Detailed Manufacturing Process of Tapioca Starch/Sago

The manufacturing process of tapioca starch and sago consists of washing, peeling, rasping, sieving, primary settling, purification of starch, final settling, settling, powdering, sizing, roasting, drying and polishing. In this process, tapioca tubers are washed, and the outer skin and the inner rind are removed mechanically. The peeled tubers are then washed again and disintegrated in a rasper with serrated surface, adding enough water. The crushed starch milk containing fibre is sieved through 200 and 300 mesh sieves to separate the starch from fibre. The resultant suspension is then settled in a settling tank for overnight and then the settled starch is purified by removing the fine fibre and dirts. In most of the factories, FSSAI permitted processing aids such as calcium hypochlorite/sodium hypochlorite, phosphoric acid/sulphuric acid, hydrogen peroxide are added to bleach the crude starch collected from the settling tank for making into whiter colour. Then the purified/bleached starch is further dried to a safe moisture level of <14 % and sold as tapioca starch. Figure 1 illustrates the different steps involved in the production of edible tapioca starch.

For making sago, the purified/bleached starch is partially dried to bring the moisture content to 35 to 40% and then powdered.

The powdered wet starch is converted into granules by using a power operated granulator. The globules are then roasted in pans and dried in the belt dryer for about 8 h. The roasted and dried sago is passed through a polisher to break the lumps and obtain smooth polish surface to obtain the final product. The detailed flowchart for the production of wet tapioca starch and subsequent production of sago from it, are given in Figure 2 & 3.

Figure 1. Flowchart for the production of edible tapioca starch

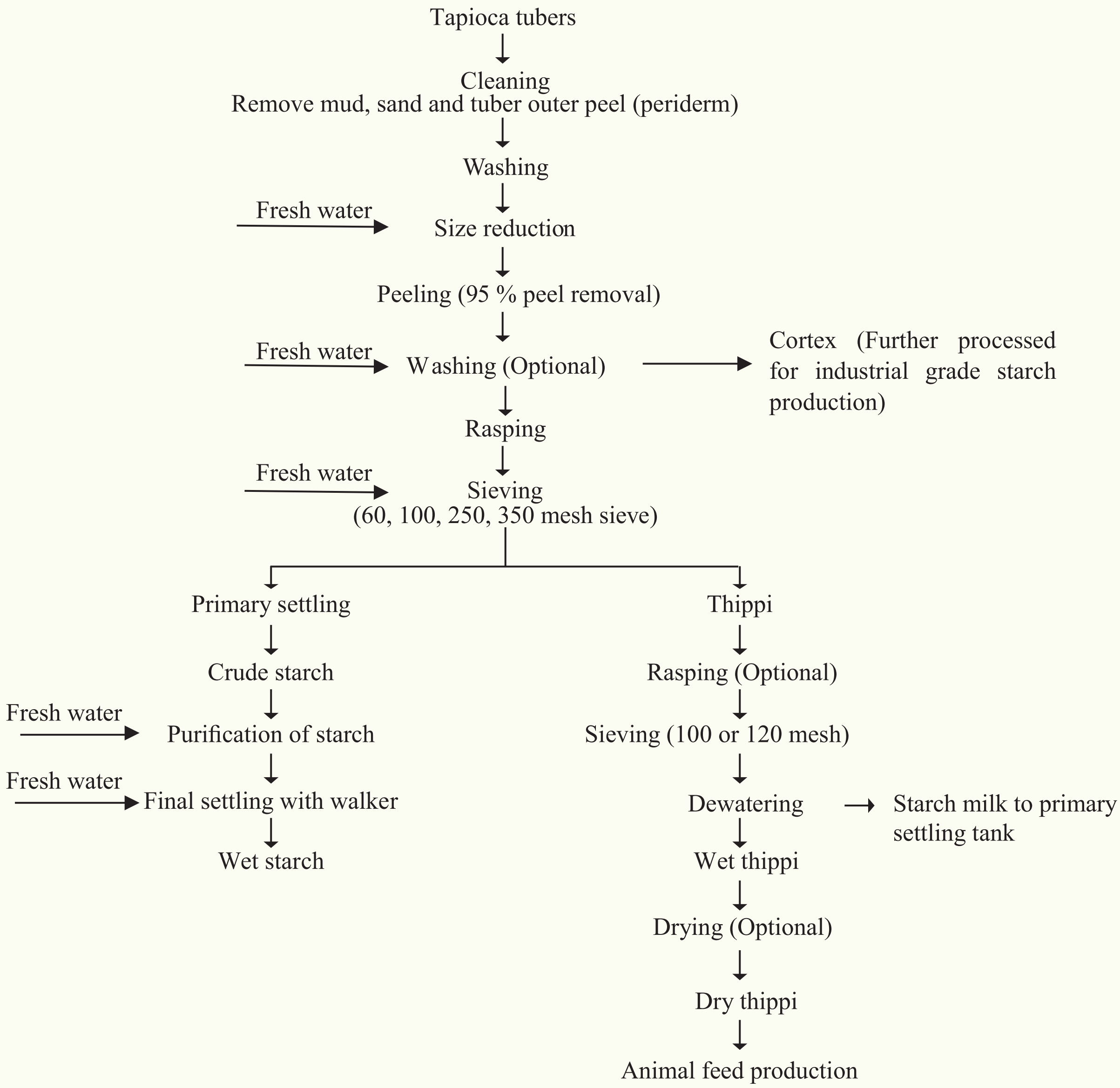

Figure 2. Flowchart for the production of wet tapioca starch

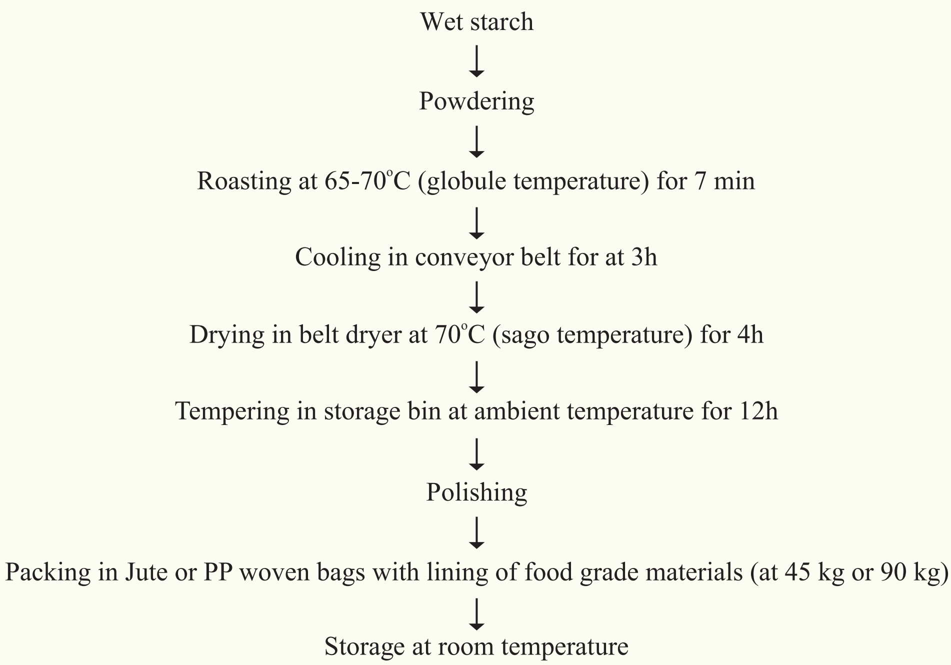

Figure 3. Flowchart for the production of tapioca sago from wet starch

The details of different steps involved in the process of starch and sago production are described below.

Cleaning

The fresh tapioca tubers containing mud, sand and outer peel (periderm) are cleaned using a rotary dry peeler.

Washing

It is done to remove and separate all adhering soil as well as protective epidermis to get colourless (white) pure starch. Tubers are washed mechanically with water using the root washer.

Size reduction

The washed tubers are cut into small sizes to facilitate the peeling process.

Peeling

Peeling is one of the most significant and important unit operations that determine the quality of sago production. Peeling is necessary to reduce the hydrocyanic acid (HCN) content of the tubers. The peel (cortex) contains 60-70 % of total cyanogenic glycoside content of tapioca tubers, while the flesh contains only 30-40 % of cyanogenic glycoside content. Hence, removing the peel substantially decreases the cyanide content in the finished products such as tapioca sago. To make edible sago, fresh tapioca tubers undergo removal of both their outer (periderm) and interior (cortex) peels. It is carried out with the help of a mechanical peeler works on abrasive action using a mechanical peeler works on the principle of abrasive action to minimize the loss of edible fleshy part of the tubers.

Rasping

In tapioca, the starch cells are comparatively small, and the cell wall is thick. It is necessary to rupture the cells to free the starch. Rasping is the one of the most important processing operations which determines the extraction efficiency. Inefficient rasping would leave starch in the fibre which would lead to a loss of available starch. Excess rasping would lead to the breakdown of the starch granules and increase the energy costs. Presently, most of the sago processing units use saw tooth rasper. This rasper consists of a rotating drum of about 40-50 cm diameter and 30-50 cm length with longitudinally arranged saw teeth blades placed in grooves around the circumference. Blades have 8 to 10 saw teeth per cm and is spaced 6 to 10 mm apart projecting about 1 mm above the surface. The drum rotates inside housing with a hopper at the top for feeding the tubers and with a perforated metallic plate underneath, through which the rasped pulp passes into the sump below. Water is continuously added during rasping. In this method, 70-90% rasping effect is obtained during first rasping operation itself.

Sieving

Crude starch milk is separated from the slurry containing starch and fibrous by-product (Thippi) by wet sieving with the addition of liberal amount of water. It is done by rinsing the pulp on screens by continuous addition/sprinkling of water. The pulp is pumped into a series of diminishing mesh sizes. The sieving is completed when the water running out of the screen is partially clear. The starch milk obtained after screening is collected in tanks and from where it is channeled for sedimentation. Residual pulp remaining on the screen after the second pass is taken for drying in the sun and is used as an ingredient in cattle feed. To separate course fibre and other non-starch particles, four to five reciprocating sieves are typically used and for the separation of fine fibre, one to two reciprocating sieves are used. More number of sieving increases the purity of the final products such as starch & sago.

Primary settling

It includes a series of operations performed to separate the pure starch from other contaminants. The settling process should be completed as quickly as possible to prevent chemical and microbial reactions. Settling tanks or tables is used for this purpose. Starch milk is allowed to settle for a period of about 8-12 h in the settling tanks, whose capacity varies with the processing capacity of the factory. Starch settles at the bottom of the tank and the supernatant fruit water is let off through the outlets provided at different depths of the tank. The upper layer of settled starch contains many impurities and is scrapped off and rejected.

Purification

Purification of starch is done by washing or by means of using permitted processing aids as per FSSAI for starch and sago industries. It is the process of removing impurities (fine fibre, sand, fruit water and silt) from the crude starch. Purification of starch is an essential part of sago manufacturing process to obtain good quality sago. The purification is done by washing the crude starch with water. Thus, starch slurry is first mixed with clean water, stirred and then the starch is separated from the impurities. It is obvious that that starch and impurities should be separated as completely as possible.

After the primary settling process, the wet starch is stored in separate granite lined concrete tank and is mixed with water approximately in the ratio of 1:3. Then it is filtered through 500 or 550 mesh sieve and then moved into granite lined purification tank measuring 27-30 feet long, 10-12 feet wide, and 3.0-3.5 feet height to undergo purification. To brighten or whiten tapioca starch, FSSAI permitted processing aids such as calcium hypochlorite, sodium hypochlorite, hydrogen peroxide, phosphoric acid, or sulphuric acid are typically used. The crude tapioca starch milk is then forced through a high-pressure jet nozzle into a purification tank, separating impurities which rise to the surface as foam.

Drying (for starch production)

Many factories utilize solar energy for drying of the wet starch. The process of drying wet starch in polycarbonate solar dryer has been proven as efficient method for large scale drying despite major drawbacks such as dependency on weather conditions. Alternatively, flash dryer can be used for drying of wet tapioca starch. For final dried starch to be marketed as edible grade starch, it must comply with the requirements as per IS 1319-1983 standards.

Final settling

Final settling of the starch is done using mechanical walker for further purification, mainly to remove fine fibres. After passing through a 550 mesh sieve, diluted starch milk is sent to a walker plate. The moisture content of the wet starch settled in the walker plate is verified. For sizing, the required range of moisture content of wet starch should be between 35 and 40%. A digital infrared moisture balance can be used to estimate the moisture content of sago.

Powdering

The wet starch in the form of cake is made into powder form mechanically for making sago globules.

Sizing

In this process, the powdered wet starch is converted into globules by using sago globulator. Sizing of globules will not occur if the moisture content of powdered wet tapioca is less than 35%, whereas the starch will turn into lumps and stick to the conveyor if the moisture content is greater than 40%.

Roasting & Cooling

Roasting is the process carried out to partially gelatinize the starch globules, especially the surface part to mainly retain the shape. This is done by using a mechanical roaster. The temperature of the roasting pan varies between 170°C and 200°C at the uncharged condition. Ensure that the temperature and exposure time of globules in the roasting pan should be between 65 and 70°C and about 6 to 7 min, respectively. Once roasting is complete, transfer the roasted sago to the cooling belt conveyor for about 3 h to allow it to cool to ambient temperature. Place the cooled sago in a lump breaker to remove any lumps and brokens.

Drying, Polishing & Grading

Drying is a process carried out for removing the moisture present in the sago. This is done by hot air assisted mechanical belt dryer. The hot air (drying medium) temperature in the dryer is set at 70°C. The sago should be dried at a temperature between 50°C and 70°C for about 4 h. The temperature of the sago is checked at the end point of the dryer for moisture content at every 30 min to ensure that it is ≥12% by using a digital infrared moisture balance. Once the sago attains a moisture content of 12%, it is transferred to a storage silo/tank and allow to cure or temper for approximately 12 h. The sago is then transferred to a polisher through the conveyer for separating large lumps and undersized sago. The sieve size in the polisher is 3.75 mm for making premium sago. Polisher will grade the sago into three fractions *viz*., premium sago, course broken sago and fine broken sago.

Packing & Storage

Dried, polished and graded premium starch/sago is packed in clean and dry bags made up of jute with suitable lining of food grade materials (IS:15138:2010) or HDPE/PP woven bags (IS:14968:2015). The bag shall be free from any insect infestation or fungal contamination and any undesirable or obnoxious smell.

IS standard for edible tapioca starch

Edible tapioca starch should comply with IS: 1319-1983 (Reaffirmed, 2012)

Table 1. Specifications of edible starch (IS: 1319-1983)

Sl.No.	Parameters	Specification
1	Moisture, % by Mass (Max)	14
2	Total ash (on dry basis), % by Mass (Max)	0.5
3	Acid insoluble ash (on dry basis), % by Mass (Max)	0.05
4	Starch (on dry basis), % by Mass (Min)	98
5	Protein (Nx6.25) (on dry basis), % by Mass (Max)	0.3
6	Sulphur dioxide, ppm (Max)	100
7	Crude fibre (on dry basis), % by Mass (Max)	0.2
8	pH of aqueous extract	4.5 - 7.0
9	Cold water solubles (on dry basis), % by Mass (Max)	0.7

FSSAI standards for tapioca sago

Sago should comply with FSSAI regulations for tapioca sago. The specifications are as follows:

Table 2. Specifications of tapioca sago (FSSAI)

Sl.No.	Parameters	Requirement
1	Moisture, % by weight (Max)	12.0
2	Total ash (on dry basis), % by weight (Max)	0.4
3	Acid insoluble ash (on dry basis), % by weight (Max)	0.10
4	Starch (on dry basis), % by weight (Min)	96.0
5	Protein (N×6.25) (on dry basis), % by weight (Max)	0.30
6	Sulphur dioxide, ppm (Max)	100
7	Crude fibre (on dry basis), % by weight (Max)	0.20
8	pH of aqueous extract	4.5 - 7.0
9	Colour of gelatinized alkaline paste in the porcelain cuvette on the Lovibond Scale, not deeper than	0.4 R + 1.5 Y
10	Colouring matter	Absent
11	Hydrogen cyanide content, ppm (Max)	10

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