# STARCH

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# STARCH

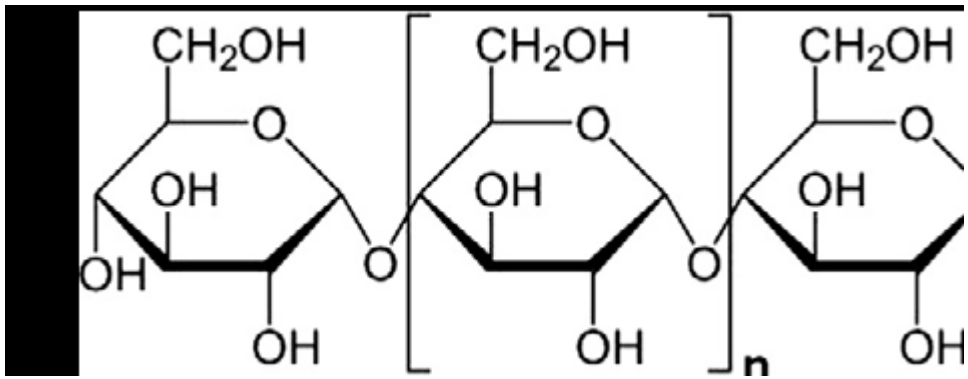
- Starch is a natural product from renewable resources
- Produced during photosynthesis as food reserve for plants and vegetables
- It is the second most abundant biomass material in nature
- It is found in plant roots, stalks, and crop seeds
- The most important industrial starch sources are crops such as corn, wheat, potato, tapioca and rice

# Source

| Source | Diameter (mm) | Amylose Content (wt%) |
|---|---|---|
| Maize | 5–25 | 28 |
| Waxy maize | 5–25 | ~0 |
| High-amylose maize | 5–35 | 55–85 |
| Cassava | 5–35 | 16 |
| Potato | 15–100 | 20 |
| Wheat | 20–22 | 30 |
| Rice (normal) | 5/3–8 | 20–30 |
| Banana | 26–35 | 9–13 |

# Thermoplastic Starch

- Starch is not meltable and cannot be processed as thermoplastic
- Starch granules can be thermoplasticized through a gelatinization process
- In this process, the granules are disrupted and the ordered crystalline structure is lost under the influence of plasticizers (e.g., water and glycerol), heat, and shear.



# Thermoplastic Starch…

- Compared to granular starch, TPS offers a great advantage in material processability and morphology control.

- TPS can be deformed and dispersed to a much finer state than the dry native starch

- Polymers used to blend with TPS are

  LDPE, PP,PU,PA, PHA,PCL tec.

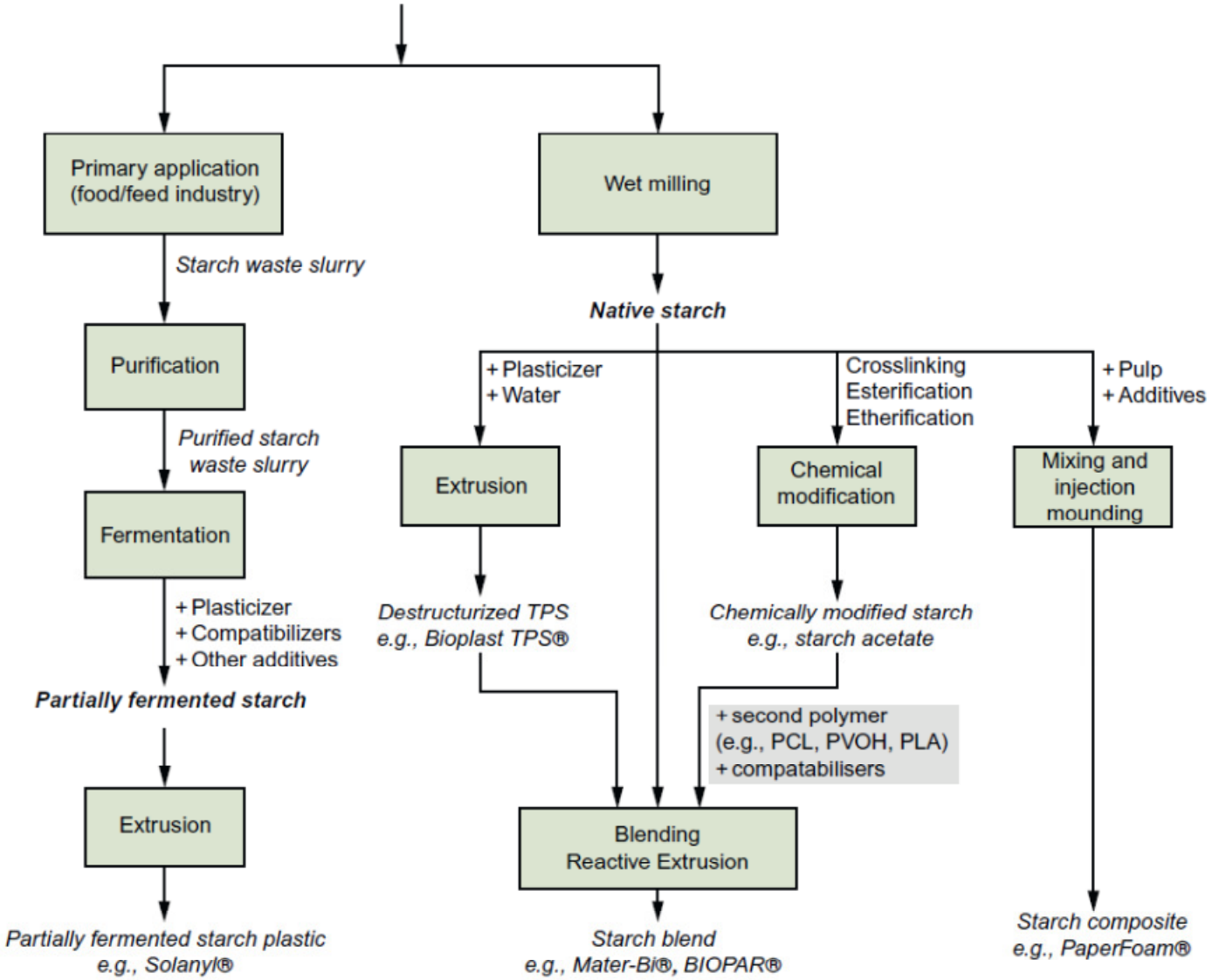
# TPS BLENDS

- TPS blends, starch can be the continuous or the dispersed phase, depending on the starch/second polymer ratio and on the processing conditions
- The use of polymers bearing polar groups, particularly those able to form hydrogen bonds (e.g., PVA, EAA, EVOH, and natural polymers like cellulose and its derivatives, gelatin and zein)
- The use of mixtures of polymers where one of them acts as a compatibilizer between starch and less hydrophilic components (e.g., PVA in TPS/polyethylene blends)

# TPS BLENDS

- The use of reactive compatibilizers, which can promote a better interface by polymere polymer chemical interlinking (e.g., methylenediphenyl diisocyanate (MDI), pyromellitic anhydride, or glycidyl methacrylate

# Production of Starch



# Properties TPS

- Relatively high glass transition temperature
- Glass transition temperature of dry starch is 332 ° C
- The mechanical properties of TPS depend on the starch production temperature and water content, as well as the quantity and type of added plasticizers and auxiliary materials .
- The most common plasticizers, such as glycerol, glycol, or sorbitol, possess hydroxy groups similar to those that appear in starch, and so are compatible with starch macrogranules.

# Properties TPS…

- High-amylose materials generally result in products with higher strength and stiffness than high-amylopectin materials
- Increasing plasticizer content decrease the tensile strength
- Whereas the elongation at break increases
- Increase in water content decreases the tensile strength and an increases the elongation at break.
- Addition of filler materials such as cellulose fibers, flax, kaolin, or pectin increases the tensile strength but reduces the elongation at break.

# Properties TPS…

- Granulate from corn or wheat starch containing 20% glycerol shows low values of Young modulus because of the presence of pores in the Extrudates.

- Irrespective of the plasticizer type and amount, melted TPSs exhibit non Newtonian flow behavior typical of pseudo - plastic liquids.

- Increasing plasticizer content causes decreasing viscosity, as a result of which TPS materials' flowingcapacities increase.

# Starch- Polymer System

- PLA/Starch
- Starch/Polycaprolactone
- Starch/PP
- Poly (Vinyl Acetate)-Starch
- Starch/PVA
- Starch/Polyethylene
- PHB–Starch

- Significant reduction of environmental impact
- Performaces similar to traditional plastics
- Processability similar or improved
- Soft, silky feel
- Wide range of permeability to water vapour
- Wide range of mechanical properties
- Antistatic behaviour
- Colourability with food contact approved pigments
- Compostability in a wide range of composting conditions