STARCH UTILIZATION IN ASIA

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ABSTRACT

This paper aims to present the commercial products made from starch, to suggest promising products of the future and to comment on key issues relating to sago starch. While there are several starch sources, rice and cassava are the main sources of starch for the Asians. Based on experience on cassava starch in Thailand, 4 categories of products are made from starch. 1. Direct use of starch in paper industry, plywood industry, textile industry and home cooking. 2. Modified starch has found special usage such as drug caplets. 3. Hydrolytic products are used in the form of glucose and further conversion into fructose and sorbitol. 4. Fermentation products from starch include monosodium glutamate and lysine. Due to the rising concerns over energy shortage and the environment, future promising products from starch which may reach the commercial scale will be ethanol fuel and polylactic acid as biodegradable plastics. For sago starch to be developed as a prominent raw material, much has to be done on speeding up the maturity of the plant and reducing pollution during starch processing.

INTRODUCTION

Among polysaccharides, starch is one of the most important energy sources of the living world. While all green plants can fix atmospheric carbon dioxide and synthesize sucrose and starch, only some plant species can actively accumulate and store starch. Rice, corn, wheat, maize, potato, cassava, jam and sago palm are among the known plants with high contents of storage starch and they are widely consumed as caloric sources in the forms of human food and animal feed. Agricultural practices have not only made these crops the main part of the rural living but also have resulted in better yielding varieties of most of them. The economic values of some of the agricultural commodities are vital to survival of the rural poor and the commerce in many developing countries. Because of their importance, modern biotechnological tools including gene technology have been applied to impart upon these crops one or more of desirable characteristics such as high yielding, resistance to pests and drought and enhanced nutritional values. In Asia, rice has long been and remains to be the stable food of most Asians and hence it is most cultivated and consumed. In fact, the world rice consumption is on the rise and rice export will continue to grow. Cassava or tapioca is a substantially staple diet for nearly half of the poor population in the tropic, mainly in Africa and part of Asia. Consequently, cassava cultivation and starch processing have been much studied and many advances have been made. On the contrary, for sago palms which grow well in the swampy areas of tropical islands of Malaysia, Indonesia and the Philippines, not as much work has been done to improve on the cultivation and starch processing. So this meeting is one of the few occasions where more attention will be devoted to the investigation of sago palm and its starch.

Biochemically, starch is made of polymers of glucose units in the forms of amylose and amylopectin. The physical, chemical and nutritional properties of starch vary depending on the plant sources, agricultural practices and the starch processing methods. Although variations of the starch quality may not matter for most traditional use of plant starch, several industrial applications of starch are strong influenced by the choice of starch sources. Therefore, the aim of this presentation is to illustrate, using cassava, the applications of starch. Then, a discussion on the future directions for starch utilization will be made. Before ending, the presentation will address key issues relating to the future of sago starch. Excluded from this presentation will be the traditional cooking and industrial processing of plant storage parts, roots or tubers in the case of cassava, as human food and animal feed. Neither the burning of cassava roots as source of energy for power generation will be included. However, use of starch in food industry will be mentioned.

COMMERCIAL PRODUCTS FROM STARCH

Thailand is a major producer of cassava (Table 1). Cassava roots from farms are normally transported to processing factories for production of cassava pellets and chips which are used as animal feed or exported. Some factories extract starch from the roots or dried chips. Industrial processing of cassava starch has been a dominant productive sector which consumes a sizable portion of the cassava roots from the farms. It takes 2.3- 2.5 tons of fresh roots to yield 1 ton of pellets or chips. However, 4.5-5 tons of the fresh roots will be needed to yield 1 ton of starch. Cassava starch has been widely used and converted into many industrial products. By category, the starch usage may separated into 4 groups as follow (Table 2).

Table 1. World cassava production. Unit = million tons

Region	1997	1998	1999
World	165.3	161.0	166.7
Africa	85.8	88.1	85.5
Asia	47.8	45.2	50.2
Latin America	31.8	27.5	30.8
Thailand	18.1	16.3	20.3

Source: http://www.fao.org

Table 2. Estimation of cassava starch consumption in various industries of Thailand (1994).

Direct use	**%**	**Hydrolytic products**	**%**
Paper industry	11.49	Glucose/Fructose	11.97
Plywood industry	2.14	Sorbitol	1.55
Textile industry	1.86		
Glue	1.19	**Fermentation**	
Food	11.87	MSG/lysine	12.70
Sago	3.58		
		Other use	
Modified starch		Other	9.49
Chemical	25.41		
Physical	7.37		

Source: Association of Tapioca Trade Industry.

1. Direct use of starch. Starch is vital as smoothening agent to the industrial production of paper and sizing of treads in the textile industry. In plywood manufacturing, starch is used as glue between the sheets. Glue gel and liquid glue made from starch are utilized in the paper box industry and in offices. Starch is also used as thickening in the soup and baby food production. Household use of starch in cooking and making of many traditional sweets is another major use of cassava starch domestically.

2. Modified starch. Because of certain quality requirement in special industrial applications, starch may be modified chemically. Derivatization and chemical cross-linking lead to change in physical and chemical properties of starch and hence its applications are extended. One known application is the use of modified starch in the manufacturing of pharmaceutical caplets. Another industrial use of modified starch is in the lubrication of oil drilling.

3. Hydrolytic products. Enzymatic hydrolysis of starch by glucoamylase yields free glucose which may be further processed into intravenous glucose or food-grade glucose. Chemical hydrolysis may also be employed to produce free glucose. Further conversion of free glucose into fructose will increase the sweetness and may be used as high fructose syrup. Another conversion product is sorbitol which is a sweetener.

4. Fermentation products. Microbial fermentation of starch occurs naturally during the delayed starch extraction or during starch storage under high-moisture conditions. However, industrial production of monosodium glutamate, MSG or a sweetener, from starch or cassava roots is a growing industry. In this case, cassava has replaced molass as the raw material. Another fermentation product from starch is lysine which is an essential amino acid supplement used in animal feed.

PROMISING PRODUCTS FROM STARCH

Research and development continue to explore and expand new use of starch in the future. While there are several reports on the experimental achievements, commercialization of these technical successes will be a major hurdle. Not only heavy investment is needed to move from research to market, competition with the existing products in use will be intense. However, there are noted trends on the rise of energy cost and the environmental concerns. It is therefore tempting to speculate that ethanol production from starch by fermentation and gasohol will be an answer to the fossil fuel shortage in the foreseeable future. Although ethanol production by fermentation is well known and use of ethanol fuel and gasohol have been done before, much more promotion is needed for the use of the renewable biofuel in place of fossil fuel. Resistance by the oil industry will be expected to persist but it will have to be overcome.

Another promising product from starch in the future will be biodegradable plastics which can be made from polylactic acid. The latter can be obtained from polymerization from lactic acid which is a fermentation product from starch or cane sugar. Currently polylactic acid can be produced and used for special use but the cost is still too high.

In both cases, there will be a danger that other substitutions such as cane sugar and molass may replace starch as the starting materials in the production of ethanol or lactic acid. Cost and technology will be key deciding factors.

FACTORS INFLUENCING UTILIZATION OF STARCH

As mentioned above, starch from different sources may possess some differences in properties primarily due to varying amounts of amylose and amylopectin. These variations may affect certain industrial applications where whole starch is used directly but is less likely to alter the products derived from hydrolysis or fermentation. However, where there is no real difference in applications, the decision to use starch from a source depends on cost, availability of the material and technology involved in the industry. In some cases, a non-starch substitution of a lower cost but of equivalent property may be used instead. A switch from one source of starch to another will need time and much inducement. Because of this difficulty, it is often frustrating to see a technical success fail to gain an adoption by industry and by commercial enterprise.

ISSUES OF SAGO STARCH

Sago palm appears to be a neglected starch source which should be further promoted through research and development. However, there are some key issues about the plant which should be critically addressed.

1. Sago palm takes about 10 years to reach maturity while most starch storing plants such as potato and cassava mature much faster, maybe in 6 months. This will influence the competitive position of sago palm as a alternative source of starch in the world which is well supplied with many existing sources of starch.

2. Trunks as starch storage part of sago necessitate the cutting of the whole plant in order to harvest the starch. With long maturity, a new plant will not yield any starch for many years. This is likely to cause inconvenience in industrial production of sago starch.

3. Polluting process of starch extraction from sago trunks may be another issue which must be addressed urgently. Soaking the cut trunks in a large body of water for a long time allows microbial growth, starch degradation and causes smelly odor. In contrast, technology to extract starch from cassava has been much more developed. Unless a new traction method causing less pollution is available, it will be difficult to envisage a wide-spread development of sago starch industry.

4. A lack of comprehensive strategy to promote sago palm is an obvious disadvantage in comparison with cassava which a globally promoted as a food-security crop of the poor.

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