



PROCESSING OF TOMATO PRODUCTS

-Tomato Puree, Paste, Ketchup and Sauce



Indian Institute of Food Processing Technology

Ministry of Food Processing Industries, Govt. of India

Thanjavur, Tamil Nadu

2020

CONTENT

1. Background of tomato Nutritional benefits of tomato
2. Health benefits of tomato
3. Post-harvest loses of tomato
4. Tomato varieties
5. Tomato ripening stages
6. Tomato grades and storage
7. Importance of tomato processing
8. Points to be considered while processing of tomato
9. Characteristics of tomato colour during processing
10. Effect of processing on nutrients in tomato products
11. Tomato paste and puree
 - a. Processing of tomato paste and puree
 - b. Pilot scale production of tomato paste
 - c. Shelf life stability of tomato puree/ paste
 - d. Quality problems
 - e. Market issues
 - f. Salient features of tomato paste / puree:
12. Tomato ketchup
 - a. Processing of tomato ketchup
 - b. General considerations
 - c. Pilot scale production of tomato ketchup
 - a. Quality changes during storage
 - b. Marketing issues
13. Tomato sauces and chutneys
 - a. Processing of tomato sauces
 - b. Processing of tomato chutney
 - c. Pilot scale production of tomato sauce and chutneys
 - d. Additional processing notes

14. Food Safety and Standards Regulations, 2010

- a. Regulation 5.3.14 thermally processed tomato puree and paste
- b. Regulation 5.3.27 tomato ketchup and tomato sauce
- c. Regulation 5.3.8 thermally processed tomato juice
- d. Microbiological requirements of tomato products
- e. Quantity of sample to be sent to the public analyst

16. Tomato products – Basic recipes

- a. Tomato puree and simple concentrate
- b. Tomato paste
- c. Tomato sauce or ketchup
- d. Basic sauce and chutney - italian style
- e. Tomato juice

Figure

- 1. Processing flow-sheet for tomato puree/paste
- 2. Flow diagram of tomato paste process at pilot scale level (paste jar filling and aseptic drum filling)
- 3. Process flowsheet for tomato ketchup
- 4. Flow diagram of tomato ketchup process at pilot scale level
- 5. Processing flow-sheet for tomato sauce
- 6. Processing flow-sheet for tomato chutney

Table

- 1. Tomato puree and paste at various level of total soluble solids (tss %)
- 2. Formulation of tomato ketchup
- 3. Formulation of tomato sauces

Background of Tomato

Tomato (*Lycopersicon esculentum*) 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. They are a good source of vitamin C. Fresh tomatoes are very refreshing and appetizing but cannot be stored for a long period. It is estimated that a loss of about 25% of the produce occurs due to lack of post-harvest handling operations in India. Under this situation, production, storage/transport of an intermediate product would help in reducing the huge post-harvest losses and would be highly beneficial to the development of processing industry. But, sophisticated technology for bulk storage of tomato pulp, has limited application in Indian, due to higher costs involved. The intermediate products which would help the farmer to get more profit from the crop. Often they are sold at distress prices during the peak harvest season and huge percentage of the produce is spoiled due to mishandling. Such losses can be avoided by converting tomatoes in to delicious products.

Nutritional Benefits of Tomato

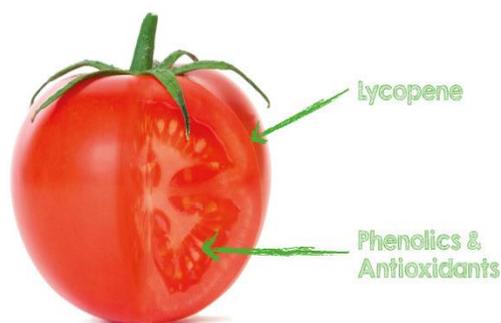
Tomato is a warm season crop and ranked highest in comparison of crops and its contribution of nutrients to the diet. Tomatoes also provide potassium, iron, phosphorus, and B vitamins and are good source of dietary fiber. The ripe tomatoes are red in color because they contain lycopene and other natural antioxidants are carotene, anthocyanin, ascorbic acid (vitaminC), vitamin E, phenolics, flavonoids. Antioxidants have anti-inflammatory, anti-allergic and anti-thrombotic properties and beneficial in lowering the incidence of cardiovascular problems, cancer and neurological pathologies.

Water comprises 90% of the fresh weight of tomato fruit and the size of the fruit is influenced by the availability of water to the plant. The presence of large amount of water in the fruit makes it perishable. As the tomato fruit develops, starch decreases while carbohydrates such as sucrose and reducing sugars increase. Sugars are mostly found in ripe fruit and starches in unripe fruit. In a ripe tomato, solids form about 5-7% of the total fruit weight. About half of the solids comprise sugars and one eighth is acids. The main sugar in tomatoes is glucose. Citric acid is the main acid in tomato juice; and the pH of fruit is normally between 4.0 and 4.5.

The fruits and vegetables have colored pigments. The green colored chlorophyll pigments are contained within the chloroplast. This pigment may also be lost through photo degradation which occurs when chlorophyll molecules are bleached by light and oxygen. This process occurs during ripening and senescence. The carotenoids are pigments with colours ranging from yellow to orange red. The important pigments in tomatoes are the lycopene and the beta carotene.

Tomato fruit is consumed in diverse ways, including raw as an ingredient in many dishes, sauces and in drinks, while it is botanically a fruit and is considered as a vegetable in culinary, carotene, anthocyanin and other natural antioxidants (George, 2004).

- **Anti-oxidant** : Tomatoes contain a lot of vitamins A and C, mostly because of beta-carotene, and these vitamins act as an anti-oxidant, working to neutralize dangerous free radicals in the blood stream.
- **Vitamin A** : Because of all that vitamin A, tomatoes are also an excellent food to help improve your vision. This also means tomatoes can help your eyes be better about night blindness.
- **Calcium** : Tomatoes have a fair amount of vitamin K and calcium, both of which help to strengthen and possibly repair in minor ways bones and bone tissue.



Health Benefits of Tomato

Health benefits of tomato include eye sight, good gut health, low hypertension, diabetes, skin problems and urinary tract infections. Tomato is considered both a fruit and vegetable and forms an integral part of the cuisine all across the globe especially in the Mediterranean region. Daily consumption of tomato provides a great boost to health apart from improving the flavour of food. It consists of a large number of antioxidants which have been proven to fight different forms of cancer. It is a rich source of vitamins and minerals and exerts a protective effect against cardiovascular diseases. It also improves eye health and prevents hypertension and urinary tract infections.

- **Diabetes** : Tomatoes also have plenty of the mineral chromium, which helps diabetics to keep their blood sugar level under control.
- **Kidney stones and gallstones** : Eating tomatoes without the seeds has been shown in some studies to lessen the risk of gallstones and kidney stones
- **Heart Troubles** : Due to potassium and vitamin B, tomatoes help to lower blood pressure and to lower high cholesterol levels. This, in turn, could help prevent strokes, heart attack and other potentially life-threatening heart problems.
- **Cancer** : Various studies have shown that because of all that lycopene in tomatoes, the red fruit helps to lessen the chances of prostate cancer in men, and also reduces the chance of stomach cancer and colorectal cancer. Lycopene is considered somewhat of a natural miracle anti-oxidant that may help to stop the growth of cancer cells. And, interestingly enough, cooked tomatoes produce more lycopene than do raw tomatoes, so enjoy that tomato soup.
- **Smoking** : No, tomatoes can't help you stop smoking, but what they can do is to help reduce the damage smoking does to your body. Tomatoes contain chlorogenic acid and coumaric acid, which help to fight against some of the carcinogens brought about by cigarette smoke.

Post-Harvest Loses of Tomato

Tomato is one of the most sensitive crops in that the price of the produce in the markets fluctuates erratically year by year. It is one of the most important basic vegetables. Since, being a highly perishable commodity it is extremely susceptible to price variations in the market implying that the produce should be immediately sold and cleared from the market without any delay. A bumper harvest of tomatoes has not pleased farmers in Tamil Nadu as the excess production has caused a sharp drop in tomato prices. Tomatoes, known as poor man's apple, are cultivated on 70,000 acres of land in the state with a average yield of 140,000 tons of tomatoes a day being produced. Farmers used to reap profit from their crop. But this time, the high yield of tomatoes has brought down the prices of crop to seven rupees per basket. Farmers are bitter over tomato prices heading southward and causing them heavy loses. They said that for cultivating tomatoes on one acre, a farmer has to spend 40,000 rupees and the prevailing prices even do not meet the

cost of cultivation. Tomatoes not destined for the kitchen: Tomatoes lie discarded in fields during season as supply exceeds demand. Even in north India also farmers are disappointed because they are getting money that meets even their production cost.

After harvesting, the farmers bring their produce to the market for sale. Their mode of transport from field to the market is preferably by bullock/buffalo cart, which is the cheapest among the available transport. Packaging is almost absent in the farmers' field. However, few farmers use paddy straw as cushioning material in the cart to carry the tomatoes to market. In the market, the middlemen use to pack the tomatoes in paper cartoon of 20 kg capacity (approx) having no ventilation and send them to distant market. Once the consignment reach the market, damaged and decayed fruits are sorted out either at wholesaler or retailer level and these are sold at throwaway prices if there are any takers. In the whole process right from farmers field to the consumer the percentage of loss goes up to minimum 25 to 30 %. The post-harvest loss in tomatoes has been estimated to be about 30 to 40% due to inadequate post-harvest handling, lack of infrastructure, processing, and marketing and storage facilities.

India tops among largest producers of fruits and vegetables in the world, as a processor we are perhaps in the bottom three countries. This has resulted in a huge national loss by way of 30 to 50 % post-harvest losses of the fresh produce. Farming will be lucrative like industry if farmer gets reasonable price for the fresh produce. Although the consumer pays high or moderate price for the fresh commodities, the grower usually gets an unfair low price due to unfavorable distribution chain network and some examples like during high season Tomatoes and Onions do not even fetch even Rs. 1 per Kg!! This will change only if vegetables and fruits are processed near the site of production and converted into value added products.



Tomato Varieties

It is widely accepted as 'Protective Food' and is grown extensively in India. The main varieties of tomato grown in the country are Pusa Ruby, Pusa Early Dwarf, Arka Abha, Arka Alok, Pant Bahar, Pusa hybrid-1, Pusa hybrid-2, MTH-6, Arka Vardan, Rashmi etc.

- 1) **Vaishali** This is a determinate hybrid variety of tomato which produces medium sized (100g) quality fruits. The variety is suitable for growing in hot and humid weather conditions. Suitable for tomato juice preparation.
- 2) **Roma** This is a variety of IARI, New Delhi. Fruits are elliptical in shape with yellow and thick stem end. Suitable for processing.
- 3) **Pusa Ruby:** This is an early maturing variety developed by IARI, New Delhi; derived through selection from the cross Sioux x Improved Meeruthi. Plants are indeterminate (80- 85 cm), spreading and hardy with fewer branches. Fruits are flattish round, small-medium, uniform red, slightly lobed (4-5 locules) and acidic; suitable for processing; suitable for cultivation during autumn, winter and spring-summer seasons; gives an average yield of 30 t/ha.
- 4) **Pusa-120:** Plants are semi determinate, spreading, late maturing with dark green foliage. Fruits are flattish round, attractive, medium to large, uniform red, less acidic, less seeded, resistant to nematode and suitable for winter and summer seasons. Average yield is 300- 320 q/ha.
- 5) **Pusa Sheetal:** Plants are determinate, fruit set successfully under low night temperature (up to 80 C) and suitable for early spring season, fruits are flattish round with yellow stem end, smooth, attractive, medium sized, red colour and uniform ripening. Harvesting starts from early march. Average yield is 350 q/ha.
- 6) **Arka Vikas:** Fruits are medium large (80-90g), oblate with light green shoulder, which develop deep red color on ripening. Suitable for fresh market. Adapted to both rain fed and irrigated conditions. Average yield is 350 q/ha.
- 7) **Arka Abha:** Fruits are oblate with light green shoulder. Develops deep red colour on ripening. Average fruit weight is 75g. Resistant to bacterial wilt caused by *Ralstonia solanacearum*. Suitable for fresh market. Average yield is 430 q/ha.

- 8) **Arka Saurabh:** Fruits are medium large (70-80 g), round with light green shoulder, deep red in colour, firm with nipple tip, Suitable for both fresh market and processing. Average yield is 300-350q/ha.
- 9) **Arka Alok:** Fruits are square round on lower cluster, large in size, firm with green shoulder, resistant to bacterial wilt. Suitable for freshmarket. Average yield is 460 q/ha.
- 10) **Kashi Vishesh (DVRT-2):** Plants are determinate, dark green, fruits are red, spherical, medium to large sized. First harvest at 70-75 days after transplanting, Resistant to TLCV. Average yield is 400-450 q/ha.
- 11) **Kashi Sharad:** Plants are indeterminate, leaves are broad, fruits are attractive red, slightly oval, firm with thick pericarp, longer shelf life, avg. fruit weight is 90-95 g. Average yield is 400-500q/ha.
- 12) **HS-101:** Plants are determinate, multi branched, fruits develop in clusters of 2-3, round, small to medium sized, red at ripening and suitable for winter season cultivation. Average yield is 250-275 q/ha.
- 13) **Pant Bahar :** The plants are bushy and profusely branched. Fruits are flattish round, medium in size with 5-6 locules, slightly ridged and uniform red at maturity. First picking starts in 75-80 days after transplanting. Average yield is 250 q/ha.
- 14) **Pant T-3 :** The fruit weight is about 70 g. Fruits become uniform red at maturity. Suitable for processing. Average yield is 300 q/ha.
- 15) **Pusa Early Dwarf:** It is an early ripening selection from the cross between 'Improved Meeruti' and 'Red Cloud'-a typical dwarf type with medium large fruits of uniform colour. It has been observed to do well in both the seasons, and yields 395 q/ha.
- 16) **Hisar Arun (Sel-7):** It is an early maturing variety developed by CCSHAU, Hisar; derived through modified pedigree method from the cross Pusa Early Dwarf x K-1. Plants are determinate dwarf, erect, with cut leave and synchronized clustered flowers, bear 15-20 fruits. Fruits are round, red, medium size (65-70 g), 4-6 locules with deep red flesh. First picking starts in 60-65 days after transplanting; gives an average of 150q/ha and 287 q/ha early and total yield respectively in 80-85 days of crop duration.

- 17) **Hisar Lalit:** It is a nematode resistant variety developed by CCSHAU, Hisar. It is derived from the cross HS101 x Resistant Bangalore. Plants are determinate and early maturing. Fruits are round and medium to large in size. It is suitable for cultivation in nematode infested areas.
- 18) **Punjab Chhuhara:** The plants are dwarf, bushy, determinate with dense and luxuriant foliage. Its dense foliage protects the fruit from sunburn. The fruits are pear shaped, small to medium sized, firm fleshy, less seedy and uniformly red at maturity. Yield: 350- 400 q/ha
- 19) **Marglobe:** Indeterminate in nature, fruits large, round with green stem end, smooth and juicy. It is late in maturity. Yield: 280-300 q/ha

Hybrid tomato varieties

- 20) **Arka Vardan:** High yielding F1 hybrid with root knot nematode resistance. Suitable for fresh market. Average yield is 750 q/ha in 160 days.
- 21) **Pusa Hybrid-2:** Plants are compact, semi determinate with good foliage cover. Fruits are round to flattish round, firm, smooth and attractive with uniform red color at maturity. Plants are highly tolerant to root knot nematode. Average yield is 600-625 q/ha.
- 22) **Rupali** This hybrid has been developed by IAHS, Bangalore. Plants are determinate and tolerant to bacterial wilts. Fruits are orange-red, oblong, 90 g of average weight, firm with 5.6% of TSS; gives an average yield of 79.5 t/ha.
- 23) **NS-815** This is an early maturing and determinate hybrid, developed by Mamdhari Seeds Pvt. Ltd., Bangalore. Fruits are blocky, square-round, medium size (70-80 g), excellent appearance and firmness with uniform green and round shoulder, low pH with good colour and high soluble solids; also suitable for processing.
- 24) **NS-2530** This is an early maturing hybrid, developed by Mamdhari Seeds Pvt. Ltd., Bangalore. Plants are determinate and prolific bearer. Fruits are oval medium size (80-90 g), attractive, red with superior firmness.
- 25) **Pusa Hybrid-2** This determinate hybrid has been developed by IARI, New Delhi. Fruits are round, medium with good keeping quality; field resistance to nematodes; gives an average yield of 55 t/ha.

- 26) **Avinash-2** This hybrid has been developed by Syngenta India seeds, Pune. Plants are determinate with very vigorous growth, dense foliage and profuse fruit setting. Fruits are medium, thick walled, round, glossy, dark red with average weight of 70-90 g; first picking starts at 55 days after transplanting; gives an average yield of 75 t/ha; suitable for cultivation in TYLCV prone areas.
- 27) **Naveen** This hybrid has been developed by IAHS, Bangalore. Plants are determinate and tolerant to bacterial wilts. Fruits are dark red, oblong, intermediate firmness with 6.2% TSS and 90 g average weight; gives an average yield of 57.5 t/ha.
- 28) **Rashmi** This hybrid has been developed by IAHS, Bangalore. Plants are determinate and tolerant to bacterial wilt and early blight. Fruits are oblong, dark red, 65 g of average weight, intermediate firmness with 5.5% of TSS; gives an average yield of 67.5 t/ha.
- 29) **Meenakshi** This is indeterminate hybrid, developed by Bejo Sheetal Seeds Pvt. Ltd., Jalna. Fruits are dark red, round-global, 80 g of average weight and very attractive; gives an average yield of 70 t/ha.
- 30) **Tolstoi** This is indeterminate hybrid developed by Bejo Sheetal Seeds Pvt. Ltd., Jalna. Fruits are dark red, square-round, average weight 100 g, very attractive and firm. First picking starts on 70-75 days after tran

Tomato Ripening Stages

Maturity index and Harvesting: Depending on the mode of disposal, the tomato fruits may be harvested at various stages of maturity:

- (i) Green stage: The fruits are fully developed but are green and suitable for sending to distant markets.
- (ii) Pink stage-Some of the portion is red or pink and the fruit is not fully ripe. It is most suited for local markets.
- (iii) Ripe stage: The major portion of the fruit is red and the softening begins. It may be picked up for home or table use.
- (iv) Full ripe stage: The fruit develops maximum colour and turns soft. It is suited for processing purposes.

Yield: The fruit yield varies from 250 to 500 quintals per hectare

Tomato Grades and Storage

Grading: After removing green, over ripe, rotten, injured and defective tomato fruits they should be graded into four grades Super A, Super, Fancy and Commercial, packing is done in bamboo baskets, plastic trays and polythene bags.

Storage: Pre cooling of tomato after harvest at 120 -130 C on the farm prolongs their storage life. Usually the plastic crates and wooden boxes of various sizes are used for packing and long distance transportation. Mature green fruits may be stored at 10°C to 15°C for 30 days and ripe tomatoes at 4.5°C for 10 days under 85-90 per cent relative humidity.

Importance of Tomato Processing

Tomato is one of the important crops used as fresh vegetables and for preparing a variety of processed products like tomato juice, ketchup, sauce, canned, puree and paste. In advanced countries, nearly 80% of the fresh tomatoes are processed. In India, although tomato production is increasing the growth of tomato processing industry is slow, mainly due to the lack of constant supply of good quality and cheaper raw material to the processing centre.

In India, tomato sauce and ketchup are very popular and are being manufactured on an increasingly large scale, mostly in small units. As tomatoes are available practically throughout the year there is scope for setting up large-scale processing units. The quality of a tomato product is judged by its colour, which is dependent on the redness of the tomatoes used. In fact, the red pigment (lycopene) can be used as an index of the amount of tomato actually present in a product. High quality tomato products can be prepared only by:

- (i) Using plant – ripened uniformly red tomatoes as the yellow and greenish portions not only mask the red colour but also cause browning due to oxidation.
- (ii) Avoiding prolonged heating, and cooling the product quickly after preparation; and
- (iii) Not using iron and copper equipments at any stage of processing. Lycopene (Self-oxidizing isomer of carotene) turns brown when it comes into contact with iron. Iron also forms black compounds with the tannin in the tomatoes and the spices used. Equipments used should be glass-lined or made of stainless steel.

Points to be considered while processing of tomato

- (i) Use only plant-ripened red tomatoes as far as possible. The yellow and greenish portions not only mask the red colour of the fully ripe tomatoes, but also turn brown due to oxidation.
- (ii) Avoid use of iron equipment during processing. Lycopenes turns brown when it comes in contact with iron. Iron also forms black compounds with the tannin of the tomatoes or of the spices used.

oxidized



- (iii) Avoid prolonged heating and cool the product quickly after preparation of tomato based processed products like ketchup, sauce, chutney and soups.
- (iv) Mere rinsing of tomatoes in water is not enough, because mould filaments and other microorganisms found in the cracks, wrinkle, folds and stem cavities, are not easily removed by gentle washing alone.
- (v) After filling tomato products in bottle it is better to pasteurize to avoid fermentation.
- (vi) Black neck formation is one of the major problem in tomato ketchup and sauce like products. It affects the quality of the product. Black neck can be prevented by
- (vii) Filling hot sauce at a temperature not less than 85°C temperature.
- (viii) Leaving minimum headspace in bottles (the more the air than greater is the blackening)
- (ix) Reducing contamination with iron, source of iron are salt and metal equipments
- (x) Partial replacement of sugar by corn syrup or glucose, syrup which contain sulphur and prevent blackening.
- (xi) Addition of 100 ppm sulphur dioxide or 100 mg per cent ascorbic acid.
- (xii) Storing bottles in horizontal or inverted position to diffuse the entrapped air (O₂) throughout the bottle thus reducing its concentration in the neck sufficiently to prevent blackening.
- (xiii) Use cloves after removing the head

Characteristics of tomato colour during processing

The attractive red colour of tomatoes and tomato products is due to the plant pigment, lycopene. The constitution of this pigment is similar to that of the well-known yellow plant pigments, carotene, which is the precursor of vitamin-A. Lycopene, contrary to popular opinion is not in the clear portion of the tomato, known as serum, but is in the insoluble pulp and is found to the maximum extent in fully ripe red tomatoes. It undergoes a considerable amount of oxidative changes when heated, especially in the presence of air.

The tannin which are present in some of the spices like clove, cinnamon, etc. which are used in the preparation of the ketchup, sauce, soup like processed products also have an adverse effect on the colour of the ketchup. It is therefore, necessary to minimise the incorporation of these tannins through spices. In order to achieve this, spice oils, instead of the whole spice are generally recommended. The above characteristics obviously indicate the necessity for proper selection of fully ripe and red tomatoes for the preparation of tomato processed products in order to get a product having the maximum colour.

Further the colour present in green tomatoes has a tendency to turn brown during storage. The use of green tomatoes in the raw material for the preparation of processed products would, therefore, naturally contribute to the general darkening of the tomato processed product during storage. To get over this trouble, manufacturers in other countries pay the greatest attention to the selection and grading of tomatoes employed in the preparation of tomato products. Any loss that may accrue either as a result of discarding unripe tomatoes or trimming off the green portions from partially ripe tomatoes would be compensated for to a large extent by the high quality of the products. The majority of tomato product manufacturers, however, add colours to get a product having a bright red colour. These colours to some extent, mask any browning of the freshly made product, which is caused by the use of tomatoes which are not fully ripe and red, but this browning definitely evinces itself during storage.

Effect of Processing on Nutrients in tomato products

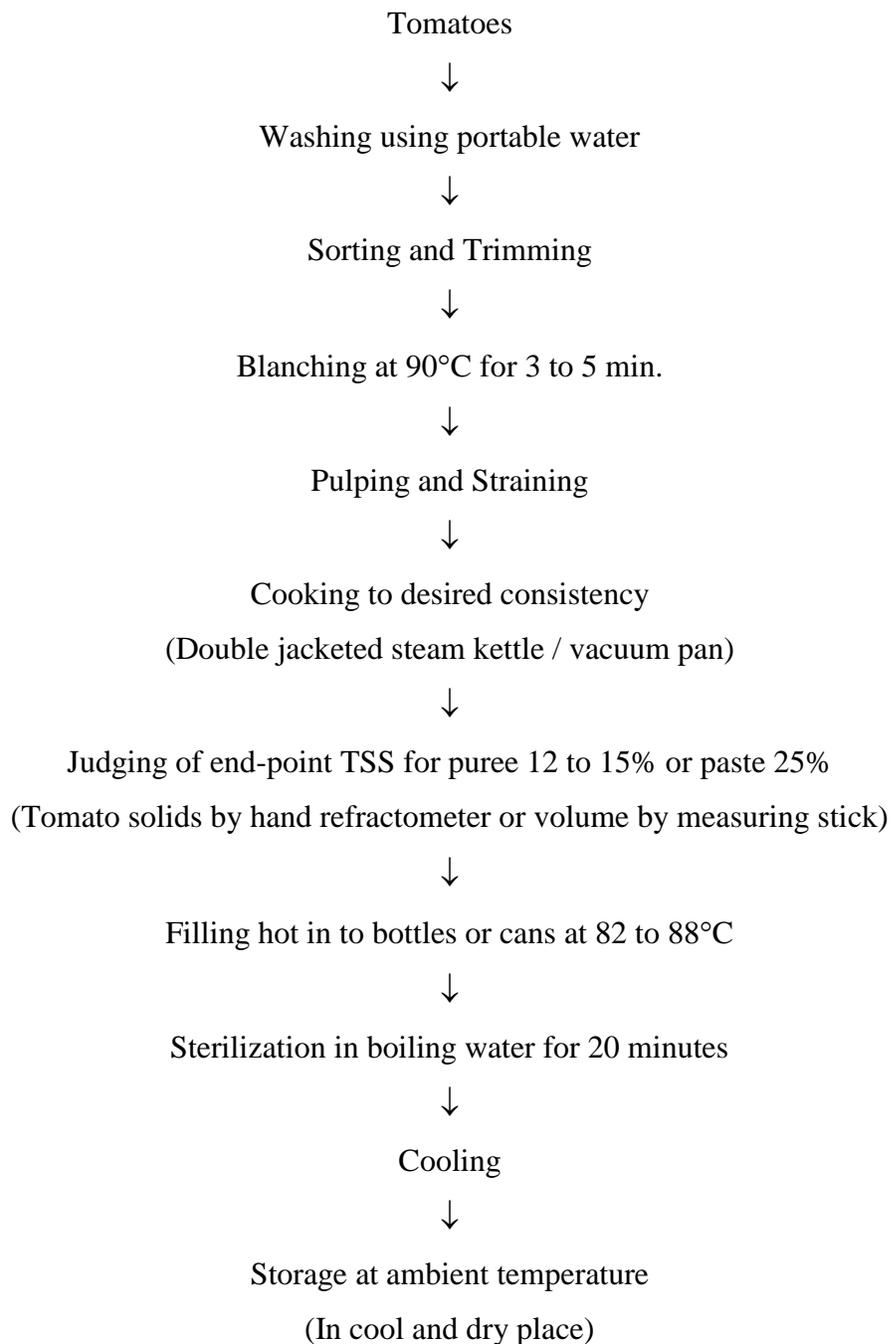
- Bioavailability of certain carotenoids viz. β -carotene, lycopene, phenolics increases after processing of tomato into value added products
- The proportion of all trans lycopene – 96% of total lycopene in preserved tomato paste and 77% in tomato ketchup
- 65% flavonoid present in fresh tomato retained in processed tomato paste
- The total phenolics content in tomato pulp and puree increased during storage due to release of bound phenolics
- Ascorbic acid loss 40% in tomato pulp, 55% in tomato puree and 60% in tomato paste
- Processed tomato products have a distinctively different aroma from fresh tomato products. This is due to both the loss and the creation of volatiles

TOMATO PASTE AND PUREE**Processing of tomato paste and puree**

Tomato paste is made by de-seeding and de-skinning the tomatoes and cooking/concentrating them for several hours. Sometimes it can be sweetened for flavor. It is a thick, dark red concentrate. Tomato paste is made from whole processing tomatoes generally containing between 4.5 to 6.0 percent tomato solids. With regard to solid content, the industry normally refers to TSS (total soluble solids), a measure which excludes all insoluble solids. In accordance with generally accepted market standards, tomato paste must contain at least 14 percent TSS. On average, 6kg of fresh tomatoes are required to make 1 kg of tomato paste at 26 to 28° Brix. Most common tomato paste is “concentrate” or double concentrate with 26 to 28° Brix, but “concentrate” or triple concentrate with 36 to 38° Brix is also present in the market.

Tomato puree differs from tomato paste in consistency and depth of flavor. Tomato paste is more concentrated and has got a very strong flavor, whereas tomato puree had diluted flavor and is thinner in consistency. Tomato puree contains between 11 and 14 percent TSS, and differs from paste only because of the lower concentration.

Figure 1: Processing Flow-Sheet for Tomato Puree/Paste





Tomato Puree



Tomato Paste

This above technology aims at processing and preservation of glut season tomato for use during the off-season. Hybrid tomatoes, suitable for the production of tomato concentrate/ paste, are made into pulp in a pulper. The pulp is concentrated to puree (12-15°Brix) or paste (25°Brix) in an open steel vessel / a steam kettle. Sodium benzoate is added as a preservative @ 250 ppm or 0.1% and packed for storage.

Table 1: Tomato puree and paste at various level of Total soluble solids (TSS %)

Concentration of TSS	Tomato puree	Tomato paste
Light	8.0 - 10.1	24.0 - 28.0
Medium	10.1 - 11.3	28.0 - 32.0
Heavy	11.3 - 15.0	32.0 - 38.5
Extra heavy	15.0 - 24.0	over 38.5
Concentrated tomato juice	20.0 - 24.0	--

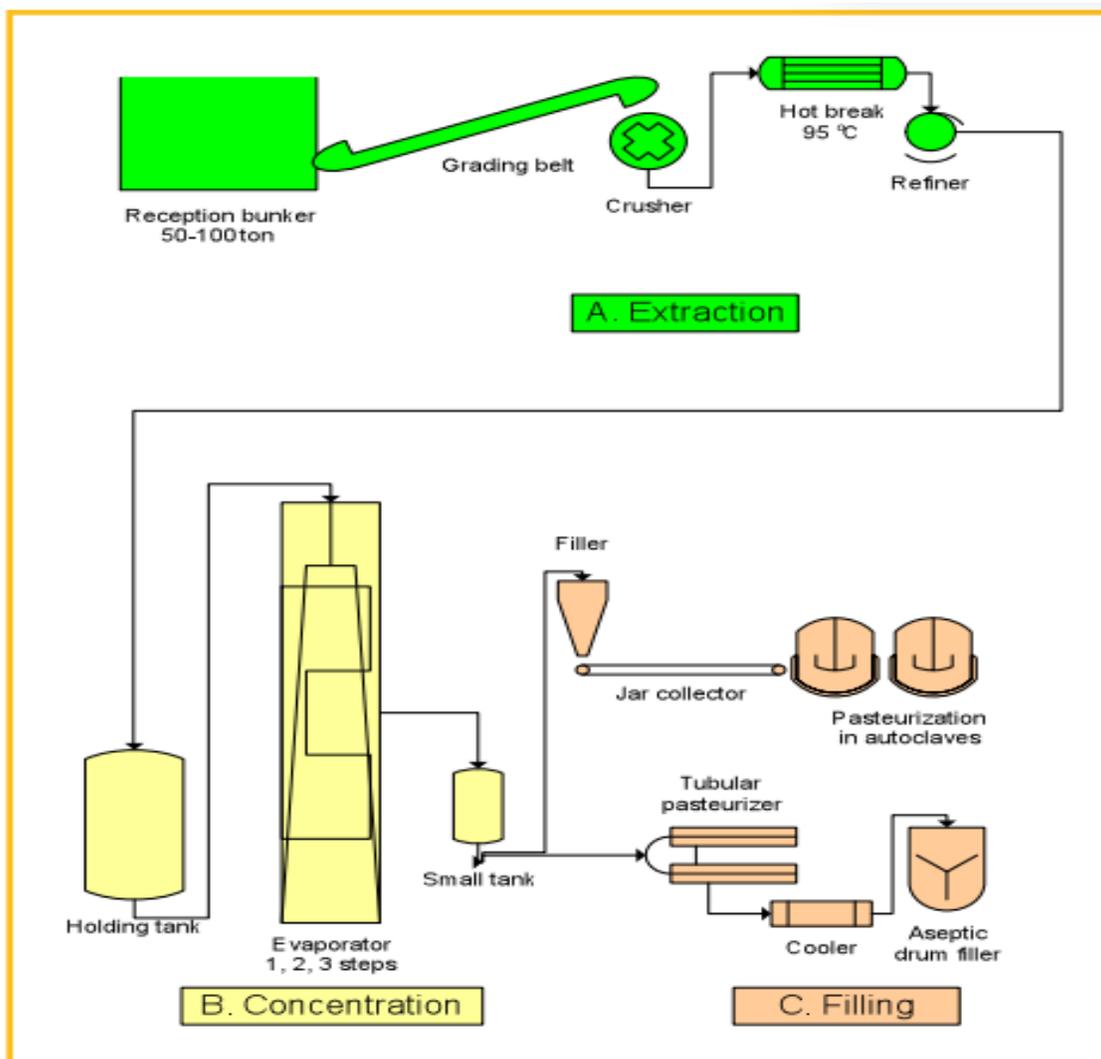
Tomato pulp without skin on seeds, with or without added salt and containing not less than 9.0 percent of salt free tomato solids is known as “medium tomato puree”. It can be concentrated further to “heavy tomato puree” which contains not less than 12 percent solids. If this is further concentrated so 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.

Pilot Scale Production of Tomato Paste

1. **Product.** Tomato paste is a thick paste made from ripened tomatoes with skin and seeds removed. Depending on its manufacturing conditions, it can be used to make either ketchup or reconstituted tomato juice. Tomato paste is concentrated tomato purée. Purée has a Brix of 15–20 and paste has a Brix of 25–36.
2. **Raw material.** The preferred raw material is processing tomato of 5–6.5 Brix, but consumption tomato of 4–5 Brix is more often used.
3. **Yield benchmarks.** The actual yield (on partially irrigated, poorly managed open land) is 15–25 tons/ha. The potential yield (on irrigated open land) is 60–120 tons/ ha. Greenhouse yield (year-round and with good management) is 300–600 tons/ha.
4. **Processing ratio.** Five to 7 kg of tomatoes are needed for 1 kg of paste. The higher the sugar content (measured in Brix) of the raw tomato, the better/ lower the processing ratio.
5. **Production process.** After reception in 10–50 ton bunkers filled with water, the tomatoes are crushed by a pulper. The pulp is then pumped through a heat exchanger at a temperature of 95 °C to destroy the pectinase released during pulping (this is known as “hot break”). The pulp is sieved to remove seeds and skin, which constitute 3–4% of the weight. Next, water is evaporated from the pulp by adding steam. One kg of steam removes 1 kg of water. This is called the “effect”. To double or triple steam use efficiency, two or three effect evaporators are in use and the steam is recycled two or three times. To maintain quality, the temperature in the evaporator must be as low as possible; therefore, a vacuum is created above the pulp so that water will boil at 70°C. Once the paste has the required concentration, measured in Brix, it leaves the evaporator to be pasteurized and packaged.

6. **Packaging.** Industrial paste (to be repacked or reused later) is packed in aseptic bags of 25–250 litres and kept in steel or plastic drums. Consumer paste is either filled in tins of 30–900 g or in glass jars of 200–3,000 ml.
7. **Quality description.** The paste must be bright red and have the right consistency: solid, not liquid. It must have a true tomato aroma and be free from off-tastes or smells.

Figure 2: Flow diagram of tomato paste process at pilot scale level (paste jar filling and aseptic drum filling)



Shelf Life Stability of Tomato Puree/ Paste

Tomato is processed in the forms of pulp, paste, juice, ketchup, puree (Hayes *et al* 1998). A number of studies have used hedonic measurements to determine the end of shelf life for tomato products. However many of these studies did not go long enough to find the end of shelf life.

Food processors store tomato pulp under conditions available in their premises. It has been observed that temperatures varying from as high as 20 to 40°C, refrigeration (4 to 10 °C) to as low as 20 °C are employed for storage purpose. High temperature storage is detrimental to product quality while lower temperature adds cost to the product (Jamil, 1990). No significant differences were found between the flavor of tomato concentrates stored for six months at 4°C and those stored at 21°C for the same period

Tomato paste could be stored at varying storage condition for 240 days (8 months) with minimum damage to the product quality at lowest possible cost. It was observed that samples stored at low temperature such as 6° C and 10° C remained acceptable after 240 days storage and samples were rejected organoleptically at higher temperatures storage at 25 °C (Muhammad et al., 2010).

Quality problems

- If the tomato paste is too dark, it indicates that it has been overcooked.
- If it is too liquid, the temperature of the hot break is too low.
- A yoghurt taste indicates the presence of lactic acid bacteria, which results from the raw tomato standing for too long before being processed.

All these problems can be overcome with proper technology

Market issues

The containers require proper labelling with a list of ingredients and net content, as well as the whereabouts of the manufacturer.

Salient Features of Tomato Paste / Puree

- Paste recovery is 14%
- Can be stored up to 6 months in bottles and pouches and up to one year in cans

- Most suited during the market glut, when the process go down.
- Tomatoes can be used during off –season
- Paste is suitable for manufacture of other products from tomato

Due to increasing standards of living in the cities and the rapid urbanization taking place in the rural areas, consumption of tomato based products is expected to go up steadily. Tomatoes and tomato-based foods are considered healthy for the reason that they are low in calories, but possess a remarkable combination of antioxidant micronutrients. A number of tomato products e.g. ketchup, juice, puree, paste, sauce, pickles are items of common use in households, hotels, restaurants, institutions.

TOMATO KETCHUP

The product shall be derived from sound and wholesome tomatoes practically affecting the quality of the fruit. Skin and seeds shall be excluded. The only substances that may be added are spices, salt, sugar, vinegar, acetic acid, onion, garlic and preservatives. It shall not contain any other fruit or vegetable substances. The finished product shall have good flavour and shall be free from burnt or any other objectionable flavour.

Tomato ketchup is one of the most popular among fruit and vegetable products manufactured in our country. It is prepared by boiling the pulp of ripe tomatoes with sugar, salt, spices and vinegar, to a fairly thick consistency and packed in glass bottles. On account of its attractive red colour and spicy flavour it has a wide consumer appeal. Although the method of this preparation is quite simple in principle as well as in technique, there are some difficulties encountered during its storage and distribution. Among these, mention may be made of a peculiar black ring called "Black neck" near the surface of the ketchup inside the narrow – necked bottles. Among other minor defects, mention may be made of the separation of watery fluid from the ketchup, development of moulds, etc. These defects can be easily overcome by using tomatoes of good quality and adopting standard methods for the preparation of the ketchup.

Processing of Tomato Ketchup

Select fully ripe and healthy tomatoes having well developed colour and wash them thoroughly in fresh water. Remove the green and blemished portions with a stainless steel knife and discard them. Cut the sound portions into small pieces. Collect the prepared fruit in an aluminium or stainless steel open vessel and crush with a wooden ladle. Cook the crushed mass to a temperature of 80 to 85 °C or till the skins are loosened from the flesh. Strain through fine mosquito net cloth or 1 mm. mesh stainless steel sieve, by rubbing gently with the bottom end of an enameled mug. Discard the seeds and skins.

Tomato ketchup is made from strained tomato juice or 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 per cent total solids.

Table 2: Formulation of Tomato Ketchup

Tomato juice	25 kg	Sugar	1 kg
Salt	50 g	Onion	320 g
Garlic (chopped)	30 g	Clove	13 g
Cinnamon	13 g	Black pepper	5 g
Cardamom	5 g	Cumin	5 g
Mace	1 g	Red chilli powder	10 g
Glacial acetic acid	50 ml		

Weigh the ingredients listed above. First add 1/3 of the sugar to the juice and start heating. Place the spices (onion, garlic, cloves, cardamom, black pepper, cumin, mace, cinnamon and chilli powder) in a muslin or cloth bag. Tie it loosely and immerse it in the juice. Continue cooking till the juice volume is reduced to 1/3 of the original volume. Remove the spice bag and squeeze it well. Add back the spice extract obtained. Stop heating. Add vinegar, salt and remaining sugar. Mix well and heat again for about a minute to bring it to boiling point. Stop heating.

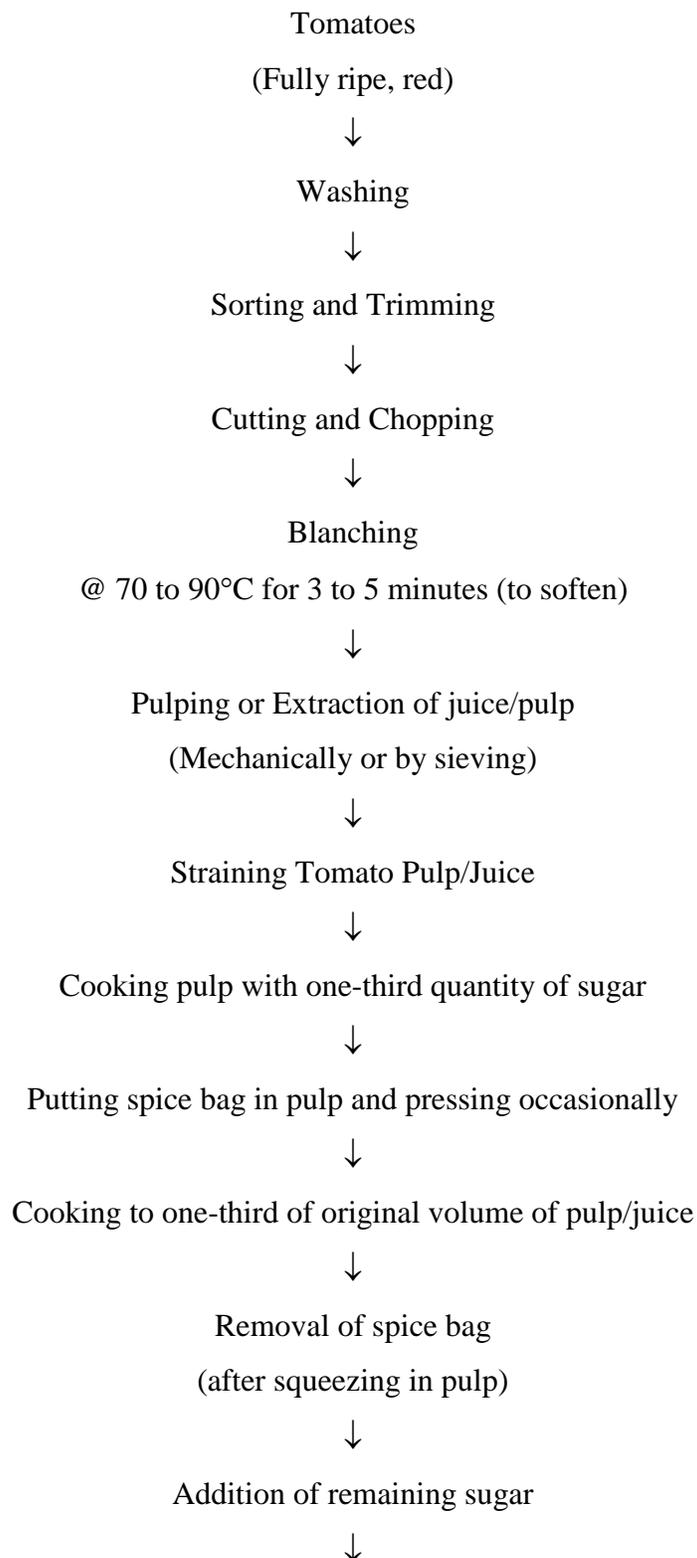
General considerations

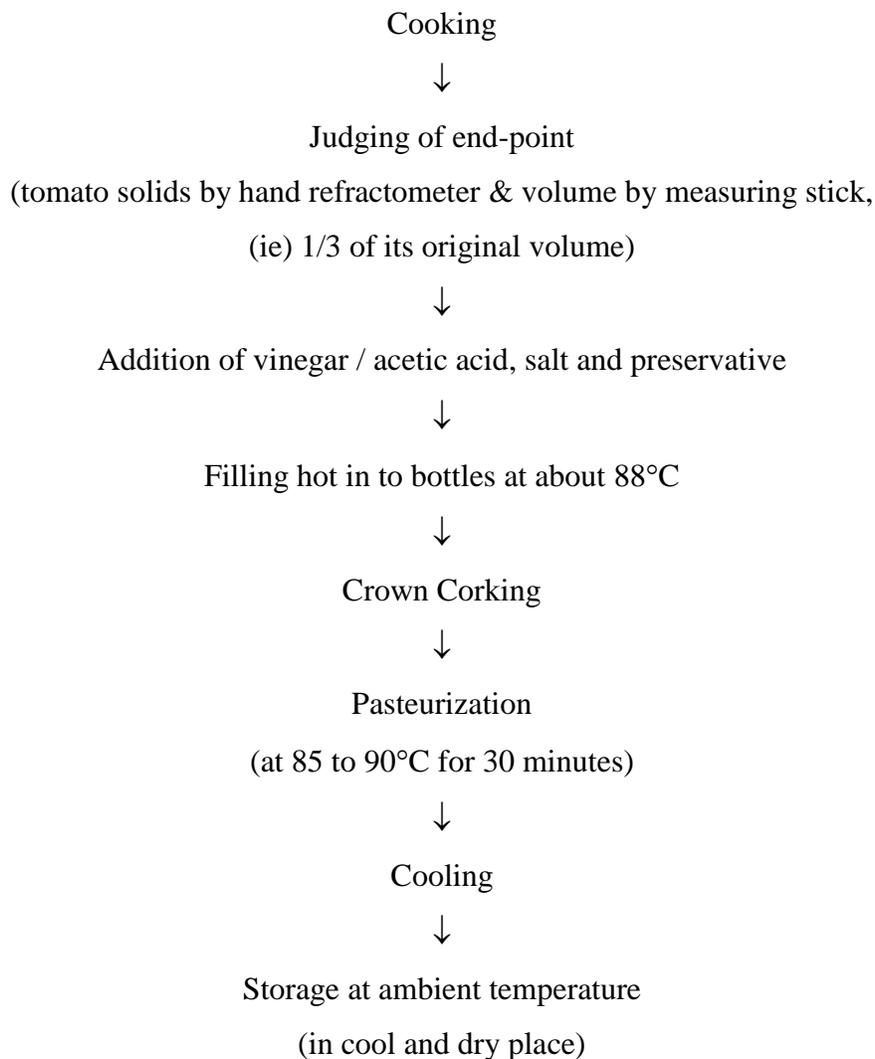
About one-third of the sugar required is added the time of commencement of boiling to intensify and fix the red tomato colour. If the whole quantity of sugar is added initially, the cooking time will be longer and the quality pulp will be adversely affected. Generally the sugar content in ketchups/sauces varies from 10 to 26 per cent. On the other hand, salt bleaches the colour of the cooking process. Spices are generally added in powdered form to the product by spice extract bag method. Instead of whole spices, essential oils of spices oleoresins and spice extract can also be used. Essential oils, however, do not give the characteristic true aroma of whole spice but oleoresins provide true aroma. At present, spice extract is used in many industries for sauce/ketchup preparations. These do not adversely affect the colour of the product and are generally added a few minutes before the end of cooking.

The salt content of the product should be 1.3 to 3.4 percent. Good quality vinegar is essential for the preparation of high quality sauce/ketchup. It should contain 5.0 to 5.5 per cent acetic acid and should be added when the product has thickened sufficiently, so that the acid is not lost by volatilization. Tomato sauce/ketchup generally contains 1.25 to 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 to 0.2 per cent by weight of the finished product.

The ketchup should be filled hot (about 88°C) to prevent browning and loss of vitamins during subsequent storage. If it is made from tomatoes of good quality, using sugar, salt, vinegar and spices in the 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 the 3 to 4 weeks that the ketchup remains in the opened bottle before it is used up.

Figure 3: Process Flowsheet for Tomato Ketchup





Pilot Scale Production of Tomato Ketchup

1. **Product** Tomato ketchup is a sauce made from tomatoes or residues from the processing of tomatoes to which salt and spices are added as well as one or more nutritive sweetening ingredients, vinegar or onion, garlic or other vegetable flavouring ingredients.
2. **Raw material** Tomato paste has a Brix of 28–36.
3. **Processing ratio** 0.3–0.4 kg of tomato paste is needed for 1 kg of ketchup. The higher the sugar content (measured in Brix) of the tomato paste, the better/lower the processing ratio.

4. **Production process** The product is made from concentrated tomato juice or tomato paste, to which ingredients such as vinegar, salt and spices are added, after which the product is boiled, fine sieved, placed in bottles and pasteurized in an autoclave.
5. **Packaging** Ketchup for hotels and restaurants is packed in 3 – 10 litre tin containers. Consumer ketchup is filled in plastic or glass bottles of 250 – 1,000 ml.
6. **Quality description** Ketchup must be red. It must be liquid but not too fluid with a good aroma of tomato and ingredients and be free from off-tastes or smells.

Quality changes during storage

The main processing problem is related to the issue that the product turns black at the contact zone with air due to the action of iron on the tannins. This can be prevented by avoiding the use of iron equipment, avoiding the crushing of tomato seeds and sealing the bottles in a vacuum.

Black-neck formation comes across sometimes during storage of tomato ketchup in bottles. As oxygen is primarily responsible for this phenomenon, by employing techniques such as :

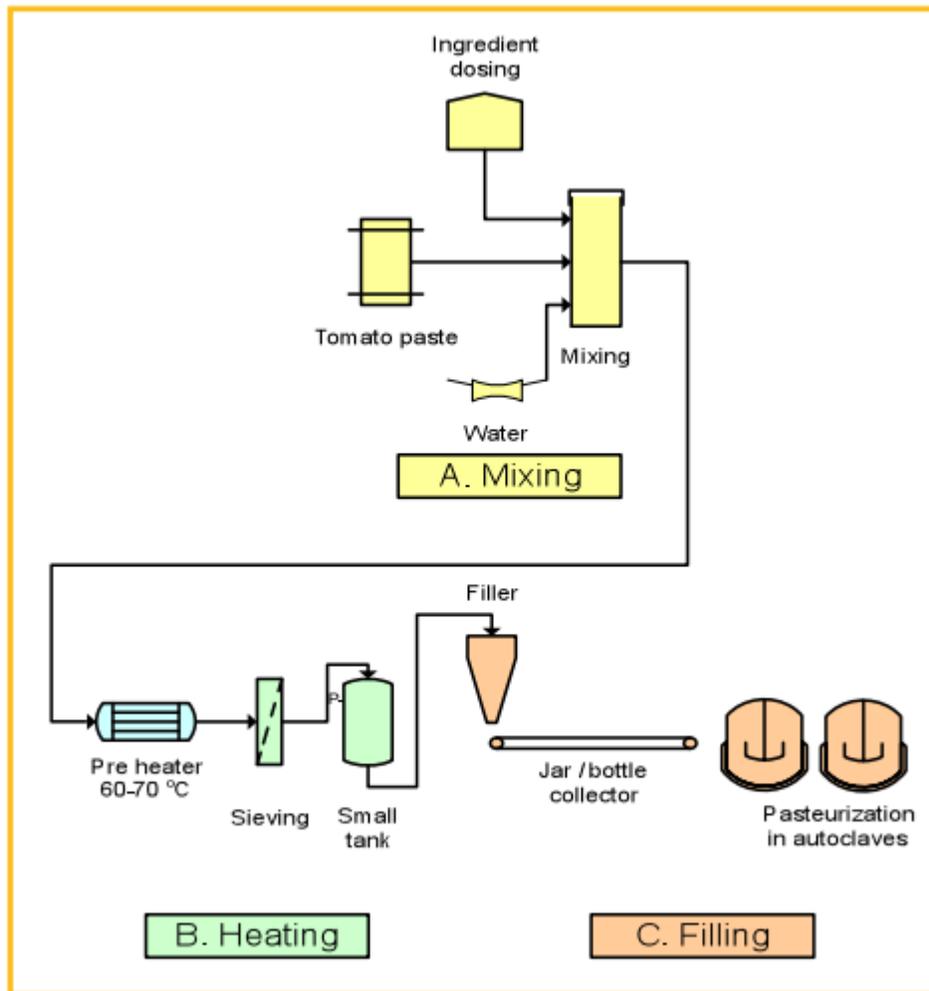
- Absorption of oxygen from the head space in the ketchup bottles+
- Addition of substances capable of readily reacting with oxygen in the head space
- Minimising the contact between iron of the crown cork and tannin present in the lining material etc.

This defect in tomato ketchup can be overcome by adding to the surface of the ketchup in the bottle, before closing ascorbic acid at the rate of about 100 parts per million based on the total weight of the ketchup in the bottle. To render this technique very effective, it is necessary to fill the bottle completely with hot ketchup and thereby minimize the incorporation of oxygen and also not to disturb the bottle for at least 1-2 days so that the topping with ascorbic acid may be fully effective. It may, however, be pointed out that black ring formation is quite distinct from general darkening of the ketchup and addition of ascorbic acid cannot be considered a remedy for the latter defect. It is better to rely more and more on the quality of the tomato itself to manufacture ketchup of high quality rather than resort to the use of artificial colour.

Marketing issues

Ketchup is a branded product and the recipe is the key secret of the producer. The product knows strong international labels such as Heinz and is heavily promoted via marketing efforts. Year-round availability on the shelves is a must to achieve customer loyalty.

Figure 4: Flow diagram of tomato ketchup process at pilot scale level



TOMATO SAUCES AND CHUTNEYS

Sauces can be made from almost any combination of fruit or vegetables, but in practice the market in many countries is dominated by tomato sauce, chilli sauce and to a lesser extent, mixed fruit sauces such as 'Worcester' sauce, which contains apples and dates in addition to tomatoes.

Chutneys are thick, jam like mixtures made from a variety of fruits and vegetables, spices, sugar and sometimes vinegar. Any edible sour fruit can be used as a base for chutney to complement the sweet taste from the sugar. The high sugar content has a preservative effect and vinegar is not always necessary, depending on the natural acidity and maturity of the fruits that are used. Most chutneys are boiled, which produces a caramelised syrup and alters the taste, colour and thickness of the product. Boiling also helps preserve the product through pasteurisation.

Sauces and purees are a mixture of vegetables (generally tomato based), spices, salt and sugar that are heated to evaporate water and concentrate the mixture. They are thinner than chutneys and tend to be more acidic. Sauces and purees can be further heated to concentrate them and make pastes. A semi-processed form of tomato puree can be prepared when there is a glut of tomatoes. This can be further processed into sauce and paste later in the season.

Processing of Tomato Sauces

It is highly spiced product made from ripe, peeled and crushed tomatoes and salt, sugar, spices, vinegar, with or without onion and garlic. The method of preparation is similar to that of tomato ketchup except that the total unstrained pulp is used and seeds are not removed. Hot product is filled in bottles or cans and processed in water at 85-90°C for 30 minutes. The composition of tomato sauce is similar in many respects to that of the thicker ketchup

Table 3. Formulation of Tomato Sauces

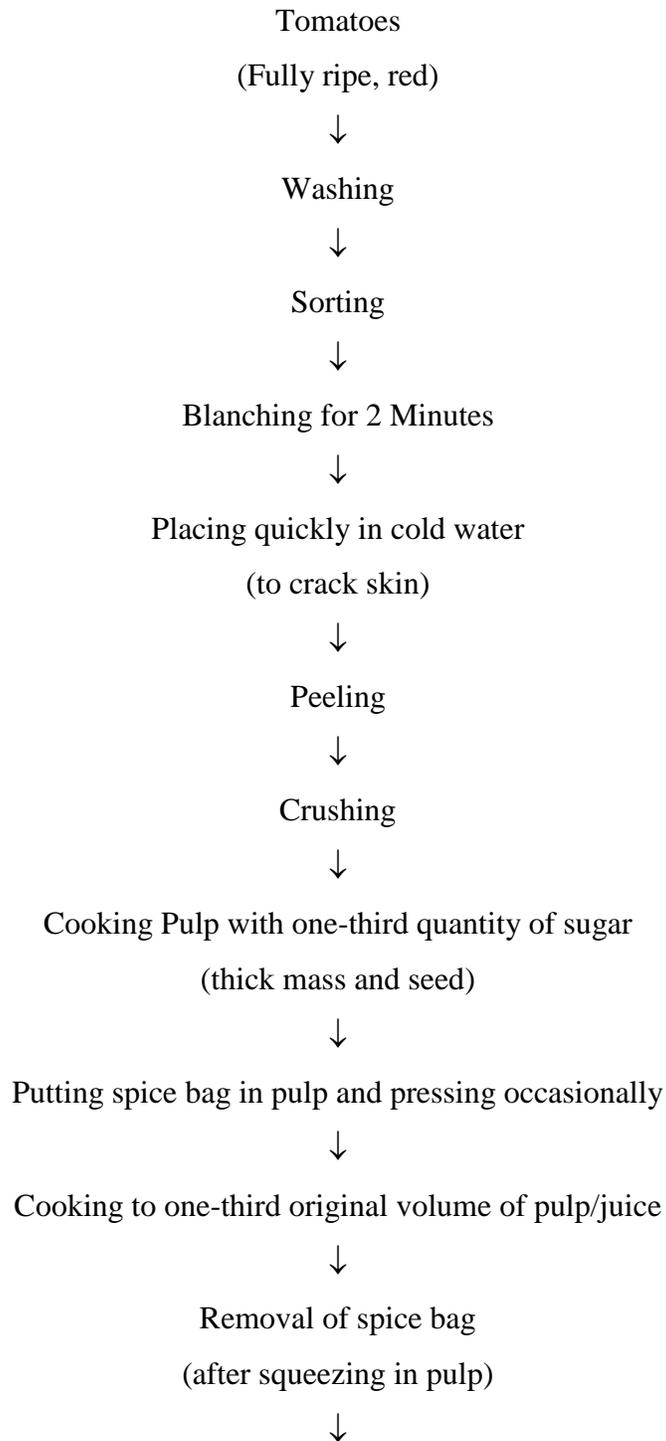
Tomato pulp	29.5 kg	Cinnamon	10 g
Cardamom, pepper and jeera in equal quantities)	8.5 g	Cloves (only stalks)	8.5 g
Salt	0.7 g	Mace	5.7 g
Garlic	18 g	Onions	155 g
Red chilli powder	15 g	Sugar	2.2 kg
		White vinegar	580 ml

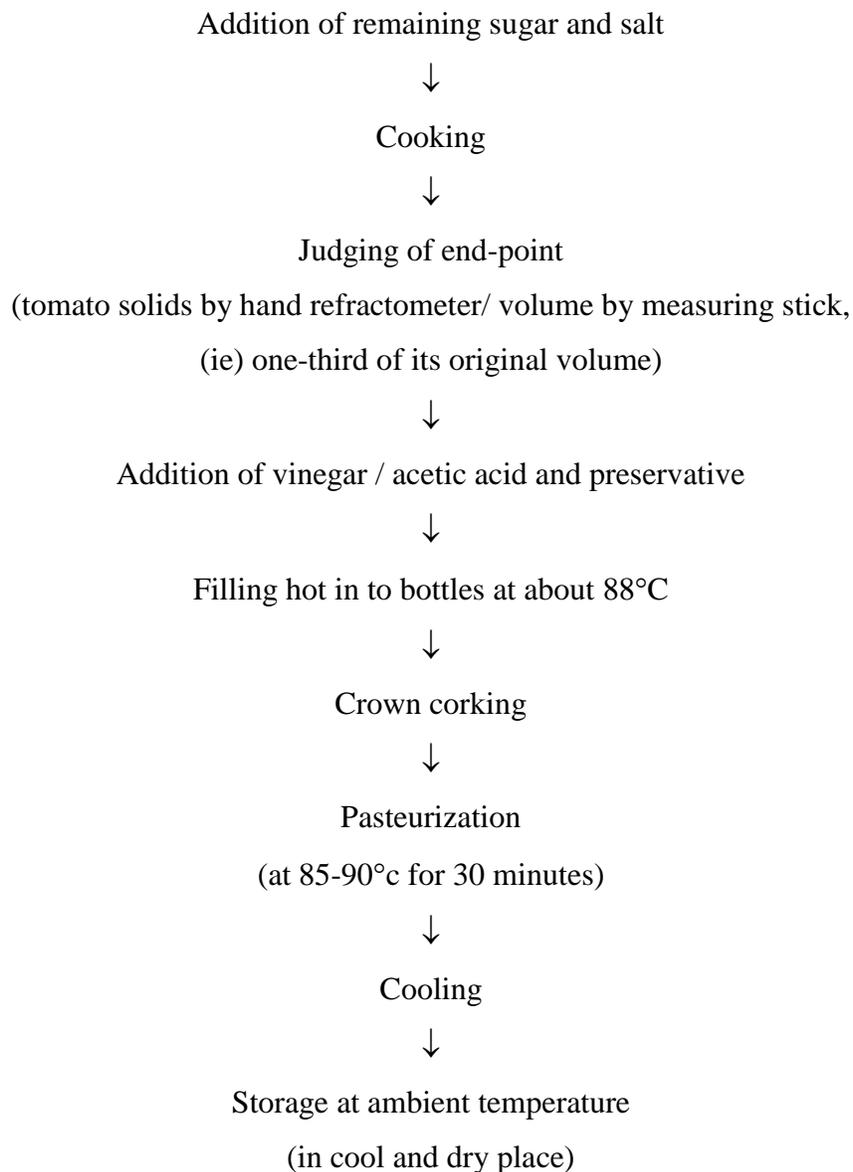
Wash fresh tomatoes of proper ripeness and good colour and cut them into pieces. Heat for 10 minutes; pass the heated material, through a screw extractor to separate the skin and seeds. Chop onion and garlic into small pieces, grind spices coarsely. Place the spices and onion in a muslin cloth and prepare spice bag. Heat the tomato pulp with 1/3 of the sugar and spice bag in a medium heat. After the volume is reduced the 1/3 squeeze the spice bag and add back the extract.

Add salt and remaining sugar and heat. Finally add glacial acetic acid. Heat the mass for a few minutes so that the volume of the finished product is half of the original pulp. Mix 885 mg sodium benzoate (preservative) per kg of the finished product. Fill the hot sauce into the sterilized narrow mouth bottles upto the brim and seal air tight using crown corks.

Otherwise fill the finished sauce into clean, sterilized A2 1/2 size plain cans, seal them and process for 45 minutes in boiling water and store for subsequent use. Dilute the sauce with half its weight of water and add cornstarch (1 per cent by weight of the diluted sauce) to improve the consistency of canned product.

Figure 5: Processing Flow-Sheet for Tomato Sauce

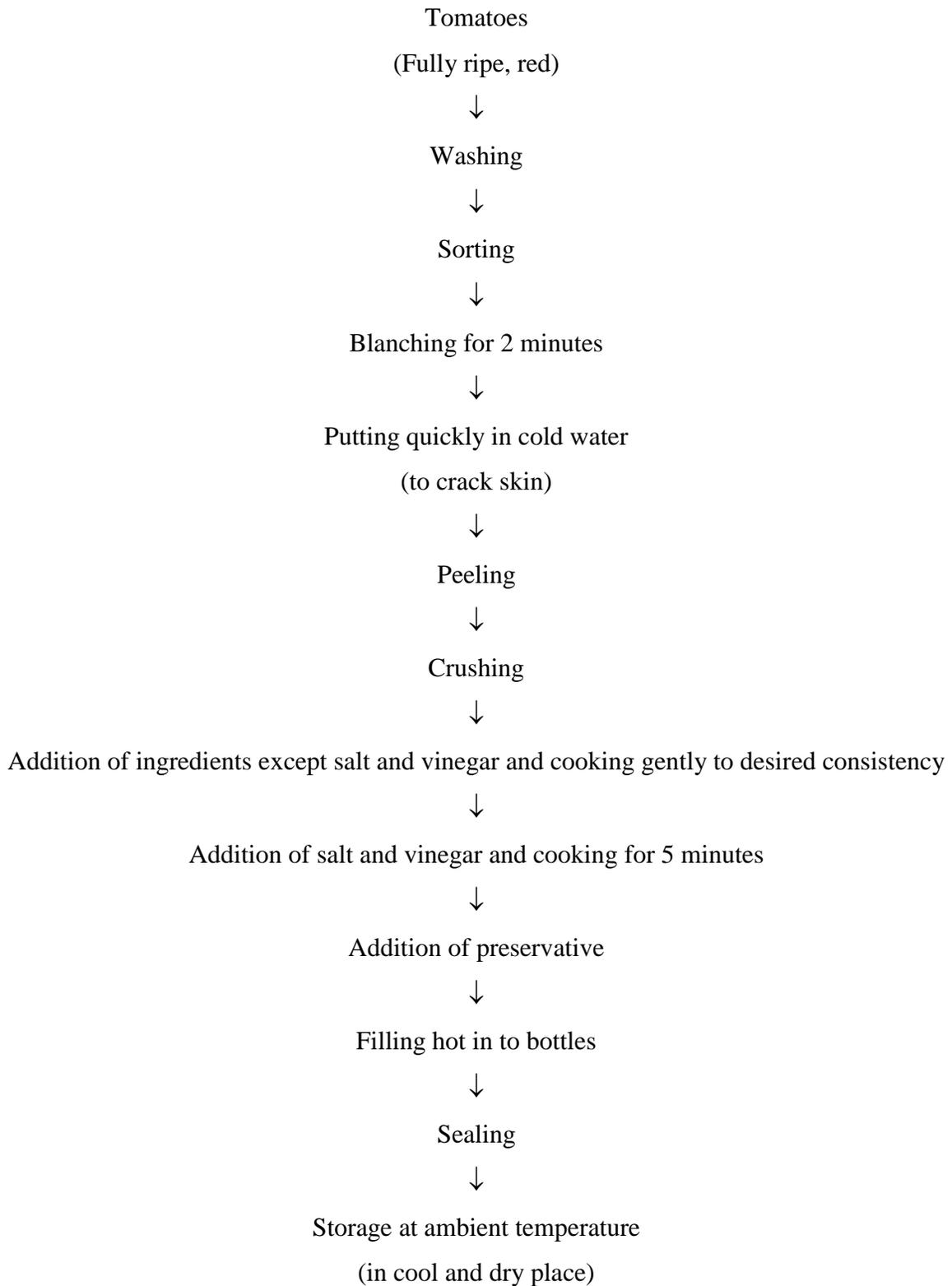




Processing of Tomato Chutney

Tomato 1 kg, sugar 500g, salt 25g, onion (Chopped) 100g, ginger (chopped) 10g, garlic (chopped) 5g, red chilli powder 10g, cinnamon, black pepper, cardamom (large), aniseed, cumin (powdered) 10g each, vinegar 100ml and sodium benzoate 0.5g per kg of final product.

Figure 6: Processing Flow-Sheet for Tomato Chutney



Pilot Scale Production of Tomato Sauce and Chutneys

- 1. Preparation of the fruit** Only ripe fruit should be used to make sauce. Under-ripe fruits should be left to ripen and used at a later date. Chutneys are often made from fruits that are slightly under-ripe. Over-ripe or rotten fruits should not be used. Fruit and vegetables should be washed in clean water. Some fruits, particularly tomatoes, are blanched in hot water for up to 5 minutes to soften the skin and to destroy enzymes and microbes. After blanching, they should be cooled by plunging in cold water. Fruits should be peeled with a stainless steel knife to prevent discolouring the flesh. They are chopped into various sized pieces according to the recipe. Accurate scales are needed to make sure that the correct amounts of ingredients are used each time. Two sets of scales are needed - one with a large capacity for fruit and a smaller set for spices.
- 2. Pulp juice extraction** Fruit pulp is extracted either by using a manual pulper of a pulper-finisher that separates out the seeds and skins from the pulp. The seeds and skin can be passed through the pulper a second time to obtain the maximum amount of juice and pulp from the fruit. The acidity of the pulp should be checked using a pH meter or pH paper. If it is above 4.0, lemon juice should be added to reduce it. Sodium benzoate can be added to the pulp (0.3g per 10kg pulp) to preserve the product after opening.
- 3. Added ingredients**

Spices - Spices should be clean, mature and not infected with mould. The proportions of spices added can be varied to create different products, but the same formulation must be used for each batch of the same product. Therefore, the quantities should be accurately weighed each time. Spices not only add flavour, some of them also have a preservative effect.

Chemical preservatives - Sodium benzoate is sometimes added to sauces and purees to help preserve them after the bottle has been opened. Sodium benzoate is added to semi-processed fruit and vegetable puree to hold it for processing at a later date. The

permitted levels of preservative are strictly controlled by the law in many countries. Check with the local authorities for the local regulations.

4. **Heat Treatment** The pulp is heated in a large open pan over a low heat. An open pan is best as it allows moisture to evaporate more quickly. The product must be stirred continuously during heating to prevent burning. The bright red colour of tomato sauces can be preserved by very slow heating. The end of boiling is determined by checking the soluble solids content with a refractometer.

Sauce/puree 10-12%

Simple concentrate 16%

Double concentrate 29%

Triple concentrate 30-32%

5. **Filling** Sauces and chutneys are hot-filled into hot, clean jars or bottles. If the glass jars are cold, there is the risk of breaking when the hot liquid is added. Alternatively, the chutney can be cooled and filled into polyethylene bags or pouches.
6. **Packaging** It is preferable to use glass jars with new metal lids. Paper, polythene or cloth lids can also be used, but they look less professional and there is more risk of spoilage. Plastic containers with foil lids can also be used if available as these tend to be cheaper than glass.
7. **Heating** Sauces are pasteurised in the jar after filling. The jars or bottles are immersed in a large pan or water bath and heated. Both the time and temperature of pasteurisation are critical to achieve the correct shelf life and to retain the colour and flavour of the juice.
8. **Cooling** After heating, the bottles are cooled to room temperature by immersing them in clean cold water. If the bottles are cooled too quickly they will crack and break.

General All equipment must be thoroughly cleaned each day to prevent contamination by insects and micro-organisms.

Additional Processing Notes

Sauces are thick viscous liquids, made from pulped fruit and/or vegetables with the addition of salt, sugar, spices and vinegar. They are pasteurised to give the required shelf life, but the basic principle of preservation is the use of vinegar, which inhibits the growth of spoilage and food poisoning micro-organisms. Other ingredients such as salt and sugar contribute to the preservative effect and the correct Preservation Index ensures that the product does not spoil after opening and can be used a little at a time. Some may contain a preservative such as sodium benzoate, but this is not necessary if an adequate Preservation Index is achieved. Sauces can be made from almost any combination of fruit or vegetables, but in practice the market in many countries is dominated by tomato sauce, chilli sauce and to a lesser extent, mixed fruit sauces such as 'Worcester' sauce, which contains apples and dates in addition to tomatoes. Depending on the scale of production, pulping and sieving out seeds and skins can be done by hand or using special pulper-finisher machines. The process for making sauce is outlined in the process chart below, using tomato sauce as an example.

Similarly, at a small scale, sauces can be made using simple open boiling pans, provided that care is taken to heat slowly with constant stirring to avoid localised burning of the product, especially at the end of heating. At a larger scale, processing is done using steam heated, stainless steel 'double jacketed' pans.

Stage in process		Quality Assurance	Equipment Required	Notes
Essential	Optional			
<p>Harvest fruit</p> <p>↓</p> <p>Wash</p> <p>↓</p> <p>Sort</p> <p>↓</p> <p>Heat/Peel</p> <p>↓</p> <p>Pulp or Chop</p> <p>↓</p> <p>Filter</p> <p>↓</p> <p>Mix ← Spices sugar, vinegar salt</p> <p>↓</p> <p>Heat</p> <p>↓</p> <p>Fill & Seal ← bottles & caps</p> <p>↓</p> <p>Heat</p> <p>↓</p> <p>Cool, Label & Store</p>		<p>Check for full maturity.</p> <p>Essential to produce uniform quality products.</p> <p>Check temperature and time of heating.</p> <p>Check for uniform pulp.</p> <p>Check all seeds removed.</p> <p>Check correct formulation used.</p> <p>Check time and temperature (measurement of solids content optional)</p> <p>Check fill-weight and correctly sealed pack.</p> <p>Check time and temp., of heating</p> <p>Check label</p>	<p>Wash tank.</p> <p>Boiling pan, wire basket (pulper-finisher optional)</p> <p>Mesh screen.</p> <p>Weighing scales or scoops, muslin bag.</p> <p>Boiling pan, heat source, scales or scoops, refractometer.</p> <p>Funnel or paste filler, scales.</p> <p>Stainless steel boiling pan.</p> <p>(Label applicator optional)</p>	<p>Mature but not over-rip fruit (of the 'plum' tomato variety) are picked carefully to reduce puncturing, bruising, etc., which would cause spoilage and loss of quality. Transport in stackable boxes to avoid crushing. Use clean water to remove dust, leaves, pesticide residues, etc.</p> <p>Sort by hand for similar colour, discard under-ripe, mouldy or discoloured fruits.</p> <p>Tomatoes are placed into a wire basket and heated in boiling water for 10 minutes. They are then removed and peeled by hand. Alternative, use a pulper finisher.</p> <p>Chop finely by hand if heat peeled. Mesh screen not needed if pulper-finisher used.</p> <p>A typical formulation per kg of tomatoes is 10g salt, 200ml vinegar and 80g sugar. Herbs and spices, such as 1g each of cinnamon, ground cloves, Allspice, and cayenne pepper are placed into a tied muslin bag and this is submerged in the pulp.</p> <p>The mixture is heated to 80-90°C until thick, usually within 20 min. Vinegar is added towards the end of the boiling to reduce the amount of acetic acid that is lost by evaporation.</p> <p>Hot fill into pre-sterilized bottles and hand seal lids - see text for alternatives.</p> <p>Pasteurize at 88°C for 20-30 min. Depending on the size of the bottle.</p> <p>In boxes on racks, in a cool dry atmosphere, away from sunlight.</p>

FOOD SAFETY AND STANDARDS AND GUIDELINES

REGULATION 5.3.14 THERMALLY PROCESSED TOMATO PUREE AND PASTE

Thermally Processed Tomato Puree And Paste (Canned, Bottled, Flexible Pack And/Or Aseptically Packed) means unfermented product which is capable of fermentation, obtained by concentrating the juice of sound ripe tomatoes to the desired concentration. It may contain salt and other ingredients suitable to the products. It shall meet the following requirements:-

S.No.	Product	Total Soluble Solids (w/w)
1.	Tomato puree	Not less than 9.0 percent
2.	Tomato paste	Not less than 25.0 percent

The container shall be well filled with the product and shall occupy not less than 90.0 percent of the water capacity of the container, when packed in the rigid containers. The water capacity of the container/net weight of the container is the volume of distilled water at 20°C which the sealed container is capable of holding when completely filled.

The product may contain food additives permitted in FSSR 2011 regulations Appendix A & Appendix B - Tomato Puree And Paste

PRESERVATIVES	Benzoic acid Sulphur dioxide	250 ppm max. in puree 750 ppm max. in paste
ACIDIFYING AGENTS	Citric Acid Fumaric Acid	GMP GMP
ANTIOXIDANT	Ascorbic Acid	GMP
THICKENING AGENT	Xanthan Gum	0.5% max.
MICROBIOLOGICAL REQUIREMENT	Yeast and spores	Not more than 125 per 1/60 c.m.m

REGULATION 5.3.27 TOMATO KETCHUP AND TOMATO SAUCE

Tomato Ketchup and Tomato Sauce means the product prepared by blending tomato juice/Puree/Paste of appropriate concentration with nutritive sweeteners, salt, vinegar, spices and condiments and any other ingredients suitable to the product and heating to the required consistency. Tomato Paste may be used after dilution with water suitable for the purpose of maintaining the essential composition of the product. It shall meet the following requirements:-

S.No.	Product	Total Soluble Solids (w/w)
1.	Total Soluble solids (m/m) Salt free basis	Not less than 25.0 percent
2.	Acidity as acetic acid	Not less than 1.0 percent

The container shall be well filled with the product and shall occupy not less than 90.0 percent of the water capacity of the container, when packed in the rigid containers.

The water capacity of the container is the volume of distilled water at 20°C which the sealed container is capable of holding when completely filled.

The product may contain food additives permitted in FSSR 2011 regulations

Appendix A & Appendix B - Tomato Ketchup and Tomato Sauce

PRESERVATIVES	Benzoic Acid Sorbic Acid	750 ppm max. 1000 ppm max.
ACIDIFYING AGENTS	Acetic Acid Citric Acid Fumaric Acid Lactic Acid L-Tartaric Acid Malic Acid	GMP GMP 0.3 % max. GMP GMP GMP
ANTIOXIDANT	Ascorbic Acid	GMP
THICKENING AGENT	Xanthan Gum Modified Starches Calcium Alginate	0.5% max. with declaration on the label GMP
MICROBIOLOGICAL REQUIREMENT	Mould count	Positive in not more than 60.00 percent of the field

		examined
	Yeast and spores	Not more than 125 per 1/60 c.m.m
	Total plate Count	Not more than 10000 / ml

Packaging requirements for Fruits and Vegetables Products

For Tomato Ketchups and Sauces, clean bottles shall be used. If acidity doesn't exceed 0.5% as acetic acid, open top sanitary cans may also be used.

REGULATION 5.3.8 THERMALLY PROCESSED TOMATO JUICE:

1. Thermally Processed Tomato Juice means the unfermented juice obtained by mechanical process from tomatoes (*Lycopersicum esculentus* L) of proper maturity and processed by heat, in an appropriate manner, before or after being sealed in a container, so as to prevent spoilage. The juice may have been concentrated and reconstituted with water for the purpose of maintaining the essential composition and quality factors of the juice. The product may contain salt and other ingredients suitable to the product. The product shall be free from skin, seeds and other coarse parts of tomatoes. The product shall have pleasant taste and flavour characteristic of tomatoes free from off flavour and evidence of fermentation.

2. The product shall conform to the requirements of Total Soluble Solids m/m free of added salt to be not less than 5.0 percent.

REGULATION 5.3.5: THERMALLY PROCESSED VEGETABLE SOUPS

1. Thermally Processed Vegetable Soups (Canned, Bottled, flexible pack And/ Or Aseptically Packed) means unfermented but fermentable product, intended for direct consumption, prepared from juice/ pulp/puree of sound, mature vegetables, fresh, dehydrated, frozen or previously processed, singly or in combination, by blending with salt, nutritive sweeteners, spices and condiments and any other ingredients suitable to the product, cooked to a suitable consistency and processed by heat in an appropriate

manner, before or after being sealed in a container, so as to prevent spoilage. It may be clear, turbid or cloudy.

2. The product shall have total soluble solids (m/m) not less than 5.0 percent except for tomato soup where it shall be not less than 7.0 percent (w/ w).

MICROBIOLOGICAL REQUIREMENTS OF FOOD PRODUCTS GIVEN BELOW:-

Products	Parameters	Limits
Tomato Puree and Paste	Yeast and spores	Not more than 125 per 1 / 60 c.m.m
	Mould Count	Positive in not more than 60.0 percent of the field examined
Tomato juices and soups	Mould count	Positive in not more than 40.0 percent of the field examined
Tomato ketchup and Tomato Sauce	Mould count	Positive in not more than 40.00 percent of the field examined
	Yeast and spores	Not more than 125 per 1 / 60 c.m.m
	Total plate Count	Not more than 10000 / ml

QUANTITY OF SAMPLE TO BE SENT TO THE PUBLIC ANALYST :-

The quantity of sample of food to be sent to the public analyst/Director for analysis shall be as specified in the Table below:

Article of Food	Approximate Quantity to be supplied
Tomato Sauce/ Ketch up/ Tomato Paste, Jam /Jelly/ Marmalade / Tomato Puree/ Vegetable Sauce	300 gms

TOMATO PRODUCT – BASIC RECIPES

A) Tomato Puree and Simple Concentrate

Fresh ripe tomatoes

Salt (optional)

This pulp-based concentrate can be concentrated to different levels of total solids to give a range of products:

Puree 10° Brix

Simple 16° Brix

Double 29° Brix

Triple 30-32° Brix

The double and triple concentrates are prepared using a vacuum evaporator.

- Sort the fruit and select ripe tomatoes. Discard any over-ripe or mouldy fruits. Save the under-ripe fruits for a later batch.
- Wash in clean water and drain. Cut the tomatoes into quarters, discarding any that are rotten inside.
- Place the tomatoes in a large pot and cook over a medium heat, stirring with a wooden spoon occasionally. Add salt to taste if desired.
- Continue heating until the total solids measure 6.5-6.8° Brix (using a refractometer). Remove from the heat and allow to cool slightly.
- Extract the juice by passing the sauce through a pulper. Pass the skins and seeds through the pulper a second time to remove as much juice as possible.

To make the puree

- Place the sauce back on the heat and concentrate until it is 10° Brix. Stir occasionally with a wooden spoon to prevent burning.
- Add 1% salt, continue heating until it has dissolved, then remove from the heat.
- Fill clean, sterile glass jars to the top with the hot puree and cover with clean lids.

- Place the glass containers into a water bath that is at the same temperature as the bottles. The water must cover the jars. Sterilise in boiling water for 45 minutes from the time that the water starts to boil.
- Remove the water bath from the heat. Gradually add cold water to slowly cool the water bath. Or, leave the jars to cool in the water bath until the following day.
- Dry the jars, add labels and store in a cool dry place away from light. The product should be stable for at least 12 months.

To make the simple concentrate proceed as follows:

- Concentrate the sauce until it reaches 16° Brix.
- Add 2% salt, dissolve and remove from the heat.
- Fill clean, sterile glass jars to the top with the hot puree and cover with clean lids.
- Place the glass containers into a water bath that is at the same temperature as the bottles. The water must cover the jars. Sterilise in boiling water for 45 minutes from the time that the water starts to boil.
- Remove the water bath from the heat. Gradually add cold water to slowly cool the water bath. Or, leave the jars to cool in the water bath until the following day.
- Dry the jars, add labels and store in a cool dry place away from light. The product should be stable for at least 12 months.

B) Tomato Paste

Ripe tomatoes

Lemon juice

Salt

This pulp-based concentrate can be concentrated to different levels of total solids to give a range of products: This is a thick, bright red paste that is used to prepare many traditional sauces and soups. It can be sold from bulk containers, in jars, polythene bags of cans and has a shelf life of several months.

- Sort the fruit and remove any under-ripe, mouldy or rotten tomatoes.
- Wash in 8 litres of clean water per 10kg tomatoes.

- Blanch in a waterbath at 80°C for 5 minutes. The tomatoes are blanched to soften the skins for peeling and to destroy enzymes and micro-organisms.
- Pass through a pulper-finisher fitted with a 1mm sieve. This removes the skins and seeds from the fruit.
- Measure the acidity of the pulp. If the pH is 4.0 or below, no lemon juice is needed. If the pH is above 4.0, lemon juice should be added until the pH falls below 4.0.
- Add 0.3g sodium benzoate per 10kg pulp to preserve the product after the bottle has been opened.
- Concentrate the pulp by one of two methods:
 - a). Traditionally this is done by heating slowly in an open pan, stirring constantly to prevent burning. If this is done carefully, the bright red colour can be retained. Heating is continued until a paste with 30% total solids is obtained. This is measured by a refractometer.
 - b). An improved method of concentrating is to place the pulp in a white cotton sack that is hung up for one hour to allow the water to drain out. The pulp loses half its weight. Add 2.5% salt by weight of concentrate and mix thoroughly. Re-hang the sack for one hour until the pulp is one third of its original weight (until it is 30% total solids).
- Fill the paste into bottles or cans, seal the containers.
- Pasteurise the bottles at 90°C for 45 minutes. Cool to room temperature.
- Dry the bottles, label and store in a cool dry place away from direct sunlight.

C) Tomato Sauce or Ketchup

- 20kg tomatoes
- 1.5kg sugar
- 450g onions, finely chopped
- 3.5g mace
- 9g cinnamon
- 11.25g cumin
- 11.25g cardamom
- 11.25g ground black pepper

5g ground white pepper

330g salt

800g vinegar

This is a red sauce made from fresh tomatoes. It is a thick sauce with a sweet taste that is commonly used in cooking and as a table relish. It has a shelf life of more than one year in glass bottles when the container is unopened. The recipe can be varied by adding different spices. For example, 2.5g chilli powder per 10kg tomato pulp can be added before processing. It is important that the ratio of ingredients is carefully monitored and controlled for each batch to produce the desired taste, consistency and flavour each time.

- Select good quality, fully ripe, red fruits without infection, mould or rot. It is preferable to use a variety of tomatoes that has a high solids content.
- Wash in clean water and leave to drain.
- Blanch in hot water for 3-5 minutes until the skins are loosened. Remove from the heat and plunge into cold water to cool.
- Remove the skin and core of tomatoes.
- Chop into pieces and pulp, either by hand or with a pulper-finishing machine.
- Add 500g sugar, the onions and the spices, tied loosely in a muslin bag.
- Heat to below boiling point in a pan with continuous stirring, until the volume has reduced by half.
- Remove the spice bag. Add 1kg sugar, the salt and vinegar. Continue heating for 5-10 minutes until the final total solids is 10-12% (measured by a refractometer).
- Hot-fill into clean, sterilised jars at 80°C. Close the tops with lids.
- Cool to room temperature. Label the jars. Store in a cool dry place away from direct sunlight.

D) Basic Sauce and Chutney

The following basic recipes are guidelines for the production of sauces and chutneys. The ingredients can be varied according to consumer taste and local availability of fruits, vegetables and spices.

Italian-style tomato sauce

Fresh tomatoes: 5kg of 4.2 to 4.5° Brix

1 medium onion per kg of tomato

5 medium garlic cloves per kg tomato

salt to taste

pepper to taste

1kg carrots per 5kg tomato

50-100ml vegetable oil

Dried oregano, fresh basil, chilli pepper (optional)

- Select ripe tomatoes. Discard any tomatoes that are under-ripe, over-ripe or rotten.
- Wash in clean water and drain. Cut each tomato in half and discard any that are rotting inside.
- Chop the onion in small cubes. Cut the garlic cloves into quarters. Add oil to a pan and fry the onion and garlic over a low flame until the onion turns pink. Take care not to burn the onion and garlic.
- Place the cut tomatoes in a large pan and heat over a low flame. Add the cooked onion and garlic, salt, pepper and chilli pepper if using. Increase the heat and boil for 40 minutes, stirring constantly until it reaches 10-12° Brix.
- Add fresh basil or dried oregano according to taste. Boil for a further 5 minutes and remove the pot from the heat.
- Pass the sauce through a pulper to remove the seeds and skin
- Cook the sauce for 10-15 minutes and check that the Brix is 10-12°.
- Fill the hot sauce into clean sterile glass jars or bottles. Fill them to the top and immediately close with clean lids. Alternatively, allow the sauce to cool then pour into polyethylene bags that are heat sealed.
- Place the glass containers into a water bath that is at the same temperature as the bottles. The water must cover the jars. Sterilise in boiling water for 45 minutes from the time that the water starts to boil.
- Remove the water bath from the heat. Gradually add cold water to slowly cool the water bath. Or, leave the jars to cool in the water bath until the following day.

- Dry the jars, add labels and store in a cool dry place away from light. The product should be stable for at least 12 months.

E) Tomato Juice

Fresh ripe tomatoes of 4.2-4.5° Brix

Lemon juice

Salt and pepper to taste (optional)

This tomato juice can be used as a beverage or for cooking when fresh tomatoes are not available.

- Sort the fruit and select ripe tomatoes. Discard any over-ripe or mouldy fruits. Save the under-ripe fruits for a later batch.
- Wash in clean water and drain. Cut the tomatoes into quarters, discarding any that are rotten inside.
- Place the tomatoes in a large pot and cook over a medium heat, stirring with a wooden spoon occasionally.
- Add two tablespoons of lemon juice for every kg of tomatoes. Add salt and pepper to taste (optional).
- Continue heating until the total solids measure 6.5-6.8° Brix (using a refractometer). Remove from the heat and allow to cool slightly.
- Extract the juice by passing the sauce through a pulper. Pass the skins and seeds through the pulper a second time to remove as much juice as possible.
- Place the sauce back on the heat and cook until it begins to boil. Check that the Brix is 10-12°
- Fill the hot sauce into clean sterile glass jars or bottles. Fill them to the top and immediately close with clean lids. Alternatively, allow the sauce to cool then pour into polyethylene bags that are heat sealed.
- Place the glass containers into a water bath that is at the same temperature as the bottles. The water must cover the jars. Sterilise in boiling water for 45 minutes from the time that the water starts to boil.

- Remove the water bath from the heat. Gradually add cold water to slowly cool the water bath. Or, leave the jars to cool in the water bath until the following day.
- Dry the jars, add labels and store in a cool dry place away from light. The product should be stable for at least 12 months.
