12ISS02

Production, Purification and Health Benefits of Sago Sugar

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Abstract This paper reviews our previous works on the conversion of sago starch and sago hampas into sago sugar, production of cellobiose from sago fronds and the current studies on the health benefits from consumption of brown sago sugar. Sago starch can be enzymatically hydrolyzed into sugar with total (100%) recovery, containing mostly glucose (94%), with maltose and other impurities, both at 3% each. The syrup is best purified using powdered activated charcoal under gravity to remove all impurities and color. Drying of the purified and concentrated sago syrup is best performed in an oven (minimum 60°C), producing high (100%) yield of sugar crystals after several days. Analysis of sweetness revealed that the sago sugar is as sweet as 50% glucose. Consuming brown sago sugar is beneficial to health due to the presence of antioxidant, analyzed based on total phenolic content (TPC) at 300mg/kg sugar. Enzymatic hydrolysis of physically treated sago hampas has also been shown to be able to generate substantial amount of sugars (70% w/w) by recycling the hydrolysate. Current discovery also reveals on the production of cellobiose (approx. 12% w/w) from fresh sago frond, a type of pharmaceutical sugar which commands a higher price than glucose. The sago palm therefore has tremendous potentials to be utilized as an alternative to replace the supply of sugars by processing imported sugar cane.

Key words: Sago Starch, Fiber, Glucose, Flavonoids.

Introduction

In a world market where starch is dominated by corn, potato and tapioca, the world production of starch has been estimated to be 27.5 million, with insignificant amount of sago starch consumed, at about 3% or between 200,000 to 300,000 tons per annum. Clearly, there is a need to amplify the importance of sago as a major crop in South East Asia for global recognition.

The common knowledge about sago is that, it thrives in swampy areas or shallow peat soils without copious need for pesticide and herbicide (Pei-Lang *et al*., 2006), very much unlike the oil palm. Sago palm is also a hardy palm, only minimally affected by flood and forest fire. More than 90% of all sago-planting areas in Malaysia are found in Sarawak in East Malaysia. Sago is also the world's highest starch producer at 25 tons/ha. This is 4 times higher than rice, 5 times than wheat, 10 times than potato and almost 17 times of tapioca (Ishizaki, 1997). Since the average annual intake of starch per person is approximately 250 kg, a 1,000 ha sago farm can support and save 100,000 people from starvation (Ishizaki, 1997).

The most significant criteria is sago palm proliferate from suckers, hence re-planting is not necessary. The author has the opportunity to visit a sago field owned by a small community of farmers near Pusa in Sarawak, allegedly planted by their great grandparents, over 300 years ago.

Our table sugar is derived from sugar cane, a relatively easy and profitable plant to grow but rather ineffective in reproducing naturally (Braun, 1999). On a per caput basis, the amount of sugar consumption in this country is about 50 kg (raw equivalent), one of the highest in the region. The cultivation of sugarcane in Malaysia is relatively small and although the annual production of sugarcane is relatively high at 1.3 to 1.6 million tons, the sugar recovery is rather low at only 7-10%/kg fresh weight.

Lack of local raw materials induces heavy dependency of the sugar industry on imported materials (over 90%). Increases in industrial applications of cane sugar naturally lead to higher price of this commodity (Adam, 2010). Hence, a cheaper alternative which can be obtained in abundance locally is imperative for production of sugar.

Production of Sugars from Sago Starch

Initial studies on production of sugars were performed in 1 L lab-scale vessels on hydrolysis of various types of starch (sago, corn, tapioca and sweet potato flour). Modified procedure for enzymatic hydrolysis of sago starch at the optimum parameters has been detailed elsewhere (Bujang *et al*., 2000a).

Typical enzymatic hydrolysis uses Termamyl-12OL (a thermostable α-amylase from *Bacillus licheniformis,* 120 KNU/g) for liquefaction (0.5μl/gram of starch) and incubated at 90°C for 2hrs. This is followed by Dextrozyme (a mixture of glucoamylase from *Aspergillus niger* and pullulanase from *Bacillus acidopullulyticus,* 225 AGU/ml) for saccharification (0.6μl/gram of starch), and incubated at 60°C for another 4-6 hrs to produce hydrolysed sago sugars, or HSS (Bujang *et al*., 2000b; Bujang & Jobli, 2002). This period may be extended for larger volumes of hydrolysis (Bujang & Law, 2006). This method generates a 100% recovery of glucose from sago starch.

It has been confirmed earlier that 20% (w/v) sago starch is the optimum starch concentration (Bujang *et al*., 2000a; Bujang *et al*., 2004), at the best pH of 6.5 for liquefaction and 4.5 for saccharification for producing sago sugars at over 100% recovery. The same procedure was performed on other types of starch and comparatively, the highest concentration of sugars was obtained from sago starch at 100% recovery, followed by sweet potato (75%), corn (65%) and tapioca starch at 60% (Booty & Bujang, 2009).

Increasing the amount of starch from 200g/L to 10 kg/50L reduces the glucose recovery by 20%, more due to the constraints and capacity of our lab equipment. These results confirmed that it is possible to scale-up the process of enzymatic hydrolysis of sago starch with some loss in glucose yield (Booty and Bujang, 2009).

Purification of Sago Sugars

Powdered activated charcoal (PAC) has been used extensively in purification and filtration processes due to its ability to absorb odorous or coloured substances from gases or liquids. HSS is centrifuged and filtered to produce brown sago sugar (BSS). Purified sago sugars (PSS) or white sugar is