promising enterprise. This system of integrating tree crops with livestock rearing can be extended to orchards (Rajion et al., 1988).

The other alternative is to utilise the fibrous by products from agricultural crops and agro-industries as animal feeds. It has been estimated that more than 5.0 million tonnes of agro-industrial by-products is available in Peninsular Malaysia (Mustaffa Babjee, 1987). Some of these are already commercially well-utilized (eg. Palm Kernel Cake) although the majority (eg. Sago fibre, palm oil mill effluent, pineapple waste) has yet to be developed as useful feeds. It is known that thousands of tonnes of agro-industrial by-products are being burnt or dumped into the river and ponds causing pollution to the environment. Effective utilization of these by-products would serve two useful purposes, e.g. reducing the rate of pollution and providing new sources of feedingstuffs for livestock.

Emphasis on food and industrial crops in Malaysia results in a number of by-products being produced such as sago fibre, an end by-product of the extraction of sago starch from sago palm. Sago fibre has not been given much attention as a feedstuff for ruminants and hence little is known of the potential of this fibre as an ingredient of diets for ruminants. More than 47,000 tonnes of sago fibre per year is produced in Malaysia. This amount is calculated on the basis of starch extraction rate given by Colon (1958); Sarawak Ministry of Agriculture and Community Development (1974) and Vegter et al., (1983).

As a source of nutrient, however, sago fibre has limitations because of its low crude protein, essential minerals and high lignified fibre content (Jalaludin, et al., 1970; Muller, 1977). Concentrate feed may alleviate some of these nutritional inadequancies but they are expensive. Increasing the contribution of fibre to the total nutrient intake of the animal may optimize the usage of more expensive concentrates. This may be approached by:

a) improving the feeding value through chemical, physical or biological methods.

b) providing supplementary nutrients through the use of concentrate feeds.

Little information on the chemical and nutritive value of sago fibre is available in the literature. In order to utilize the sago fibre, it is necessary to have some knowledge of its chemical composition and nutritive value.

The primary objective of this study is to evaluate the sago fibre for its nutritive value and nutrient bioavailability as indices of their feeding value and develop methods for enhancing the feeding value of sago fibre through chemical pretreatment. The objective of chemical pretreatment of sago fibre is to improve the feeding value by increasing its digestibility and intake through solubilization of some of the cell wall components.

Chemical pretreatment of fibrous by-products from agricultural crops may improve nutritive value of these fibrous materials (eg. Straw and other fibrous by-products) to meet the maintenance requirements of ruminants but it may be insufficient for productive function such as for meat, milk or reproduction (Doyle, 1982). Initial study showed that the sago fibre has a low potential metabolisable energy, protein and mineral content (Muller, 1977; Hutagalung, 1978; Devendra, 1979). It is possible that sago fibre could be used as a basal diet which therefore needs to be supplied with energy and protein sources. The response of different level of fish meal as supplements to a sago fibre diet mixed with corn will be investigated on the performance of growing fattening lambs.

CHAPTER II

REVIEW OF LITERATURE

History and General Description of Sago Palm

The sago palm was probably one of the first plants used for food by man in South-East Asia and Oceania (Ave, 1977). Sago has been known in trade in South-East Asia for at least 700 years and also known to exist for 400 years in Sarawak, Malaysia (Burkill, 1966; Sim, 1986).

Two million ha exist as wild sago while only 0.2 million ha is cultivated in the world (Flach, 1984). Of the estimated 130,000 ha of swamp land in Malaysia, only 30,000 ha is under sago. Therefore, there is still a big potential for an increase in sago production from the swampy areas (Jalaludin, 1987).

Varieties, Growth Habit and Cultivation

At least 14 species of sago palm are exploited for stem starch production but of these *Metroxylon* (Plate 1) is by far the most important genus (Ruddle *et al*., 1978). Beccari (1918) was of the opinion that *Metroxylon* had its centre or origin in the Moluccas Islands.

Plate 1. View of Metroxylon Sago

The origin of *Metroxylon* could also include the nearby sub-continent of New Guinea, where huge natural forests of *Metroxylon* are found (Barrau, 1959). There are two important species of sago palm, present in Malaysia namely, *Metroxylon sagus* Rottb., the smooth sheathed variety and *M. rumphii* Mart., the spiny sheathed variety (Fairweather and Yap, 1937).

During its vegetative phase the sago palm accumulates a vast quantity of starch in its stem; it saturates the pith with starch, probably from the base of the stem upwards. It is only at maturity that the stem is fully saturated with starch almost to the crown. The highest starch content was found to be at 1.5 m from the ground up to 4 - 6 m (Sim and Ahmed, 1978). Many workers (Johnson and Raymond, 1956; Barrau, 1959; Corner, 1966; Rijatmo, 1972; Sastrapradja and Mogea, 1977; Ave, 1977; Satari, 1979; Soerjono, 1980) reported that it takes 6 - 20 years for the sago palm to mature, but 9 - 10 years are cited in Malaysia (Fairweather and Yap, 1937; Kueh, 1977; Morris, 1977; Sim and Ahmed, 1977).

Sago palms, in their semi-wild and cultivated forms, are usually found along river banks and in low-lying areas in the vicinity of rivers. The sago palm is a perennial crop and once established, does not need to be replanted because when a palm is felled, a sucker among several in a clump will grow up to form a new palm. Traditionally, a sago stand is semi-wild and farmers only do occasional slashing of the weeds and undergrowth to maintain them. Sago palm produces suckers quite freely and no strict planting distance, fertilization and drainage are practiced at present in Sarawak, Malaysia. They are normally given an annual round of weeding, then thinning and pruning (Sim, 1986).

Around Batu Pahat, Johore, West Malaysia, there are still well-tended sago palm plantings which have been described by Nicholson (1921) and again by Flach (1977b). The sago palm is propagated by planting suckers at 6 m x 6 m or 277 plants per ha. After the trunk begins to form, one sucker is left to develop into a trunk every second year. About 4.5 years after the start of trunk formation, flower initiation occurs. The trunk is harvested just before this time. In this way, each of the 277 clumps of palm produces one trunk every two years, resulting in an average production of 138 - 139 trunks per year (Flach, 1984).

Harvesting and Processing

The age at which the palm has the highest starch content for harvest is still a subject of research (Fairweather and Yap, 1937; Flach, 1977b; Sim and Ahmed, 1977; 1978; Sim, 1986). However, according to Johnson and Raymond (1956) and a preliminary study by Sim and Ahmed (1978), the probable time for harvesting is soon after flowering and before fruit development.

It is the time when the palm should be felled for sago production since it is at this stage that the reserve of starch in the pith is maximum. Flach (1977b) reported that in Batu Pahat, Peninsular Malaysia. The palms were harvested before the flower development eight years after planting when the starch production was highest.

When the palm is judged to be ready for harvesting it is felled by cutting as close to the ground as possible, using a chain saw. In Malaysia, the trunk is left on the ground if there is suitable watercourse very close at hand, it is cut into logs of 1 m length (Cecil et al., 1982) and towed down stream to the factory. Water transport is preferred to road haulage, as it is more economical and easier to handle on the soggy terrain. Excess production of the logs can be left in water up to 3 months for slack periods (Wee, 1977).

The first stage in the extraction of starch is to separate the bark from the pith. In commercial operations rasping (grating) is used exclusively (Tan, 1981). The rasped pith is called repos. Starch is washed out of the repos using large quantities of water. The fibrous residue remaining after the extraction of starch is called "hampas" or sago fibre. The starch slurry in water is screened to remove finely divided "hampas", and is then allowed to stand so that the starch settles out. The supernatant water is then drained off, and the wet starch (called lemantak) is either sold for