CHAPTER ONE

INTRODUCTION

The sago starch-bearing palm *Metroxylan* spp (derived from Greek words "metra" meaning heart and "xylon" meaning xylem or wood) is one of the earliest crops exploited by mankind. The Malaysian Government started its agricultural diversification programme in early 1960's, and since then sago palm is being grown mainly in the state of Sarawak. The sago industry represents one of the oldest industry in the state of Sarawak starting as a traditional cottage industry serving the needs of the local inhabitant, the industry have evolved and grown into a multimillion dollar industry. Sarawak, at present is the world's leader in sago cultivation and is the principal exporter of sago starch (Zulphilip *et al.*, 1991) exporting annually about 25,000 to 40,000 tones of sago products to Peninsular Malaysia, Japan, Taiwan, Singapore and other countries.

On the commercial scale, about 90 palms per hectare per year are harvested (Harun, 1995) with each palm yielding an estimated 166 kg dry starch (15 tonnes per hectare per annum) (Kueh and Jong, 1993). The sago palm cultivation, however, has a potential yield of 37 tones of starch per hectare per annum and is currently the most inexpensive source of starch (Anon, 1995). It is for this reason that sago is termed by many, including the Japanese as the "Starch crop of the 21st century".

With the increase in production and the downstream uses of sago starch (Fig.1.1), the sago starch industry is now being confronted with tremendous amount of solid and liquid waste disposal problems. The sago starch processing

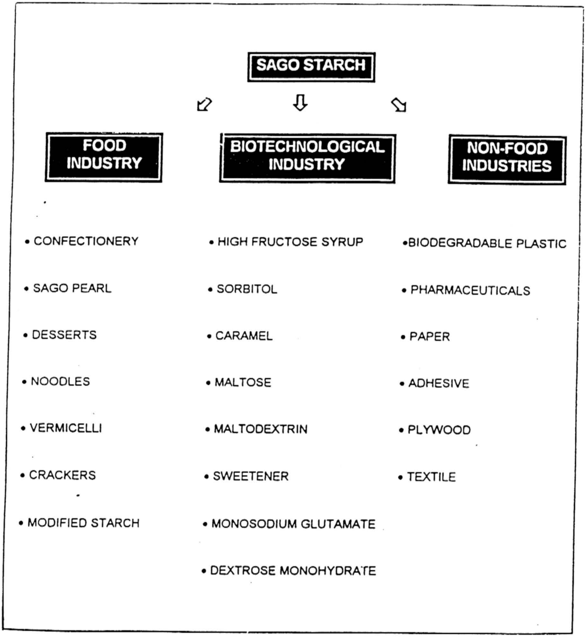

Fig 1.1: Utilization of sago starch
Source: Kueh & Lim (1993)

industry produces three major types of by-products, viz. bark of sago trunk, fibrous pith residue, commonly known as 'hampas' and wastewater (Fig 1.2). According, to (Bujang *et al.*, 1996) the sago mill consumed an average of 600 standard (1.2m or 4 ft) logs/day, thereby producing 12 tonnes of sago starch, concomitantly generating 238 tones of wastewater containing over 7 tonnes of total solid (at 3% dry matter). At 20% fresh weight from a single log, the sago bark contributes over 15 tones of solid waste/day (average weight of log at 130 kg).

As such, percentage of wastage and the amount of potentially polluting waste materials generated from this industry are very high. The hard bark from the trunk is normally disposed into the river and may take several years to degrade (Bujang *et al.*, 1996). The wastewater is pumped daily into the waterways, contributing further concern to environmental pollution from this industry and this is believed to be the main cause of poor water quality in rivers near by sago factories (Chew and Shim, 1993). Sago 'hampas', the fibrous pith residue obtained after starch extraction from the rasped sago pith, consists of about 66% starch, 15% crude fiber and 1% crude protein on a dry weight basis (Shim, 1992).

Considering the huge amounts of wastes generated once the replanting scheme gets into full swing in the following years, there is an urgent need to look into the possible utilization of the above residues. Till date, although a lot of attention has been focused towards increasing the efficiency of sago processing, little or no attempts have been made to utilize the wastes generated, especially 'hampas', which is normally washed off into the drain along with the wastewater. In some cases and areas 'hampas' has been to a limited extent used as a dietary

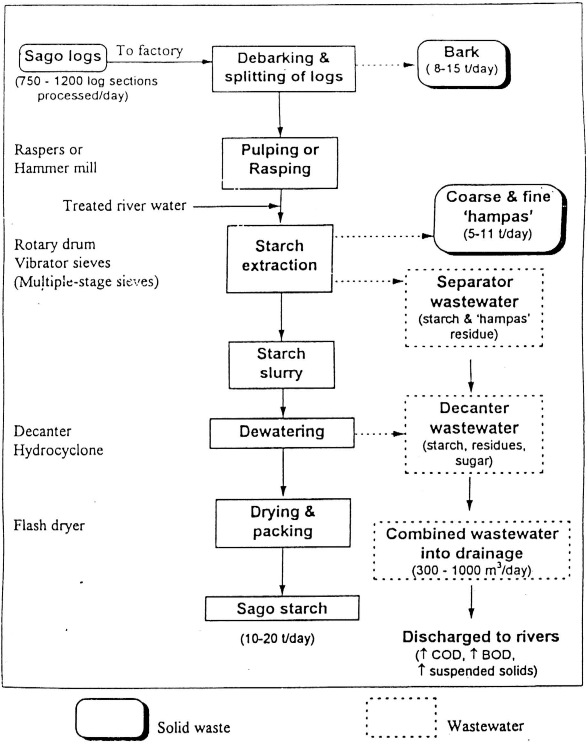

Fig 1.2: Sago processing at a conventional factory and by- products generated (adapted from Shim, 1992; Chew and Shim, 1990, 1993)

fiber or as a cheap carbohydrate supplement in ruminant feed (Kumaran, 1996).

The development of appropriate technology for converting sago 'hampas'into value added products has been undertaken by several workers (Pongsapan *et al.*, 1984; Horigome *et al.*, 1991; Paridah, 1992, Tuen, 1994) 'Hampas', which contains large amounts of trapped starch granules, has been studied by Vikineswary and Shim (1996); Vikineswary and Nadaraj (1992); Bintoro (1995); Kumaran *et al.* (1997) and Renuvathani (1999) for its utilization by ligninolytic fungi. Vikineswary and Shim (1996) found high activities of cellulase and α-amylase during growth of *Myceliophthora thermophila* on sago 'hampas'. Since sago 'hampas' constitute the major portion of the available by- products of sago factories, research should emphasize on hampas utilization.

Solid substrate fermentation (SSF) using fungi is being exploited commercially to convert agricultural and lignocellulosic residues to edible fungi including mushrooms. Agro industrial residues are generally considered the best substrates for solid substrate fermentation processes. Biotransformation of industrial residues for improved nutritional qualities, in waste treatment processes, in paper pulping processes and in the value added products such as enzymes and chemicals has been among the most important area where solid SSF has been of potential application, offering techno- economical feasibility (Pandey *et al.*, 2000). White rot fungi have commonly been employed for this purpose.

In any attempt to utilize agro-wastes properly with the aim of minimizing pollution, suitable strategies incorporating simple and effective methods need to be devised. Producing value-added products such as enzymes through SSF would be an effective and advantageous option.

This study was to monitor the growth of the white rot fungi *Pycnosporus sanguineus* (L, Murril 1904) on sago 'hampas' for the possible utilization of this agro- industrial residue.

The objectives of the study were:

1. to grow *Pycnosporus sanguineus* on sago 'hampas' based on the preliminary studies of Renuvathani (M.Biotech. Project, 1999/2000).
2. to investigate the related enzymatic profiles during the growth of this fungi as an alternative way to understand the substrate degradation pattern.
3. to assess the growth and enzyme productivity of *Pycnosporus sanguineus* on sago 'hampas' using different nitrogen concentrations in solid substrate fermentation.
3. to optimize 'Koji' inoculum age and density (w/w) for SSF of 'hampas'