

GENETIC MODIFICATION OF PLANT STARCHES FOR FOOD APPLICATIONS

Starch

Starch is the most abundant biomolecule on earth after cellulose and the major carbohydrate reserve in plant tubers and seed endosperm.

It is found as granules each typically containing several million amylopectin molecules accompanied by a much larger number of smaller amylose molecules.

Major starch sources are cereals (40 to 90%), roots (30 to 70%), tubers (65 to 85%), legumes (25 to 50%) and some immature fruits like bananas or mangos, which contain approximately 70% of starch by dry weight

Structural unit

Starch synthesized by plant cells is formed by two types of polymers:

- a. Amylopectin
- b. Amylose

Amylopectin consists of linear chains of glucose units linked by α -1,4 glycosidic bonds and is highly branched at the α -1,6 positions by small glucose chains at intervals of 10 nm along the molecule's axis; it constitutes between 70 to 85% of common starch.

Amylose is essentially a linear chain of α -1,4 glucans with limited branching points at the α -1,6 positions and constitutes between 15-30% of common starch.

Starch modification

1. Genetic modification of starch crops has recently led to the development of starches with improved and targeted functionality.
2. Modified starches are normal starches that have been altered chemically or physically in some way. It is a food additive which is prepared by treating starch or starch granules, causing the starch to be partially degraded.
3. Modified food starches (MFS) is corn starch that has been processed either chemically, or with enzymes to give it desired properties like withstanding heat & acidity, retaining water, or gelling in cold solutions.
4. Useful to food manufacturers in adding bulk.

5. It is used as a filler to increase the volume & mass of a product while reducing the use of more expensive ingredients like meat.
6. When starch is modified, the molecules are chemically engineered into a new structure that gives the desired property.

Methods of starch modification

Several methods have been developed to produce modified starches with a variety of characteristics and applications. All of these techniques alter the starch polymer, making it highly flexible and changing its physicochemical properties and structural attributes to increase its value for food and non-food industries

These are some methods of producing a modified starch:

1. Treating it with acid
2. Roasting it
3. Treating it with sodium hydroxide
4. Treating it with potassium hydroxide
5. Adding a positive electrical charge
6. Treating it with emulsifiers
7. Treating it with starch ether

Sometimes a starch may undergo more than one treatment, depending on the desired outcome.

Types of starch modification

Modifications of starch include physical, chemical and enzymatic methods. Physical methods involve the use of heat and moisture, and chemical modifications introduce functional groups into the starch molecule using derivatization reactions (e.g., etherification, esterification, crosslinking) or involve breakdown reactions (e.g., hydrolysis and oxidation).

1. Physical modification

Heat- moisture treatment

Cross linking

Annealing

Pregelatinization

2. Chemical modification

Esterification

Acid treatment

Oxidation

3. Enzymatic modification

Cross linking

Cross linked starch, one of the more commonly used modified starches, has been treated chemically to link the starch molecules together with cross bridges. Cross linking makes a starch more heat resistant.

Uses of modified starch

Food starches are modified to make them easier to use in certain recipes. Modified starch has many uses in food products:

1. Making a product easier to dissolve in cold water or milk for instant gelatinized recipes.
2. To bind ingredients together & acting as a thickener for soups. Helping powdered foods, like powdered cheese sauce & gravy, have a less lumpy consistency when mixed. Serving as a fat substitute for low-fat foods.
3. Acting as an emulsifier & stabilizer for salad dressings in order to keep oils from separating.
4. Forming a hard shell on some candies like jelly beans.
5. Producing foods with longer shelflife.

Food containing modified food starch

1. Chips
2. Canned soups
3. Instant pudding
4. Low-fat ice cream
5. Cheese sauces
6. Mozzarella
7. Powder coated foods such as cocoa-dusted almonds
8. Candy
9. Capsules that contain some medications