

Modification of Starch



Properties of Cooked Starch (Unmodified)

| | <u>Cooked</u> | <u>Frozen/Thawed</u> |
|-------------------|---|--|
| Corn | Opaque, gel | Gelled Chunky free water |
| Waxy corn | Heavy, cohesive, Clearer than corn | Opaque, grainy, Chunky, some free water |
| High amylose corn | Very firm gel | Syneresis |
| Tapioca | Heavy, cohesive | Grainy, more opaque |
| Potato | Very heavy, clear, Cohesive | Grainy, more opaque, Some free water |
| Rice | Opaque, soft gel | Grainy, some free water |
| Wheat | Slightly heavier than flour, opaque soft gel | Grainy, some free water |

- Poor paste texture and clarity
- Low paste viscosity
- Poor storage stability in refrigerator or freezer (molecular association results in poor texture and syneresis)
- Breakdown of viscosity under heat, high shear, and acidic conditions
- Poor adhesion property
- Poor emulsifying or hydrophobic properties

- Improve gelatinization characteristics (rapid cooking; less viscosity breakdown by heat, high shear, and acidic conditions; cold-water solubility)
- Improve refrigerator and freezer stability; improve freeze-thaw stability
- Enhance paste clarity, viscosity, and texture
- Improve adhesion property
- Impart emulsifying or water repellency properties
- Meet customs requirements of foreign countries like Japan and E.U.

Types of Modified Starches

- Acid-modified
- Bleached
- Oxidized
- Cross-linked (Esterified or Etherified)
- Substituted or stabilized (Esterified or Etherified)
- Cross-linked and substituted (or cross-linked and stabilized)
- Enzyme-modified
- Combined modification



Regulations Governing the Use of Modified Starches as Food Additives

Code of Federal Regulations, Title 21, Part 172.892

The above Code specifies the chemicals, amount of chemicals, combination of chemicals, and amount of add-on substituents allowed for modifying starch to make it suitable for direct use in foods.

The modified starch product is designated as “Food Starch - Modified” or “Modified (Botanical Source) Starch” for labeling purposes.

Acid Modification

Chemicals

Hydrochloric Acid

Sulfuric Acid

Both Hydrochloric & Sulfuric Acids

Amount

No limitations

No limitations

No limitations



Bleaching

Chemicals

Amount

Hydrogen Peroxide and/or
Peracetic Acid

Not to exceed 0.45%
Active Oxygen

Ammonium Persulfate and
Sulfur Dioxide

Not to exceed 0.075%
Not to exceed 0.05%

Calcium Hypochlorite

Not to exceed 0.036% Chlorine

Sodium Hypochlorite

Not to exceed 0.82% Chlorine

Potassium Permanganate

Not to exceed 0.2%

Sodium Chlorite

Not to exceed 0.5%



Oxidation

Chemicals

Amount

Sodium Hypochlorite

Not to exceed 5.5% Chlorine

Esterification

Chemicals

Acetic Anhydride

Adipic Anhydride and
Acetic Anhydride

Monosodium Orthophosphate

1-Octenyl Succinic Anhydride

1-Octenyl Succinic Anhydride
and Aluminum Sulfate

1-Octenyl Succinic Anhydride
followed by Beta-Amylase

Amount/Limitations

Not to exceed 2.5% Acetyl Group

Not to exceed 0.12%

Not to exceed 2.5% Acetyl Group

Not to exceed 0.4% Phosphorus
Group

Not to exceed 3%

Not to exceed 2%

Not to exceed 2%

Not to exceed 3%



Esterification-cont'd

Chemicals

Amount/Limitations

Phosphorus Oxychloride

Not to exceed 0.1%

Phosphorus Oxychloride

Not to exceed 0.1%

followed by either Acetic

Not to exceed 8%

Anhydride or Vinyl Acetate

Not to exceed 7.5%

Sodium Trimetaphosphate

Not to exceed 0.04%

Phosphorus Group

Esterification-cont'd

Chemicals

Sodium Tripolyphosphate and
Sodium Trimetaphosphate

Succinic Anhydride

Vinyl Acetate

Amount/Limitations

Not to exceed 0.4%

Phosphorus Group

Not to exceed 4%

Not to exceed 2.5%
Acetyl Group

Etherification

Chemicals

Amount/Limitations

Acrolein

Not to exceed 0.6%

Epichlorohydrin

Not to exceed 0.3%

Epichlorohydrin and

Not to exceed 0.1%

Propylene Oxide

Not to exceed 10%

Epichlorohydrin followed

Not to exceed 0.1%

by Propylene Oxide

Not to exceed 25%

Propylene Oxide

Not to exceed 25%



Esterification and Etherification

| <u>Chemicals</u> | <u>Amount/Limitations</u> |
|---|--|
| Acrolein and Vinyl Acetate | Not to exceed 0.6% Not to exceed 7.5% |
| Epichlorohydrin and Acetic Anhydride | Not to exceed 0.3% Not to exceed 2.5% Acetyl Group |
| Epichlorohydrin and Succinic Anhydride | Not to exceed 0.3% Not to exceed 4% |
| Phosphorus Oxychloride and Propylene Oxide | Not to exceed 0.1% Not to exceed 10% |



Other Modifications

Chemicals

Amount/Limitations

Sodium Hypochlorite

Not to exceed 5.5%
Chlorine

Hydrogen Peroxide, and
Propylene Oxide

0.45% Active Oxygen

Not to exceed 25%

Sodium Hydroxide

Not to exceed 1%

Alpha-Amylase

D.E. of Product less than 20

Beta-Amylase

No Limitations

Glucoamylase

No Limitations

Isoamylase

No Limitations

Pullulanase

No Limitations

- Lower molecular weight
- More linear molecules
- Low viscosity (can be used at higher solids)
- Higher gelling tendency
- Increased paste clarity
- Higher gelatinization temperature

Properties of Bleached or Oxidized Starch

- Whiter color
- More flowable powder
- Increased adhesion property
- Lower paste viscosity
- Lower gelatinization temperature
- Increased paste clarity
- Lower molecular weight



Properties of Substituted (Stabilized) Starch

- Higher swelling capacity
- Increased paste clarity
- Higher viscosity
- Enhanced storage stability in cold or freezing temperature
- Lesser tendency to retrograde
- Lower gelatinization temperature
- Increased cohesiveness

Properties of Cross-linked Starch

- Higher granule stability
- Reduced swelling capacity
- Lower paste viscosity
- Reduced clarity
- Resistant to viscosity breakdown under heat, shear, or acidic conditions
- Higher gelatinization temperature
- Shorter paste texture
- Higher molecular weight