

The future and prospective trend of Modified Starch



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Starch is a naturally occurring carbohydrate polymer, which is very important to mankind as the staple food and as the raw material for many industries. The starch has many distinct characteristics that are beneficial to various food and non-food products for different purposes such as thickening agent, binding agent, stabilizing agent, texturizing agent, coating agent, glazing agent, moisture binding agent, fat replacing agent, emulsifying agent, film forming agent and gel forming agent.

The advance of starch modification which improving and diversifying starch functionality promotes other downstream industries using starches as processing aids and/or functional ingredients by promising the opportunity of product improvement in terms of product quality and shelf-life stability, novel product development, technology development and production cost minimization. The conversion of starch can be categorized into three classes according to the conversion approaches, which are

What is modified starch?

When the native starches are used in some industrial products, they occasionally cannot provide the appropriate functional attributes under some processing conditions and/or during product storage. The starches are then usually modified by physical, chemical and biotechnological means to alter their physico-chemical properties to be more compatible for industrial application. The starch modification aims to improve the positive attributes and/ or reduce the negative characteristics of native starch including modifying cooking characteristics; decreasing retrogradation, decreasing gelling tendencies of pastes; decreasing syneresis of paste and gel; increasing freeze-thaw stability of pastes; improving paste and gel clarity; improving paste and gel texture, improving film forming ability, adhesion and emulsifying

1. Chemical modification: The most commonly produced modified starches for commercial purposes are chemically modified starch. The chemical method is very effective and produces diversified modified starch by various chemical reactions including

- Derivatization by monosubstitution including esterification e.g. starch acetate and etherification e.g. hydroxypropylated starch and by cross-linking e.g. starch diphosphate
- Acid thinning such as acid modified starch by hydrochloric acid
- Dextrinization such as yellow and white dextrin
- Oxidation such as bleached starch and oxidized starch by sodium hypochlorite
- Acid hydrolysis such as maltodextrin and glucose syrup

2. Physical modification: Starch properties can be altered by physical means such as heat, mechanical treatment and shear. The most commonly produced starch by physical method is pregelatinized starch or alpha-starch.

3. Biotechnological modification: One of the most important methods of starch conversion is enzyme process. When starch is treated with enzyme, the hydrolysate products have smaller molecules in size which can be tailored by controlling the treatment condition, providing various product types of different functionality. Further, starch can be ultimately hydrolyzed to glucose and then converted to many value-added chemicals by chemical process such as sorbitol, by enzyme process such as fructose syrup and cyclodextrin, and by fermentation process such as ethanol, citric acid and lactic acid.

The future and prospective trend of modified starch

The starch industry and the starch market still expands and grows continuously, both domestically and internationally as starch can fulfill needs of many industries utilizing it directly or as the raw materials for these reasons:

1. The most suitable raw material for industrial application: Besides being used as the major source for food and feed, starch is still the most suitable raw material for industrial application regarding many advantageous properties: naturally occurring, non-toxic, abundant, inexpensive, renewable, biodegradable and modifiable. Starch is, therefore, the most effective material for industrial uses.

2. The capability of producing tailor-made starch: The common nature of most industries is dynamic,

generating by the advance of technology and the change of consumer behaviors. Furthermore, the processing condition and product specification may vary among different industries. Consequently, each industry may have different and stringent requirement for starch functionality. Because of the number of active hydroxyl groups available on starch molecules, starches are, fortunately, readily modified for a wide range of attributes, depending on means and conditions of modification such as chemicals and degree of modification (degree of substitution, molar substitution, dextrose equivalent). The properties of starch are more diversified by combination process such as by double chemical reactions (e.g. hydroxypropylated distarch phosphate for using as thickening agent in food products; cationic cross-linked starch for using in wet end process of paper making), by chemical and enzyme process, by chemical and genetic process and by chemical and physical process. With various means of modification, starches can be readily made adaptable to industrial specific needs and consumer preferences.

3. Development of highly effective technology for starch conversion: Starch modification is usually performed when starch is suspended in aqueous phase. By wet process, a tremendous amount of liquid waste is generated with higher energy consumption. The modification technology has been developed to minimize water and energy consumption and, therefore, the production cost. For instance, a production of cationic starch can be achieved under semi-dry process, which is more environmentally friendly and less water and energy consumption. The advance in science and technology also promotes the starch industry to produce modified starches with higher yield and more consistent product quality.

4. Advance in biotechnology: At present, starch is mainly utilized as derivatives modified by chemical

process and as hydrolysates produced by enzyme process. The utilization of starch as the hydrolysates becomes increasing dramatically having the advance of biotechnology as the main driving force. By the technological development, starch is used competitively to produce many chemicals and value-added products such as

- Alternative fuel and renewable energy: ethanol
- Biodegradable plastics: Polylactic acid (NatureWorks™, Cargill Dow) Polytrimethylene terephthalic (Sorona®, Dupont), Polyhydroxyalkanoate (Biopol™ ICI Plastics)
- Functional food: Maltodextrin as fat replacer, Retrograded starch or resistant starch as dietary fiber, Non-digestible oligosaccharides (Isomaltooligosaccharides and Gentio-oligosaccharides) as Bifidus growth factor.
- Tablet excipient: Cyclodextrin as encapsulating agent

5. Biodiversity of starch sources: Starches from different botanical sources possess different characteristics which can be altered by different means of modification especially by the chemical process. The chemical modification of starch is, however, restricted to allowable reagents and levels of addition, concerning consumer safety, environmental pollution and economic feasibility. The starch industries are, therefore, limited their modification capability to only chemicals certified as GRAS (Generally Recognized As Safe) and food additives (under food starch – modified) by FDA. Accordingly, some industries start looking for new starch bases. Rather than commercial starch derived from corn, wheat, potato, cassava and rice, there are still plenty of starch – accumulating plants, presumably genetically and biologically different, that providing starch with different functionality. The new base starches may possess some unique characteristics being comparable to chemically modified starch, which is favorable for the development of

natural green products adapted to consumer trends. The potential of modified starch is even greater by yielding new modified starches produced from modification of new base starches.

Regarding unique and distinct characteristics of starches, the demand of starches and modified starches for industrial uses is still of immense value. To be leading and competitive in the world starch market, the industries have to continuously develop to possess effective processing technology, production capability of desirable starch quality, efficient application evaluation of starch products and informative technical services for customer's uses.

