Tomato Processing

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Tomato is grown in our country in abundance, both in summer and winter seasons, but those grown in winter are superior in quality because they contain more total solids. During peak season, 25 percent of the produce is spoiled due to mishandling. Such losses can be avoided by converting tomatoes into different value added products. In U.S.A., Canada, Australia, etc, large quantities of tomatoes are canned or made into paste, puree, juice, ketchup and sauce. In India, tomato sauce and ketchup are very popular. High quality products can be prepared from tomatoes by :

1) Using uniformly ripened , red coloured tomatoes.
2) Avoid prolonged heating and cooled the product immediately after cooking.
3) Avoid using iron and copper equipments and utensils at any stage of processing.

Fresh tomatoes are highly refreshing and appetizing They are rich source of vitamins particularly vitamin C. The quality of tomato products is judged by its colour, which is dependent on redness of tomatoes used. In fact the red pigment (Lycopene) can be used as an index of the amount of tomato actually present in a product.

Composition of Tomato :

Chemical composition of tomato depend on various factors such as variety, growing environment & package of practice. The composition may also vary at stage of maturity. The composition of tomato is important from the quality point of view as it affects colour, nutrient content, flavour and texture of the both raw as well as processed tomato. Chemical composition of tomatoes varies at different stage of maturity. Total solid content decreases with maturity from green to eating ripening maturity due to conversion of insoluble components mainly starch and insoluble polysaccharides into simple sugars and soluble polysaccharides respectively. Soluble solids in tomato mainly consisted of sugars, which play significant role in flavour development.

The different products prepared from tomato are: tomato juice, tomato ketchup, tomato sauce, tomato powder, tomato chutney, tomato cocktail, tomato chilli sauce, tomato puree/paste tomato pickle, canned tomatoes.

As a semi- finished product, tomato puree is prepared on a small scale while at large scale tomato paste has gained commercial significance. Both puree and paste are used for preparation of different finished products like ketchup, juice, soup, etc. The method for preparation of different tomato products are discussed.

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1. Tomato Juice :-

Tomato juice is the unconcentrated product consisting of liquid with as substanlial portion of the pulp, expressed from ripe tomatoes with or without application of heat and addition of salt. Tomato juice is the basic ingredient for preparation of different tomato products such as tomato puree, paste, ketchup. etc.

Plant ripened, fully red fruits are selected, discarding all green, blemished and over- ripe fruits. A good quality juice should be deep red colour, possess the characteristic taste and flavour of tomato, contain about 0.4 per cent acid and have high nutritive value. All varieties of tomato are not suitable for processing point of view. The varieties which are used for juice and pulp manufacture must posses following characteristic.

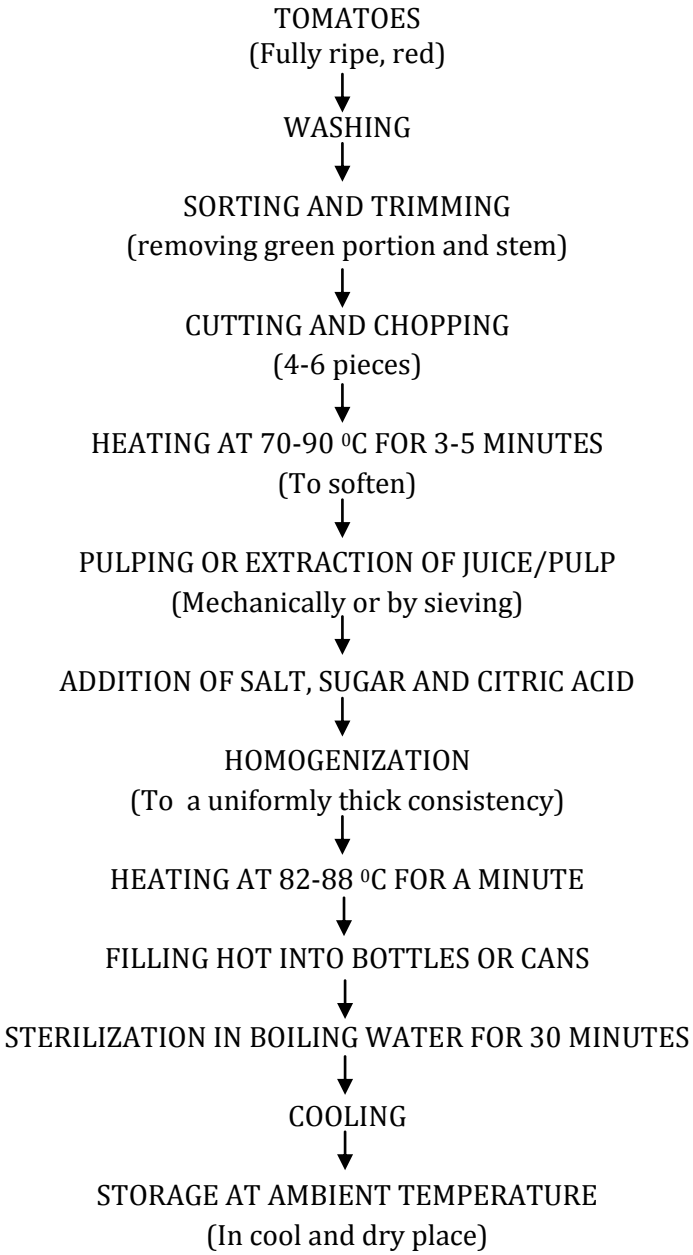
1. Deep red coloured varieties are preferred as yellow colour pigments not only mask the red colour in processed tomato products but these are also susceptible to oxidation resulting in brown colouration
2. Firm but ripe fruits should always be used as they contain sufficient amount of pectin which is essential for the consistency of the finished products like puree, sauce, ketchup etc.
3. Green coloured and sour varieties should not be used as they will affect the flavour and colour of the resultant products.
4. Tomatoes are also susceptible to microbial decay, hence any infected or diseased fruit should never be used for the manufacture of products as they may pose health hazards

F.P.O. Specifications :-

Product (Prepared from any suitable variety)	Minimum total soluble solids (%)	Mould count
Tomato Juice	5	Not in excess of 30 per cent of the field examined

In addition the juice should contain 0.5% salt, 1 % sugar and 0.4 % acids. In the home it is prepared by using 1 litre of juice, 10g of sugar, 5 g of salt, 1 g of citric acid and 1 g of sodium benzoate . Tomato juice / pulp can be extracted by hot or cold pulping. On commercial scale, a pulper or continuous spiral press is used for juice extraction but in homes tomatoes are strained through a steel sieve.

Processing Flow Sheet For Tomato Juice:-



2. Tomato Ketchup :-

Tomato Ketchup is the commercial product made either from fresh tomato by converting them into juice/ pulp or by using tomato puree or tomato paste. It is made from strained tomato juice / pulp and spices, salt, sugar and vinegar, with or without onion and garlic and contains not less than 12 per cent tomato solids and 25 percent total solids.

F.P.O. specifications of tomato ketchup are :-

Product (Prepared from any suitable variety)	Minimum total soluble solids (%)	Mould count
Tomato Ketchup	25 (Minimum acidity as acetic acid 1 %)	Not in excess of 40 per cent of the field examined (yeast and spores not in excess of 125 per 1/60 c.mm.; Bacteria not in excess of 100 million per c.c.)

General Consideration :-

About one third of the sugar is required at the time of commencement of boiling to intensify and fix red tomato colour. If the whole quantity of sugar is added initially, the cooking time will be longer and quality of pulp will be adversely affected. Generally, sugar content in ketchup varies from 10-26 per cent. On the other hand, salt bleaches the colour of the tomato product; it is, therefore, desirable to add it towards the end of cooking process. Spices are generally added in powdered form to the product by spice bag method. Essential oils; however do not give the characteristic true aroma of whole spice but oleoresins provide true aroma.

The salt content of the product should be 1.3-3.4 per cent. Good quality vinegar is essential for the preparation of high quality ketchup. It should contain 5-5.5 per cent acetic acid and should be added when the product has thickened sufficiently, so that acid is not by volatilization. Tomato ketchup generally contains 1.25-1.5 per cent acetic acid. Sometimes glacial acetic acid (100 per cent acetic acid) is used which is colourless and cheaper than vinegar. In order to increase the viscosity and prevent the separation of pulp from clear juice, pectin can be added to the extent of 0.1-0.2 per cent by weight of finished product. The ketchup should be filled hot (about 88^0C) to prevent browning and loss of vitamins during subsequent storage. If it is made from tomatoes of good quality, using salt, sugar, spices and vinegar in correct proportion, it does not spoil for a fairly long time, even after opening the sealed bottle, if the latter is kept in a cool and clean place. It is, however, advisable to add 0.025 per cent sodium benzoate to the product before bottling and then pasteurize the bottles as a precaution against spoilage during 3 to 4 weeks than the ketchup remains in opened bottle before it is used up.

Recipe :-

Tomato pulp 1 kg, sugar 75 g, salt 10 g, onion (chopped) 50g , ginger (chopped) 10 g, garlic (chopped) 5 g, red chilli powder 5 g, cinnamon, cardamom (large), aniseed, cumin, black pepper (powdered) 10 g each, clove (headless) 5 number, vinegar 25 ml or glacial acetic acid 5 ml and sodium benzoate 0.25 g per kg final product.

Problem in the preparation of ketchup :-

Black Neck :-

Formation of black ring in the neck of bottles is known as black neck. It is caused by iron which gets in to the product from the metal of the equipment and the cap or crown cork through the action of acetic acid This iron coming into contact with tannins in spice forms ferrous tannate which is oxidized to form black ferric tannate. This can be prevented by

* Filling hot not temperature less than 85^0C
* Leave little head space.
* Use plastic lid in place of iron lid.
* Partial replacement of sugar by glucose or corn syrup.
* Storing bottles in horizontal or inverted position.

Discolouration :-

Other that black neck some time whole product not looking red may be brownish probably due to extra squeezing of spice bag & addition of salt too early during cooking of the product. Care gently squeeze the bag as per required pungency or taste added in the product and salt addition at the end of final cooking of the product.

Precautions :-

1) Do not use copper and iron utensils / equipments.
2) Clove with head and iron lid cause bottle neck disorder.
3) Leave head space 2 cm at top and the bottles are sealed or corked at once.

4) Best use of the product within one month of opening and see the date of manufacture & expiry.
5) Addition of artificial colour / chemical are dangerous for health so should not be used.

Processing Flow Sheet For Tomato Ketchup :-

TOMATOES
(Fully ripe, red)
↓
WASHING
↓
SORTING AND TRIMMING
↓
CUTTING AND CHOPPING
↓
HEATING AT 70-90 ^{0}C FOR 3-5 MINUTES
(To soften)
↓
PULPING OR EXTRACTION OF JUICE/PULP
(Mechanically or by sieving)
↓
STRAINING TOMATO JUICE/PULP
↓
COOKING PULP WITH ONE-THIRD QUANTITY OF SUGAR
↓
PUTTING SPICE BAG IN PULP AND PRESSING OCCASIONALLY
↓
COOKING TO ONE-THIRD OF ORIGINAL VOLUME OF PULP/JUICE
↓
REMOVAL OF SPICE BAG
(after squeezing in pulp)
↓
ADDITION OF REMAINING SALT AND SUGAR
↓
COOKING
↓
JUDGING OF END POINT
(Tomato solids by hand refractometer/volume by measuring stick i.e.
one-third of its original volume)
↓
ADDITION OF VINEGAR/ACETIC ACID AND PRESERVATIVE
↓

FILLING HOT INTO BOTTLES AT ABOUT 88^{0}C

↓

CROWN CORKING

↓

PASTEURIZATION
(at 85-90^{0}C for 30 minutes)

↓

COOLING

↓

STORAGE AT AMBIENT TEMPERATURE
(in cool & dry place)

3. Tomato Puree and Paste :-

Tomato pulp without skin or seeds , with or without added salt, and containing not less than 9 per cent of salt free from tomato solids is known as 'medium tomato puree'. It can be concentrated further to 'heavy tomato puree' which contains not less than 12 percent solids. If this is further concentrated so that it contains not less than 25 percent tomato solids, it is known as tomato paste. On further concentration to 33 percent or more of solids , it is called concentrated tomato paste.

F.P.O. Specification:-

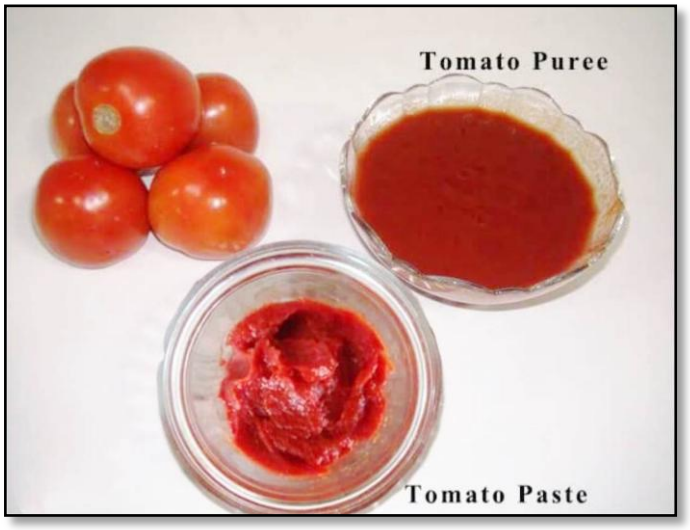
Product	F.P.O. Specification
Tomato Puree	* It shall contain minimum of 9% solids excluding salt. * The percentage of TSS required to be declared on the level of product. * Shall have good flavour of tomato and be free from burnt or any other objectionable flavour. * Mould count should not be excess of 60% of field count.
Tomato Paste	* Properly prepared and strained tomatoes shall be free from skin and seeds. * Finished product should have good flavour characteristics of the tomato and be free from any other objectionable flavour. * It shows no sign of fermentation when incubated at 37^0 C for seven days. * Mould count in the finished product shall not exceed 60% of field examined. * It shall contain minimum of 25 % solids excluding salt. Depending on the degree of concentration, tomato paste can be grouped as, * Light tomato paste containing 25-29% of salt free tomatoes * Medium tomato paste containing 29-33% of salt free tomatoes. * Heavy tomato paste containing not less then 33% of salt free tomatoes.

Preparation :-

Tomato pulp is prepared from ripe tomatoes in the same manner as tomato juice. Cooking for concentration of the pulp can be done either in an open cooker or a vaccum pan. In the former most

of the vitamins are destroyed and the product become brown. On the other hand, use of vaccum pans, which are expensive, help to preserve the nutrients and also reduce the browning to a greater extent. In vaccum pans the juice is boiled at 71^0C only. Ordinarily tomato juice can be concentrated to 14-15 per cent solids in an open cooker, but for obtaining higher concentrations a vaccum pan is required. Moreover, sterilization of the product is also possible in vaccum pan. While cooking in an open cooker, a little butter or edible oil is added to prevent foaming, burning & sticking.

If, after cooking total solids content of the juice is higher than required , more juice is added to lower it, if it is lower, cooking is continued till the desired concentration is reached. The end- point of cooking paste and puree can be determined either with a hand refractometer or by measuring the volume with the help of measuring stick.



Processing Flow Sheet For Tomato Puree/ Paste :-

TOMATO JUICE
(Strained)
↓
COOKING TO DESIRED CONSISTENCY
(open cooker/ vaccum pan)
↓
JUDGING OF END POINT FOR PUREE OR PASTE
(tomato solids by hand refractometer or volume by measuring stick)
↓
FILLING HOT INTO BOTTLES OR CANS ($82\text{-}88^0$C)
↓
STERILIZATION IN BOILING WATER FOR 20 MINUTES
↓
COOLING
↓
STORAGE AT AMBIENT TEMPERATURE
(In cool and dry place)

4. TOMATO SOUP :-

Soup is becoming very poplar in homes. It can be prepared either form pulp or tomato juice. Butter or cream, spices, starch, etc. are used for preparation of soup. These are added in different proportions an the basis of desired taste.

F.P.O. Specification :-

Product	Minimum total soluble Solids (%)	Mould Count
Tomato soup	7	Not in excess of 30 per cent of the filed examined.

Recipe :-

Tomato pulp 1 kg, salt 20g, sugar 20g, butter or cream 20g, flour /starch 10g, onion (chopped) 20 g, garlic (chopped) 5 g, clove (headless) 5 numbers, cumin, cardamom (large) , black pepper, cinnamon (powdered) 1 g each and water 350 ml

Method for Preparation of Tomato Soup:-

* The juice is boiled in pans for concentration.
* Add spices in a cloth bag as in case of tomato ketchup, while it is being concentrated.
* In the mean time arrowroot and butter with small amount of juice are mixed to form smooth paste and added to the whole lot.
* Boiling is continued to desired consistency by stirring it continuously.
* At the end, salt and sugar are added and mixture is boiled for about 2 minutes to dissolve them.
* The soup is filled hot (88^0C) into cans and is processed at 100-110^0C for 20-45 minutes depending on the size of cans & cooled quickly after processing.

Processing Flow Sheet For Tomato Soup :-

TOMATO PULP/JUICE
(Strained)
↓
BOILING TO CONCENTRATE
↓
PUTTING SPICE BAG IN COOKING PAN
(as in sauces)
↓
PREPARING PASTE OF BUTTER AND FLOUR/STARCH
↓

ADDITION TO CONCENTRATED JUICE

↓

COOKING TO DESIRED CONSISTENCY WITH CONTINUOUS STIRRING
(to prevent coagulation of starch)

↓

ADDITION OF SUGER AND SALT AND COOKING FOR 2 MINUTES

↓

REMOVAL OF SPICE BAG
(after squeezing)

↓

FILLING INTO CANS
(plain cans)

↓

STERILIZATION
(at 115^0C for 40-45 minutes)

↓

COOLING

↓

STORAGE AT AMBIENT TEMPERATURE
(In cool and dry place)

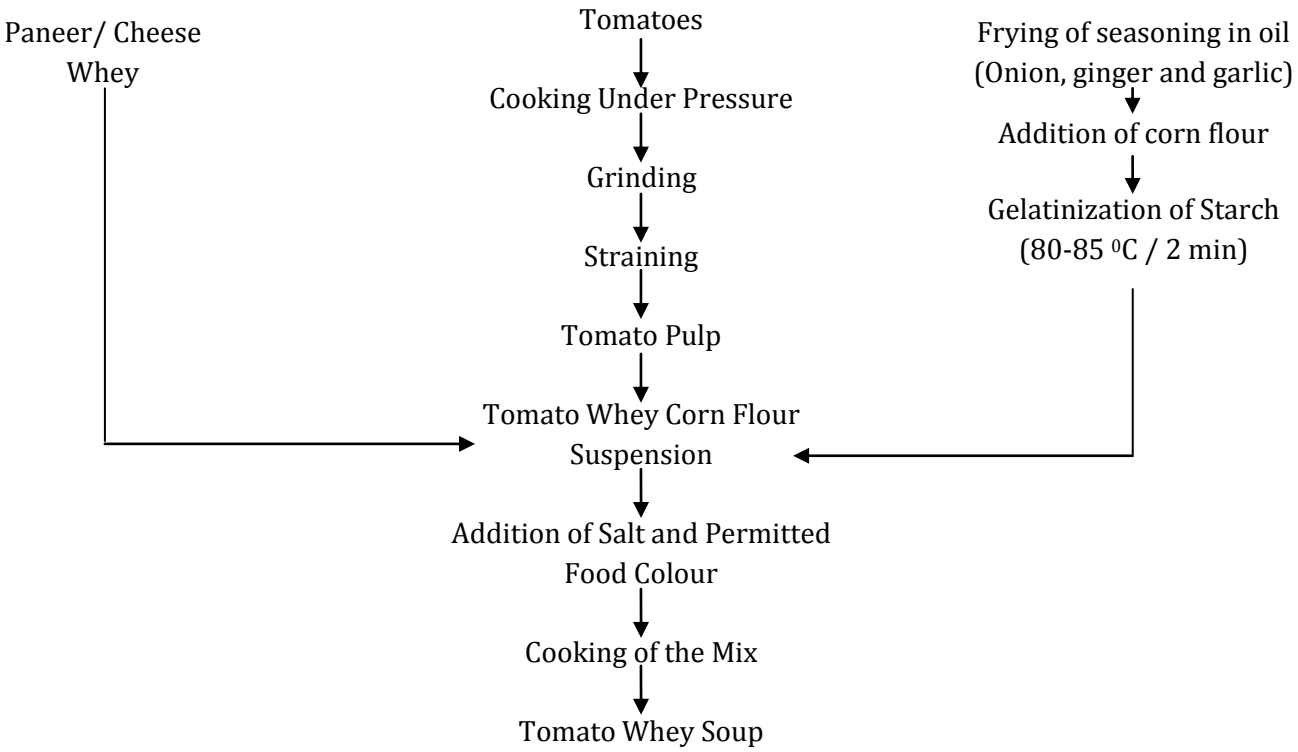
Whey Tomato Soup:-

Soups are served as appetizers before meals as they stimulate the secretion of gastric enzymes that leads to feeling of hunger. A large number of ready-to- make soup mixes are available in the market. But certain additives in each soups mixes are considered harmful particularly to children. Moreover apparently they do not seem to provide quality nutrients and utilization of whey for soup preparation is attractive possibility.

The process for the manufacture of whey based soup involves blending of vegetables in whey and cooking of corn flour followed by heating. The time-temperature combination of cooking of vegetables, corn flour and seasoning is important for dispersion of vegetables, gelatinization of starch and flavour perception of soup respectively. The developed product could be stored for a week under refrigeration and UHT treatment can be adopted to improve the shelf-stability. The soups can be packaged in retort pouches as well and processed in boiling water bath (85-90°C) for at least 30 min.

Cheese whey is preferred for the manufacture of vegetable soups than paneer whey, the latter being acidic. Whey based soups have been reported to be more viscous as compared to water based most probably due to gelation of whey proteins on heating. Whey based soups require less amount of salt, thickener and fat.

Manufacturing Process For Whey Tomato Soup :-



5. TOMATO CHILLI SAUCE :-

Several such commercial preparations like Tomato Chilli Sauce, Tomato and Tamarind sauce, etc. are available in the Indian market. It is highly spiced product made from ripe, peeled and crushed tomatoes and salt, sugar, spices, vinegar, with or without onion & garlic.

The manufacturing technology for the tomato chilli sauce is similar to as discussed for tomato ketchup. The green chilli is pureed by hot break method and seed as well as coarse fibrous proteins are removed. The pureed chilli is added in the formulation & ratio. of sugar-acid pungency is maintained in such a way that resultant product provide the flavour sensation.

PROCESSING FLOW SHEET FOR TOMATO CHILLI SAUCE :-

TOMATOES
(Fully ripe, red)
↓
WASHING
↓
SORTING
↓
BLANCHING FOR 2 MINUTES
↓
PLACING QUICKLY IN COLD WATER
(to crack skin)
↓
PEELING
↓
CRUSHING
↓
COOKING PULP (thick mass and seed) WITH ONE-THIRD QUANTITY OF SUGAR
↓
REST OF PROCESS SIMILAR TO THAT OF TOMATO SAUCE

6) TOMATO POWDER :-

The juice is converted into a free flowing, highly hygroscopic powder by using different drying methods. Tomato powder preparation is another technique for the preservation of tomato solids during off season and offer convenience to consumers.

The tomato powder can be manufactured by using tray drying, foam mat drying or spray drying process. For the manufacture of tomato powder whole tomatoes are cleaned, washed and surface moisture is allowed to evaporate. The juice is extracted by hot pulping methods and pulp is filtered to obtain pulp free juice which is subjected to vacuum concentration. The concentrated juice is mixed with foaming agent to form foam which is dried by using hot air. The dried powder is cooled, conditioned in the form of powder.

The spray drying process for the manufacture of tomato powder is outlined in flow chart. The tomatoes with thick walled, bright red colour, high solids and high pectin content are best for dehydration. The juice is extracted by hot break method and may also subjected to enzymatic treatment to improve the recovery of juice, solids and colouring pigments. Seeds and skin pieces are removed. The juice is concentrated in vaccum pan or double effect evaporators to desired total solid level. Maltodextrin (10 DE @ 10%.) & $Si0_2$ (@1%) are added in concentrated juice to improve colour and reconstitutional properties of the powder. The atomization speed of 25,000 rpm and Inlet air temperature of 200°C is recommended for obtaining good quality tomato powder.

Colour of tomato powder depends on the lycopene content which is affected by thermal treatment. The powder can be packaged in oxygen and moisture impermeable films. Further it can be also packed under vaccum for prolonging the shelf life.

Spray drying process for the preparation of tomato powder. :-

TOMATO JUICE / PULP
(Strained)
↓
VACCUM CONCENTRATION
(Vaccum pan or multiple effect evaporatoure)
↓
TOMATO JUICE CONCENTRATE
↓
ATOMIZATION OF FEED
(25,000 rpm)
↓
SPRAY DRYING
(Inlet air temperature 200^{0}C, outlet temperature 70^{0}C)
↓
COOLING AND STORAGE

References :

1. **Fruit and Vegetable Preservation**
   PRINCIPLES AND PRACTICES
   3rd Revised and Enlarged Edition
   By R. P. Shrivastava And Sanjeev Kumar
2. www.iaritoppers.com
3. http://ecoursesonline.iasri.res.in