**8. Tomato Paste Production Technology**

Tomato paste; It is the product obtained by separating ripe, solid, red-colored and fresh tomatoes from parts such as peel, seed, fiber after washing and shredding, thickening in vacuum up to a certain brix and making it durable by heat treatment by filling in hermetic containers[15].

**8.1. Production Stages**

Tomatoes used in the production of tomato paste have a different structure and characteristics than tomatoes produced for table purposes. The generally desired properties of tomatoes to be used in tomato paste production are as follows[7,15]:

* The skin and flesh of the tomato should be homogeneously red or dark red.
* The dry matter content should be high, the amount of sugar high, the amount of acid low, and the flavor should be good.
* It should be resistant to diseases and mold.
* Product yield obtained from unit area in tomato production should be high.
* Tomatoes should be thin-skinned and resistant to cracking, locular cavity should be small and have few seeds, and flesh portions should be high.

A good quality tomato paste can only be obtained from fully ripe, healthy and red tomatoes as much as possible.

**8.1.1. Raw Material Supply**

Tomatoes should be a variety as explained above. Fully ripe tomatoes should only be used. It is highly preferred to process the harvested tomatoes within 3-4 hours[7,15,94].

**8.1.2. Washing, Sorting and Shredding**

Tomatoes are brought to the factory and discharged into the pools. In this process, a brief cleaning of the tomatoes is also done. Tomatoes are transported to the factory from the pools by means of flow channels with water. Tomatoes, whose coarse dirt is cleaned in the flow channel, are subjected to washing in the 1st washing tank by means of mixing and agitation. By shaking, mud, other dirt and molds on the surface of the tomatoes are cleaned considerably. Tomatoes are taken from here to the 2nd washing tank with a perforated and racked wheel, and the washed tomatoes are sent to the roller conveyors by conveyor. Tomatoes moving on these rollers undergo a final rinsing process and the tomatoes are cleaned all over.

The rinsed tomatoes are transported to the sorting belt. Workers line up on both sides of the belt and sort out dented, rotten, green, insect-eaten and sunburnt tomatoes or remove the damaged parts with a knife.

Tomatoes, which are ready for processing, are crushed and passed through a heater, and then given to a palper group in order to obtain tomato pulp by separating their stem, peel and seed[7,15,94].

**8.1.3. Paste Processing Methods**

Quality factors related to the color and consistency of tomato paste can be controlled in the chopping, heating and thinning processes. Tomato paste processing can be considered as two different method according to the heating process of the mash. If the tomatoes are passed through the shredding machine, the obtained mash is immediately heated and turned into pulp in the palpers, this method is called "hot break". If the mash is passed through the pulper before and then the pulp is heated, this method is called "cold break"[94-96].

In the hot-break process, tomatoes are subjected to heat as soon as they are crushed in a closed and oxygen-free environment as much as possible. Thus, the smashed tomatoes are heated before they contacted to oxygen and the pectolytic enzymes are inactivated. Thus, a more viscous product can be obtained as the pectin, which gives firmness to the tomato, remains in its structure. In addition, due to the high temperature (75-85°C), the gummy substances in the seeds pass into tomato paste and increase the consistency, while some substances changes the taste and flavor and make it slightly bitter. In the meantime, the color values change as the color substances in the shell pass into the tomato paste. In production of ketchup, sauce, etc. from tomato paste, hot-break is paste preferred because of high consistency, so that it does not flow over the food[94-96].

In the cold-break process, the tomato is passed through the rough palper and after the seeds are separated, it is heated and then sent to the other palpers having smaller aperture size, and thinned. Since there is no high temperature (60-65 °C), taste, aroma and color will not deteriorate, but a paste cannot be produced as thick as that produced in the hot-break process. Because the pectolytic enzymes breakdown the pectin during the period from the disintegration until the heating, and since the gummy substances in the core house are less absorbed into the paste, the consistency of the paste becomes less. However, the taste is better[94-96].

The thinning of the mash that is passed through the palper is done in three stages. The mash is given to the first one followed by second and third (finisher) ones having aperture diameters of 1.0-1.2 mm, 0.6 mm and 0.4 mm, respectively[7,15].

Tubular heaters are most commonly used to heat the mash. Thus, the enzymes in the mash are inactivated, the microorganism load is reduced. The pulp is taken from the palper, put into tanks and drawn into buller or evaporators, where it is processed into tomato paste.

Buller, which is an evaporator, is like a stand-alone (discontinuous) boiler. First, the wort is filled and boiled until it becomes a paste. When the last paste is made, the mixer is stopped and the paste is taken and all processes are repeated for new production. Buller systems are more suitable for jam production[7,15].

Among the evaporators, the most suitable for tomato paste processing are the forced circulation tubular evaporators. Discontinuous systems are 2-stage evaporators with feedback. The 1st stage is a tubular evaporator and pre-concentration is done here. Tomato juice brix, which is 5-60, is increased to 11-120 here. Then, the semi-concentrated pulp at 11-120 brix is given to the steam jacketed bull as the 2nd stage and the mixers run continuously. On the other hand, the system works continuously and can have 2, 3, 4 or more stages. 3-effect continuous systems are commonly used in tomato paste production. In these 3-stage evaporators, steam is first given to the 3rd stage, then to the 2nd, and finally to the 1st, according to the reverse flow principle. However, tomato paste is first thickened to the 1st, then to the 3rd and finally to the 2nd stage. Tomato pulp (5-60 brix) reaches the first stage at 42°C in a 3-effect continuous evaporator at approximately 60°C. At 70 mm/Hg pressure, tomato paste starts to boil and water vapor is removed from the environment. Caramelization of the pulp is prevented by continuous mixing and it is kept here until the brix is 11-120. Then, the semi-concentrated pulp taken to the 3rd stage is concentrated under vacuum at 85°C and the brix is reached to 18-20. Finally, it is taken to the 2nd stage at 65°C and kept there until the desired brix. If the pulp is thickened to a brix of 24-260, this paste is called “puree”; If it is thickened up to 28-300 or 28-320 brix, it is called “double concentrate” and if it is thickened up to 36-400 brix, it is called “triple concentrate”[7,15,97].

**8.1.4. Pasteurization**

The paste coming out of the evaporators at 60°C is taken to the storage tank and pasteurized at 92-95°C in pasteurizers, which are a tubular heat exchanger. The tomato paste from the pasteurizers to the filling machine is filled into cans or jars at 93°C and then cooled[7,15].

**8.1.5. Filling**

The filling device consists of a tomato paste tank, a tubular heat exchanger and a filling machine. Filling can be done in aseptic bags, cans or glass jars.

In hot filling, tomato paste taken from the evaporator is given to the filling system and filled into hot cans or jars at approximately 93°C. In aseptic filling, after the product is heated at 108-110°C and cooled to 30-35°C, the sterile packaging is filled in a sterile environment. In the aseptic canning method, the product is heated and cooled in thin layers. This method ensures that fruits and vegetables are canned without flavor changes that may arise due to overcooking. In recent years, aseptic filling unit has been increasingly used in tomato paste production. For this purpose, mostly 50-1000 liter bags of various volumes are used. Aseptic bag (bag-in box) is used as packaging material for export, and various volumes of tin cans and other packaging materials are used for domestic consumption[94-96].

**8.1.6. Closing, Cooling and Drying the Packaging**

Filled boxes are hermetically sealed in closing machines. The closed cans are turned upside down in a special way and left for 3-5 minutes to remove any possible contamination on the lid, in other words, by ensuring the lid's contact with hot tomato paste. Thus, a sterile cap is obtained. The boxes are then cooled to approximately 30°C in cooling tunnels. The tin can, which cools and gets wet under the water showers, is passed under the compressed air fans at the end of the cooling and the water residues on them are removed. Then the boxes sorted on pallets are sent to the warehouses[94-96].

**8.1.7. Storage**

Packaged tomato paste should be stored in suitable warehouses in terms of ventilation, humidity and temperature, and direct sunlight should not be allowed into the package.