PRACTICAL ACTION
Technology challenging poverty

TOMATO PROCESSING

technical brief

Introduction

The demand for tomato processing usually arises from a need to preserve the product for home use (inclusion in stews, soups, curries etc) out of season or to add value for extra income. Traditionally, the most important methods used are concentration (to a paste or purée) and drying either fruit pieces or to a powder. These remain the most suitable processes for many people to use and form the bulk of this brief. In addition you will find information for making ketchup, chutney, leather, juice and tomato jam.

Figure 1: Sorting the tomatoes in the processing unit at Walewela, Matale, Sri Lanka.
Photo: Practical Action / Zul.

It should be noted that high quality 'salad' tomatoes have the highest value when sold fresh and in good condition. These would not normally be used for processing, unless for home use to save excess at the height of the season.

Raw material quality

For each of the processes described below the tomatoes should be ripe, red, firm to soft, free of all mould growth (by cutting out infected parts) and free of stems, leaves, dirt and other soils (by washing). The under-ripe fruit can be left to ripen and used at a later date. It is less important if the tomatoes have surface blemishes or splits/cracks (provided these are not infected) as in most processes they will be cut or pulped.

Processing

Drying

Traditional methods in hot, dry regions include sun drying. Tomatoes are halved and either placed on a clean flat surface (eg a roof) with the cut side facing up or threaded onto strings which hang in the sun from a branch or beam. In both cases, drying is relatively rapid (depending on the temperature and humidity of the air) but there may be contamination of the product by insects, dirt and dust. This can be reduced by covering the tomatoes with fine muslin cloth or mosquito netting. The end product is dark, red, leathery pieces with a strong tomato flavour. Re-hydration of the dried tomatoes is relatively slow, but this may not be important in cooking applications.

Figure 2 Dried tomatoes with a wrinkled skin. Photo: Practical Action / Neil Noble

Practical Action, The Schumacher Centre, Bourton on Dunsmore, Rugby, Warwickshire, CV23 9QZ, UK
T +44 (0)1926 634400 | **F** +44 (0)1926 634401 | **E** infoserv@practicalaction.org.uk | **W** www.practicalaction.org

Provided that the humidity is low, the dried product will keep without special packaging for several months. If the humidity rises the product will go mouldy and should be protected, either by suitable packaging (e.g. sealed plastic bags - preferably polypropylene or thick polythene - or in sealed pottery jars). Alternatively, the pieces can be dried slowly over a fire to allow moisture content. It is important that the tomatoes are far enough away from the fire to prevent cooking. The pieces will be fully dried when they are hard and brittle.

Dried tomatoes

Process details	Flow sheet
Select firm, ripe tomatoes. Reject any that are over-ripe, rotten or damaged.	Preparation of the tomatoes
You can leave the skin on, or remove it from the tomatoes. If you remove the skin, the fruit will dry more evenly. Plunge the tomatoes in boiling water to loosen the skins. Remove from the hot water, cool in cold water and peel the skin. If you leave the skin on, the drying process will take longer as it is difficult for the tomatoes to lose water through the skin. The final product will have a wrinkled leathery skin with curled up edges (see figure 2). If the unpeeled pieces of tomato are too big, it might be difficult to remove all the moisture from the centre of the pieces and they will have a short shelf life.	↓ Plunge in hot water (optional step)
Chop in half or quarters depending on the size of fruit. Smaller pieces dry more quickly so give a better dried product. Do not make the pieces too small (no less than 20mm thick) or they will shrivel and become crisp during drying.	↓ Chop/slice
Place the cut pieces of tomato cut side upwards on the drying platform or tray. If you are not peeling the tomatoes, make sure the side with the peel is in contact with the tray. Place the pieces close together to get as many as possible in the dryer. But do not let the pieces touch or overlap. Sun drying. Place the trays of fruit in a shaded sunny position. Do not dry in direct sunlight or the colour will fade. Choose a spot where there is good ventilation to speed up drying. Solar drying. Place the trays of fruit into the dryer and dry until the pieces are soft and leathery.	↓ Drying
Conditioning is an important step if you leave the peel on the tomato and there is the risk of some moisture remaining in the dried pieces. Let the dried fruit pieces cool then place in a large plastic or glass container. Fill the container to about two thirds full. Stand in a warm, dry, well ventilated place for up to 10 days. After this time, inspect the pieces of tomato. If there are beads of moisture on the pieces, return to the dryer until they are fully dry. Once you are sure that the pieces are all dry, pack them in moisture proof packaging.	↓ Conditioning and packing

Sun drying is really only an option when the climate is hot and dry. If you are in a humid climate sun drying is not appropriate.

When tomatoes are dried to a very low moisture content, so that they are hard (eg 5% water), they can be pounded or milled to a powder. The powder should be stored in an airtight, moisture proof container such as a sealed glass jar or polypropylene bag. The dried powder is more convenient to use in cooking, but is more difficult to store as it will easily attract moisture and become damp. Ground powder also tends to lose its taste and flavour more rapidly than whole pieces of tomato.

If the tomato harvest season coincides with the rainy season, you will need to use an artificial dryer. The choice of dryer depends on the amount of tomatoes you want to dry, what is available locally and the climate. In addition, you need to determine whether it is financially worth investing in a dryer. Tomato that is being dried for home use will have a low economic value, therefore it is important to calculate the cost of the drier and fuel before starting to ensure that it is economically viable to use an artificial dryer.

Preparation of tomato pulp

Tomato pulp can be prepared using a pestle and mortar, some types of mill, a hand held mouli machine or a small pulping machine. It is usually necessary to remove the seeds and skins which can be done by sieving through a medium mesh (eg 1-2mm holes) or, in the case of some of the pulpers, these parts are separated by the machine. The pulp can be used for a number of different products – to make a concentrated puree or paste, jam, juice or fruit leather.

Figure 3: Tomato processing unit at Walewela, Sri Lanka. Putting tomatoes in the pulper.
Photo: Practical Action / Zul.

Process details	Flow chart
Select firm, ripe tomatoes. Reject any that are over-ripe, rotten or damaged.	Preparation of raw material ↓ Removal of skins ↓ Mill ↓ TOMATO PULP
If you need to remove the skins plunge the tomatoes in boiling water to loosen the skins. Remove from the hot water, cool in cold water and peel the skin.	
Mill the tomatoes using a hand held mouli grinder, a small mill or a pulper	
Tomato pulp is available for use in a variety of products.	

Tomato pulp can be boiled to evaporate the water. Depending on how much water is removed and what other ingredients are mixed into the pulp, it is possible to make a variety of products. Examples are given in Table 1.

technical brief

	Solids content (%)*	Temperature (at sea level)	Added ingredients
Paste	40	(101)	-
Puree	34	(100)	-
Jam	68-70	(106)	(pectin), sugar, (acid)
Chutney	42	(101)	vinegar, salt, spices
Ketchup	35	(100)	vinegar, sugar, spices
Soup	16	(100)	flour, salt, sugar

Table 1: Products made from tomato pulp

* Usually measured as °Brix using a refractometer. The figures in brackets are the final temperature of boiling at sea level, which is an alternative way of measuring the solids content (at higher elevations the boiling point is progressively reduced and separate technical advice is needed if you are above approximately 2000m)

The basic preservation principle behind all these products is to remove water by boiling to a) heat the product to destroy enzymes and micro-organisms and b) concentrate the product so that contaminating micro-organisms cannot re-grow.

Heating can be done in an open pan over a fire. It is necessary to heat slowly -especially when the product is more concentrated - to prevent it burning onto the pan. It should also be stirred continuously which is very labour intensive (and hot work). The product will be a dark red paste with a strong taste of tomato.

You can make a product with a better colour and in a shorter time by using a steam jacketed boiling pan with steam from a boiler. This is expensive and should only be considered for larger scales of operation. The bright red colour of imported tomato pastes and purées can only be obtained by using vacuum evaporators, which to the best of our knowledge, are not available at the small-scale.

Tomato puree or paste

Tomato puree and paste are formed by concentrating tomato pulp by removing the water. The moisture can be removed by careful heating or by pressing the pulp through a filter or drip bag.

Ingredients:

Fresh tomato pulp (10kg) (see the method above)
Lemon juice (50ml per litre of tomato juice - to adjust the acidity)
Salt (25g per kg tomato pulp)
Sodium benzoate (0.3g per 10kg pulp)

Process details	Flow chart
For glass jars: Wash the jars and lids and put them into a large saucepan. Fill the saucepan with water so that the jars and lids are covered and heat until the water boils. Boil for about 5 minutes. Remove the jars and turn upside down so that the water can all drain out. **DO NOT** dry them with a dirty cloth. If you are using recycled **plastic jars**, clean them with a solution of chlorinated water (100ppm). Turn upside down so all the water can drain out.	Preparation of the jars and lids
The pulp should have a pH value of 4.0 or lower. If it is higher, add lemon juice or vinegar to increase the acidity. If you cannot measure the acidity, add lemon juice (50ml per litre of tomato juice) to make sure it is high enough. Add 0.3g sodium benzoate per 10kg pulp to preserve the product.	Check acidity of pulp
Concentrate the pulp by removing the water. There are two ways of doing this – by heating or by draining: **Heating** - Heat slowly in an open pan, stirring constantly to prevent burning. If this is done carefully, the bright red colour can be retained. Continue heating until a paste with 30% total solids is obtained. For best results, this is measured using a refractometer. If you do not have a refractometer, you need to use another method: When it is cooked, the paste should easily coat the back of a spoon. You can also calculate how much water has been lost by weighing the pulp before and after heating. The pulp should be reduced to one third of its starting weight. *(Remember to subtract the weight of the pan when estimating the pulp weight!)* **Draining** - 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, until the pulp loses half its original 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). Make sure that the sack is very clean and that the pulp is not exposed to insects and dust.	Concentration
Fill the paste into bottles or plastic pouches. Seal the containers.	Filling and packaging
Place the glass containers into a water bath that is at the same temperature as the bottles. The water must cover the jars. Pasteurise at 90°C for 45 minutes.	Pasteurisation
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. Both glass and plastic packages of tomato paste should be stored away from direct sunlight to prevent the colour fading. The pasteurised puree stored in glass jars will have a longer shelf life (up to 12 months) than that in plastic pouches which cannot be pasteurised after packing (up to 3 months). Shelf life also depends on the correct level of acidity to prevent the growth of bacteria. Once opened, both glass and plastic bottles of tomato puree are susceptible to spoilage by bacteria.	Cooling and storage

technical brief

Tomato juice and squash

Tomato juice can be separated from the pulp by filtering but more commonly the entire pulp is used as juice. The juice should be bottled and pasteurised to extend its shelf life. There are two methods of pasteurisation – before or after filing into bottles. If plastic bottles are used, it is essential to pasteurise the juice before filling as the plastic bottles will not withstand the pasteurisation temperatures. The pulp is heated to 90-100°C and held at this temperature for 10 minutes. It is allowed to cool to about 80°C and then hot filled into clean, sterilised jars. If glass bottles are used, the juice can be pasteurised after it has been filled into the clean, sterilised bottles. The sealed bottles are placed in a water bath that is heated to 90-100°C for at least 10 minutes followed by cooling to room temperature. The length of time of heating varies according to the size of the bottles. The bottles should be slowly cooled to room temperature. Do not cool too quickly or the glass will crack. A bottle cooling system is illustrated in figure 2. Tomato juice that is packed in glass and pasteurised in the bottles will have a longer shelf life than juice that is hot filled into plastic containers.

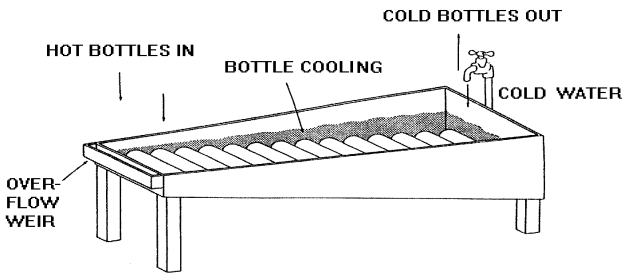

Figure 4: Bottle cooling system

During storage, there will be some separation of juice and pulp with pulp accumulating at the bottom of the bottle. However, clear separation into a pale liquid and a solid pulp layer indicates that the juice is under-pasteurised. This is not likely to be harmful but is less attractive. Some small-scale producers have found that adding 0.3% thickener (eg sodium alginate) to the juice completely prevents separation. Sodium alginate is a permitted additive in most countries but may be expensive and is not really necessary.

Process details	Flow sheet
For glass jars: Wash the jars and lids and put them into a large saucepan. Fill the saucepan with water so that the jars and lids are covered and heat until the water boils. Boil for about 5 minutes. Remove the jars and turn upside down so that the water can all drain out. **DO NOT** dry them with a dirty cloth. If you are using recycled **plastic jars**, clean them with a solution of chlorinated water (100ppm). Turn upside down so all the water can drain out.	Sterilise the glass jars and lids ↓
Prepare pulp according to the method above	Tomato pulp
The pulp should have a pH value of 4.0 or lower. If it is higher, add lemon juice or vinegar to increase the acidity. If you cannot measure the acidity, add lemon juice (50ml per litre of tomato juice) to make sure it is high enough. Add 0.3g sodium benzoate per 10kg pulp to preserve the product.	Check acidity of pulp ↓
Heat to 90-100°C and hold at this temperature for at least 10 minutes.	Pasteurise (before filling if using plastic containers)
Cool to 80C and hot-fill into sterilised bottles. Seal bottles with new clean caps	Fill ↓
Stand the bottles in a hot water bath. Heat to 90-100C and hold for at least 10 minutes. Leave one of the bottles unsealed and place a thermometer in this bottle to check the temperature.	Pasteurise (after filling if using glass containers) ↓
Cool to room temperature. Label the bottles.	Cool and label
Store in a cool place away from direct sunlight.	Store

Tomato squash is tomato pulp with added sugar syrup to give a concentration of 30-50% total solids (°Brix) measured by a refractometer. It is not a very common product as people tend to prefer squashes made from other fruits but it may well be worth investigating in your own area. It is processed in a similar way to juice and may contain up to 100ppm of sodium (or potassium) benzoate preservative (check with your local Bureau of Standards for the legal limits in your country) to help preserve it after opening the bottle.

Tomato jam

1kg tomato pulp
1kg sugar
(pectin and citric acid not usually necessary but 0.1% pectin and adjustment to pH3.3 may be needed)

Tomato pulp can be used for the preparation of tomato jam. It is not a common product, but may be worth trying.

Process notes	Flow sheet
For glass jars: Wash the jars and lids and put them into a large saucepan. Fill the saucepan with water so that the jars and lids are covered and heat until the water boils. Boil for about 5 minutes. Remove the jars and turn upside down so that the water can all drain out. **DO NOT** dry them with a dirty cloth. If you are using recycled **plastic jars**, clean them with a solution of chlorinated water (100ppm). Turn upside down so all the water can drain out.	Sterilise glass jars and lids ↓
Prepare pulp according to the earlier method	**TOMATO PULP**
The pH should be 3.3. If it is higher than this, add lemon juice or citric acid to reach this level. Add sugar to the pulp. If pectin is needed, mix this with the sugar before adding to the pulp.	Check pH. Add ingredients ↓
Heat gently to dissolve the sugar, stirring to prevent burning at the base of the pan. When the sugar has dissolved, bring to the boil and boil rapidly until the jam has the correct level of soluble solids (65-68% as measured by a refractometer). If you do not have a refractometer, you can test for the end point with the wrinkle test (see below) or drop test.	Boil ↓
Cool to about 80C and hot fill into sterilised jars. Place the lids loosely on the jars.	Fill ↓
Allow to cool to room temperature. Tighten the lids and label the jars.	Cool and label
Store in a cool place away from direct sunlight	Store

Determination of the end point of jam

Using a refractometer to measure the total soluble solids is the most accurate method. If you do not have a refractometer you can use one of the methods below:

Drop test. This is the cheapest option, but is the least accurate of the methods. It is good enough for use at the home level, for jam that will be used within a fairly short time. It is not recommended for jams that are meant for sale as there is no guarantee of consistency from one batch of jam to another.

After two minutes of rapid boiling, remove the pan from heat. Dip a clean wooden spoon into the jam and hold it over the pan for 1 to 2 seconds. If the jam runs back freely, repeat the test every two minutes until the jam looks like a heavy syrup. When a small lump of jam forms on the back of the spoon and breaks away from the rest, the setting point has been reached.

Alternatively, you can drop the jam into a glass of cold water: Take a small drop of the boiled jam on a spoon. Cool it slightly and drop into a glass of cold water. If the drop falls in a single piece until it reaches the bottom of the glass the end point has been reached. If it disperses in the water it requires boiling for longer.

The skin wrinkle test. This method is also cheap and about as accurate as the drop test. You need a cold plate or saucer. After two minutes of rapid boiling, remove the pan from heat. Dip a clean wooden spoon into the jam and drip a small amount of jam onto the cold plate surface. Let it cool and then push the lump of jam with your finger. If the surface of the lump of jam wrinkles when you push it, it is cooked.

See the Practical Action Technical Brief on jam making for further information.

Tomato leather

Tomato pulp can be mixed with spices according to local taste and availability and used to make a fruit leather. The pulp is heated and spread in a thin layer which is dried. After drying, the leather is cut and rolled into balls or cubes which can be rehydrated and used in a range of soups, stews and sauces.

Ingredients

1kg tomato pulp
1/3 onion, minced
2 garlic cloves, minced
2 tablespoons olive oil
1 teaspoon salt
1 pinch sugar
2 teaspoons parsley, chopped
Ground black pepper, to taste
1 pinch basil

Process details	Flow sheet
	TOMATO PULP
The pH should be 4.2 or lower. If it is higher than this, add lemon juice or citric acid to reach this level.	Check acidity ↓
Sauté the onions and garlic and add to the pulp with the spices	Prepare ingredients ↓
Bring the mixture to a boil. Continue to heat for 10 minutes.	Boil ↓
Pour the mixture onto paper lined trays and dry at 65-70°C until soft and rubbery. The time taken to dry depends on the thickness of the leather	Dry ↓
Cut the leather into strips or cubes.	Cut into strips and roll up ↓
Store in a moisture proof, airtight container away from direct sunlight.	Store

technical brief

Green tomato chutney

Unripe tomatoes can be left to ripen or can be used to make a fruit chutney. You can vary the recipe according to local taste and preference.

Ingredients

1kg tomatoes
125g cooking apples
500g onions
100g sultanas
450 ml vinegar
500g sugar
1 level teaspoon salt
½ level teaspoon mustard
¼ level teaspoon pepper
2 level teaspoons curry powder

Process details	Flow sheet
For glass jars: Wash the jars and lids and put them into a large saucepan. Fill the saucepan with water so that the jars and lids are covered and heat until the water boils. Boil for about 5 minutes. Remove the jars and turn upside down so that the water can all drain out. **DO NOT** dry them with a dirty cloth. If you are using recycled **plastic jars**, clean them with a solution of chlorinated water (100ppm). Turn upside down so all the water can drain out.	Sterilise glass jars and lids ↓
Chop the onions and apples into small pieces. Peel the tomatoes and chop into small pieces. Plunge the tomatoes into boiling water for a few minutes to loosen the skins and make peeling easier	Prepare raw materials ↓
Add the sultanas, vinegar and spices and mix well. Heat gently until all the ingredients are soft.	Mix and heat ↓
Add the sugar. Heat gently to dissolve the sugar, then boil for 30 minutes until the chutney has a thick consistency.	Add sugar and concentrate ↓
Allow the chutney to cool to 80°C and hot fill into sterilised jars. Cover with lids	Fill ↓
Cool to room temperature, tighten the lids and label the jars.	Label and cool ↓
Store in a cool place away from direct sunlight.	Store

Tomato ketchup

Tomato ketchup is a popular product worldwide. The following recipe is for a thick sauce with a sweet taste and tomato flavour. You can modify the spices according to local taste and availability. Chilli powder can be added (2.5g per 10kg tomato pulp) to make a tomato chilli sauce.

Ingredients

10kg tomato pulp
1.5kg sugar
450g onions, finely chopped
3.5g mace
9g cinnamon
11.25g cumin
11.025g cardamom
11.25g ground black pepper
5g ground white pepper
5g ground ginger
330g salt
800g vinegar

Process details	Flow sheet
Pulp prepared according to the above recipe	TOMATO PULP
Add 500g sugar, the onions and the spices tied loosely in a muslin bag (mace, cinnamon, cumin, cardamom, black pepper, white pepper, ground ginger).	Add ingredients ↓ Heat
Heat slowly to dissolve the sugar. Heat to below boiling point, stirring continuously to prevent burning. Continue heating until the volume has reduced by half.	↓ Separate
Remove the spice bag.	↓ Mix sugar, salt and vinegar
Add 1kg sugar, the salt and the vinegar. Continue heating for 5-10 minutes. Check the total soluble solids using a refractometer (it should be 10-12°Brix).	↓ Fill and seal
Cool to 80°C and hot fill into sterilised bottles or jars. Close the lids tightly.	↓ Cool
Cool to room temperature.	↓ Store
Store away from sunlight in a cool place. The sauce can be stored for up to a year without losing flavour and taste but can lose colour if exposed to sunlight.	

References and further reading

- *How to grow tomato and peppers*: Agrodok 17*:* M. Amati et al, Agromisa, 1989
- *Starting a Small Food Processing Enterprise* by Peter Fellows, Ernesto Franco & Walter Rios Practical Action Publishing/CTA 1996
- *Small Scale Food Processing* 2nd Ed. P Fellows & S Azam Ali, Practical Action Publishing, 2003
- *Tomato and Fruit Processing, Preserving and Packaging: An example of a village Factory*, G. Klein, CIEPAC/TOOL, 1993.
- *Fruit and Vegetables* a selection of Practical Action Technical Briefs

This document was produced by Dr. S Azam Ali for Practical Action March 2008. Dr. S Azam-Ali is a consultant in food processing and nutrition with over 15 years experience of working with small-scale processors in developing countries.

Practical Action
The Schumacher Centre
Bourton-on-Dunsmore
Rugby, Warwickshire, CV23 9QZ
United Kingdom
Tel: +44 (0)1926 634400
Fax: +44 (0)1926 634401
E-mail: infoserv@practicalaction.org.uk
Website: http://practicalaction.org/practicalanswers/

technical brief