



JAMS, JELLIES AND MARMALADE

Introduction

Jams, jellies and marmalade can be made from a variety of fruits and some vegetables such as carrot and pumpkin. They are sometimes referred to collectively as preserves. The products are typically luxury items that are purchased by consumers in affluent urban areas.

As with all food products, it is essential to carry out a market and technical feasibility study before starting to make preserves, to assess the level of demand for the products in your area. Please remember that jam making requires a large amount of sugar and making a high quality product requires some technical knowledge, the correct equipment and good packaging materials. A surplus of (over-ripe) fruit is not a good reason for starting a business making preserves.

The preservation principles of jam, jelly and marmalade production are quite complex, but in essence involve the correct combination of acidity, sugar level and pectin content. All three must be correct to obtain a satisfactory product.

One important feature of preserves is the high acidity which prevents the growth of food poisoning bacteria and also helps maintain the colour and flavour of most fruits. However, some moulds and yeasts are able to grow at levels of high acidity and these can spoil the food. They are prevented from spoiling jams by ensuring that the sugar content of the preserve is at least 68%. If for any reason the sugar content is lower than this (eg if water condenses on the lid of the jar and falls onto the jam during cooling or if the jam is not boiled for long enough to reduce the moisture content) the sugar content will be diluted and moulds will start to grow on the surface of the product.

This technical brief describes the principles and process of jam making. Generic formulae are given which the more technical processors can use to create their own recipes. In addition, some tried and tested recipes for various fruits are included.

Types of Products

Jams are solid gels made from fruit pulp or juice, sugar and added pectin. They can be made from single fruits or a combination of fruits. The fruit content should be at least 40%. In mixed fruit jams the first-named fruit should be at least 50% of the total fruit added (based on UK legislation). The total sugar content of jam should not be less than 68%.



Figure 1: Testing for the end point of jam. A food processing training course in Bangladesh. ©Sue Azam Ali/Practical Action

technical brief

Jellies are crystal clear jams, produced using filtered fruit juice instead of fruit pulp.

Marmalades are produced mainly from clear citrus juices and have fine shreds of peel suspended in the gel. Commonly used fruits include lime, orange, grapefruit, lemon and orange. Ginger may also be used alone or in combination with these citrus fruits. The fruit content should not be less than 20% citrus fruit and the sugar content is similar to jams.

Quality control and assurance

The main areas of quality control that are needed to produce uniformly high quality products are as follows: fruit preparation, accurate weighing and mixing of ingredients, hygienic preparation of fruits and fruit juices, correct acidity, moisture content and final total soluble solids content.

Fruit preparation

Fruit should be sorted and cleaned thoroughly. Only mature fruit, without mould, excessive bruising or insect damage should be used. All stems, leaves and skins should be removed and discarded. Very ripe or over-ripe fruit has low levels of pectin and is not suitable for jam making and should not be used. Fruit that is very under-ripe is also not recommended as the taste and sweetness of the fruit are under-developed.

Ingredient mixing

Accurate scales are needed to weigh out the ingredients and care is needed to make sure that the correct weights are used each time. In particular, pectin powder should be thoroughly mixed with sugar to prevent lumps forming and resulting in a weak gel.

Production/preparation

Fruit pulp/juice

It is possible to peel and pulp the fruit and press and filter the juice by hand, but the amount of fruit that can be processed this way in one working day is very low (eg 10-20 half kilogram jars per day). Also, the procedure is both laborious and time consuming and is more prone to contamination as the juice is left lying around for long periods before it is processed. If this is the level of production required, then it is fine to do the whole process manually. However, for a slightly higher and more efficient level of production it is better to use small manual or powered equipment to pulp the fruit and/or express the juice. Juice or pulp contains enzymes and in many fruits these cause rapid browning of the exposed fruit juice or flesh if they are not destroyed or inhibited from acting. The easiest way to control browning is to heat the juice in small batches as it is produced, rather than producing a large amount and storing it for several hours before use. The procedure described under 'batch preparation' and 'boiling' has been found to work very well.

Sugar

If possible, refined, granular, white sugar should be used, but even this sometimes contains small amounts of material (eg black specks) which reduce the value of a preserve. To make a higher quality clearer jam, the sugar should be dissolved in water to make a strong syrup and then filtered through muslin cloth or a fine mesh before it is added to the fruit pulp. It is most important that the filters and pans are thoroughly cleaned each day to prevent insects and micro-organisms from contaminating the equipment.

The strength of the sugar syrup can be easily calculated as follows:

$$\% \text{ sugar} = \frac{\text{weight sugar}}{\text{weight sugar} + \text{weight water}} \times 100$$

So for example a 50% sugar solution (50°Brix) could be made by dissolving 500g sugar in 500ml water.

Pectin

All fruits contain pectin in the skins and to a lesser extent in the pulp. However, the amount of pectin varies with the type of fruit and the stage of maturity. Apples, citrus peels and passion fruit all contain a high concentration of pectin while strawberries and melon contain less. In

general, the amount of pectin in fruit decreases as the fruit matures. Fruits that are high in pectin can be mixed with those that are lower, for example, strawberry and apple, to make a mixed fruit jam.

Although it is possible to make a good preserve using the pectin already in the fruit, a higher quality product can be made by adding commercial pectin powder or solution. This will produce a standardised gel each time and there will be less risk of a batch failing to set. However,

commercial pectin may not be available in all areas or may be too expensive for small scale processors. If this is so, a pectin extract can be made at home from fruits that are naturally rich in pectin.

Making your own pectin solution

Slice the skins of passion fruit, lime, lemon, orange or grapefruit and boil in water for 20-30 minutes. Filter the solution before adding to the fruit pulp. The amount of solution to be added depends on the type of fruit and a number of other factors, and must be found by trial and error.

There are several different types of pectin available, but for preserves, a slow setting type is needed so that the gel forms in the jar during cooling. However, in larger containers (eg 5-10kg jars of jam) or for preserves in which peels or pieces of fruit are suspended in the gel, a faster setting pectin is needed. In both types, the concentration of pectin varies from 0.2-0.7% depending on the type of fruit being used. Pectin is usually supplied as '150 grade' (or 150 SAG) which indicates the ratio of the weight of sugar to weight of pectin that will produce a standard strength of gel when the preserve is boiled to 65% soluble solids. 5 SAG is normally enough to produce a good gel.

How to calculate the amount of pectin to add

Assume the commercial pectin is 150 SAG. This means that if you use 100g of this pectin per 100g jam you would get a pectin strength of 150SAG. This is too strong for jam, which only needs a strength of 5SAG. Therefore the commercial pectin needs to be diluted to 5 SAG, (ie it is diluted 30 times).

Therefore 3.3g (100/30) pectin would be used for every 100g of material.

Acid

Acids are added to fruit juice to bring the pH within the range 3.0-3.3 which is necessary for jam making (pH is a measure of acidity – the lower pH means greater acidity). As the acidity varies in different types of fruit and also in different samples of the same fruit, it may be necessary to check for the correct acidity if different fruits are used. Limes are very acidic and have a pH lower than 3.3. Sodium bicarbonate may need to be added to the fruit juice to reduce the acidity.

The only acids that are allowed to be added to jam are *citric acid*, *tartaric acid* and *malic acid*. In practice citric acid (which is found in lemon juice) is usually used and this is widely available from chemists or pharmacies. If citric acid is not available, lemon juice is often used instead.

Food colours and preservatives

During boiling, fruit pulps and juices usually darken in colour. Some fruits only change a small amount and produce a colour which is still acceptable for jam making. Other fruits darken too much and produce a dark brown preserve which is not very attractive to consumers. Processors may consider adding some artificial colour to these products to improve their appearance. It is better if natural fruit colours can be used – for example, adding dark red fruits or berries can give a more attractive and natural colour to jams. Most consumers prefer to eat preserves that are free from artificial colourings. As a processor, you are likely to get a higher price for products that are more natural and free from colours. If you do need to add colour to your preserve, it is important to check with the local Bureau of Standards to see which colours are allowed in your particular country and the permitted levels.

In most countries, it is illegal to add preservative (such as benzoic acid, sodium or potassium benzoate or sulphur dioxide) to jams. Besides, if the correct recipe is used, good quality assurance procedures are in place, the method is followed accurately and the jam is made under hygienic conditions, it is not necessary to add preservatives to jams. The only exception is in jam that is made from fruit pulp that has been stored with chemical preservatives. In this case, a residue of preservative (either 100ppm sulphur dioxide or 500ppm benzoic acid) is allowed in the jam. Citric acid is not a preservative. It is added to fruit juice to adjust the pH so that the pectin will form a good gel. Jams give a gel when there is the correct ratio of pectin to water and the pH is between 2.5-3.45 pH. The optimum pH to give a good gel is pH 3.0.

Boiling to reach the final sugar concentration

The aim of boiling is to reduce the water content of the mixture and concentrate the fruit and sugar in as short a time as possible. The final Total Soluble Solids (TSS) content of a jam (also known as the “Degrees Brix” or “end-point of the jam”) should be 65 to 68%. (The TSS is a measure of the amount of material that is soluble in water. It is expressed as a percentage - a product with 100% soluble solids, has no water and one with 0% soluble solids is all water).

The correct sugar content is critical for proper gel formation and for preservation of the jam or jelly. If the final TSS of jam is lower than 65-68% the shelf life will be reduced. The jam will have a runny consistency and bacteria and moulds will be able to grow in the product. If the TSS is higher than 68%, the jam will be very stiff and the sugar might start to form crystals in the jam.

The end-point of boiling is measured in different ways. The most accurate method is to use a refractometer to measure the total sugar concentration. This method is not really suitable for home-use as a refractometer costs about US\$ 150. It is only when making jam for sale that you might consider using a refractometer to ensure consistency between different batches of the jam. When making jam for home consumption, you can use other methods to determine the end point: the drop test, the skin wrinkle test, or the use of a jam thermometer to test the temperature (68% sugar corresponds to a jam temperature of 105°C).

When the jam starts to thicken, it is important to test for the end point at frequent intervals. Remember to remove the pan from the heat source while you test or it will continue to thicken and may burn.

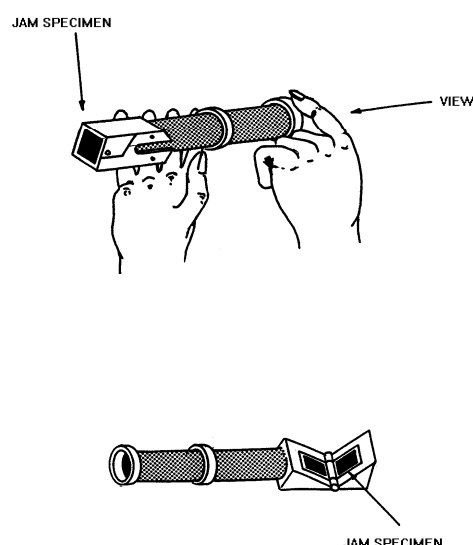
Determination of the end point of a jam

a) Use a refractometer

This is the most accurate method.

Measuring the sugar content with a refractometer

1. Take a small portion of jam from the pan. Let it cool to 20°C. (Remember to take the pan off the heat)
2. Place one or two drops of the jam onto the prism and carefully close the prism. Make sure the sample spreads evenly over the surface of the prism.
3. Hold the refractometer near a source of light and look through the end piece.
4. The line between the dark and light fields will be seen through the viewer. Read the corresponding number on the scale, which is the percentage of sugar in the sample.
5. Open the prism and remove the sample with a piece of tissue paper or wet cotton wool.



b) Use a sugar thermometer

This method is slightly less accurate, but is very useful at the small-scale. A solution of 68% sugar boils at 105°C at sea level. When the boiling jam reaches this temperature, it is at its end point.

After boiling for a few minutes, stir the jam and remove the pan from the heat. Dip the thermometer into hot water and then into the jam. If the thermometer reads 104-105°C, the jam is ready. If it is lower than this, return to the heat and continue to boil. Test the temperature frequently as the jam soon reaches its end point.

Note: At higher altitudes the boiling point decreases and should be adjusted. The end point is about 4.5-5°C above the boiling point of water at any altitude (see table 1 for estimates of the boiling point of water at different altitudes). A sugar thermometer costs about US\$10.

Altitude above sea level		Boiling point of water (°C)	End boiling point of jam (°C)
Ft	m		
0	0	100	105
1000	305	99	104
2000	610	97.9	102.9
3000	915	96.9	101.9
4000	1220	95.8	100.8
5000	1525	94.8	99.8
6000	1830	93.7	98.7

Table 1. Boiling point of water and end point of jam at different altitudes

c) Use the 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.

d) Use 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.

! TIP

You can always cook for a little longer, but you cannot go back if you heat for too long. It is better to take the jam off the heat too early and then re-heat if it is too soft. Test the jam at frequent intervals so you do not miss the end point.

Remember to remove the pan of boiling jam from the heat source while you are doing these tests as the jam will continue to cook and may become over-cooked.

Batch Preparation

The basic ingredients needed to make a batch of jam are sugar, pectin, fruit pulp or juice and acid. As a general rule, equal amounts of fruit and sugar are used to make jam. However, these ratios can be varied according to the type of fruit used and the customers' requirements. Some customers prefer a jam with a high fruit content while others like one with a higher sugar content.

The following tables contain examples of basic combinations of fruit and sugar that can be used with most fruits and a formula to calculate the approximate yield from each recipe.

In general, the maximum amount of fruit that can be used to make a good quality jam is 50% fruit, with 50% sugar (recipe 1) and the minimum amount of fruit that can be used to make a good quality jam is 40% (plus 60% sugar) (recipe 3). There are always exceptions to this general rule. For example, fruits with a high water content such as watermelon use different ratios (see the recipe later on).

From the examples below, it is evident that by increasing the percentage of sugar in the recipe (recipe 3) gives a higher total yield of jam for the same amount of fruit. This is a useful tool for calculating your daily production levels and for determining the technical and financial feasibility of your business.

Recipe 1. Proportions of ingredients for high quality jam

Recipe 1. fruit:sugar =50:50 Desired Brix in final product =68%	Yield = $11.115 \times 100 / 68 = 16.4 \text{ kg}$
Ingredients	Soluble Solids (SS)
10kg fruit at 10% TSS	1.000 kg
10kg sugar	10.000kg
60g pectin (grade 200)	0.060 kg
55g citric acid	0.055 kg
Total Soluble Solids	11.115 kg

Recipe 2. Proportions of ingredients for medium quality jam

Recipe 2. fruit:sugar =45:55 Desired Brix in final product =68%	Yield = $13.325 \times 100 / 68 = 19.6 \text{ kg}$
Ingredients	Soluble Solids (SS)
10kg fruit at 10% TSS	1.000 kg
2.5 litre water	
12.2 kg sugar	12.200kg
65g pectin (grade 200)	0.065 kg
60g citric acid	0.060 kg
Total Soluble Solids	13.325 kg

Recipe 3. Proportions of ingredients for lower quality jam

Recipe 3. fruit:sugar =40:60 Desired Brix in final product =68%	Yield = $16.165 \times 100 / 68 = 23.8 \text{ kg}$
Ingredients	Soluble Solids (SS)
10kg fruit at 10% TSS	1.000 kg
3.3 litre water	
15kg sugar	15.000kg
85g pectin (grade 200)	0.085 kg
80g citric acid	0.080 kg
Total Soluble Solids	16.165 kg

Process outline

Fruit selection and preparation

Wash the fruit in clean water, peel it and remove stones and damaged parts. Chop large fruits into smaller pieces. The fruit should be as fresh as possible and slightly under-ripe. Over-ripe and/or bruised fruit will not make good jam as it has low levels of pectin and/or acid; in this case, the jam will not set.

Preparation of pectin

Thoroughly mix the pectin powder with 5 times its weight of sugar, taken from the total sugar allowance for the recipe. This allows the pectin to fully dissolve in the fruit mix without forming lumps.

Preparation of the bottles and lids

Wash the glass 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. Let the water 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 plastic jars they cannot be sterilised by heating like this. If the jars are new and unopened, do not open them until they are needed. If the jars are recycled, wash them thoroughly in chlorinated water (100ppm). Stand upside down and leave to drain well. Do not dry them with a dirty cloth.

Extraction of juice (jelly making) or preparation of pulp (jam making)

Jelly making

To make a jelly, the fruit should be softened into a pulp to allow the juices to run

- Place the washed fruit in a pan and heat over a low heat to soften the fruit and allow the juice to be released. Add a little water to prevent the fruit burning or sticking to the bottom of the pan. Do not add too much water because you need to remove it all later during the boiling stage.
- Transfer the softened fruit to a jelly bag (a bag made from muslin cloth that is tied and suspended above a bowl into which the fruit juice drips). Allow the juice to drip out from the cloth - this may take overnight. Make sure that the juice cannot be contaminated by insects and dust while it is dripping. Do not squeeze the bag as this makes the juice cloudy.
- Measure the volume of juice extracted. Weigh out the sugar (you should have equal amounts of juice and sugar) and add it to the juice.

For jam making

To make jam, the fruit also needs to be softened into a pulp

- Place the washed fruit in a pan and heat over a low heat to soften the fruit and allow the juice to be released. Some fruits will need a little water to be added at this stage to prevent the fruit burning or sticking to the bottom of the pan. Do not add too much water because you need to remove it all later during the boiling stage.
- When the fruit has all softened and there is juice in the pan, add the sugar and continue to heat gently until all the sugar has dissolved.

Adding pectin and citric acid

- Mix together the sugar/pectin mixture and fruit juice or pulp and adjust the pH to 3.3-3.6 using citric acid. Make a note of how much citric acid you add so that next time you make this particular recipe you can just weigh out the ingredients. You will need a pH meter or pH indicator strips to do this the first time you make the particular recipe.

- For marmalade (which contains strips of peel), or jams which contain fruit pieces, it is necessary to soak the peel or fruit for 2-3 days in a concentrated (60%) sugar solution. This causes the peel or fruit to achieve the same density as the preserve and, as a result, it is evenly distributed through the jar and does not float to the surface.

Boiling

Pour the batch into a stainless steel boiling pan and heat as quickly as possible with constant stirring to prevent the product burning onto the pan. Use a large pan as this will allow the water to evaporate more quickly and reduce the time needed for boiling. This saves on fuel and time needed for production and also produces a better coloured preserve.

It is important to use stainless steel to prevent the acids in the preserve reacting with the pan and causing off-flavours. However, if this is not available, a large clean pan can be used.

Filling and packaging

In many countries there are laws concerning the weight of food sold in a package and accurate filling to the correct weight is therefore important. The weight, cleanliness of the container and appearance of the product after filling should be routinely checked. In particular it is important to avoid getting preserve around the rim of the jar as this may prevent a vacuum forming, and will look unsightly and attract insects.

Cool the jam to about 85°C and pour into the hot sterilised jars. The jars should be hot when they are filled or they may crack. If the jam is hotter than 85°C, condensation will form under the lid. This can drop down onto the surface of the jam and dilute it, which may subsequently allow mould to grow on the surface of the jam during storage. If the jam is colder than this, it will be difficult to pour. Fill the jars to about 9/10ths of their volume. Place the clean lids onto the jars, fasten them loosely and invert the jars to sterilise the lid with the hot jam.

If you are using plastic jars, leave the jam to cool to about 80°C before you pour into the jars. If the jam is hotter than this it may cause the plastic bottle to melt and become misshapen. Do not cool too much though or the jam will be difficult to pour.

The packaging is likely to be one of the main costs involved in production. Ideally glass jars should be used with new screw-on metal lids. Metal cans are also suitable but very expensive. Cheaper alternatives include plastic (PVC) bottles or plastic (polythene) sachets. However, these cannot be filled with hot jam as they will soften or melt. Technical advice should be sought from the supplier if these packs are being considered. Plastic jars are less expensive than glass, but the preserve will have a shorter shelf life than glass packaging.

It is possible to use paper, polythene, or cloth tied with an elastic band or cotton, to cover the jam jars. However, the appearance of the product is less professional and there is a risk of contamination by insects. This is not recommended unless metal lids are impossible to obtain.

Finally, the jars are held upright and the gel is formed during cooling. This can be done by standing the jars on shelves, or more quickly using a low cost water cooler. A partial vacuum should form between the surface of the jam and the lid when the product cools. This can be seen by a slight depression in the lid. If a vacuum does not form it means that the jar is leaking or the temperature of filling is too low.

Storage

Jams and jellies that are made according to the correct recipe will have a long shelf life. Jam stored in glass jars will have a longer storage life (up to 12 months) than those packed in plastic bottles (up to 4 months). For the optimum storage time, jams should be stored in a cool dry place, away from direct sunlight.

Jam Making - equipment required

Sharp stainless steel knife
Accurate weighing scales (large (up to 10kg) and small (to weigh g)
Plastic bowls
Jelly bags
Juice extractor
Mesh strainer and sieves
pH meter or pH paper (optional)
Cooker or stove
Boiling pan (stainless steel or aluminium)
Aluminium or enamelled pan for sugar syrup
Spoons for measuring
Wooden spoon for stirring
Sugar thermometer (if available)
Refractometer (if available)
Jars and lids
Jar filler and capper
Labels

Jam recipes

The following recipes have all been tried and tested. You can vary the total amounts made and substitute other fruits, but always need to use the same proportions of ingredients.

Watermelon jam

Ingredients

Water melon	115kg
Sugar	55kg
Ginger	0.9kg
Citric acid	0.47kg
Pectin	0.66kg

Selection and preparation of fruit

Choose fully ripe watermelons that have a soft red flesh. Watermelons contain little natural pectin so pectin has to be added to ensure the jam will have a good set. Citric acid is also needed to increase the acidity of the juice (to pH 2.5 - 3.45). The yield of usable fruit from the whole fruit is approximately 43%.

Wash the fruit in clean water and discard any bad part of the fruit.

Remove the skin from the melon, cut the flesh into small pieces and remove the seeds. Mash the pieces into a pulp and strain through a muslin cloth.

Method

Mix the pectin with a small portion of the sugar. This is necessary because pectin powder is very difficult to dissolve in water as it clumps together. If it is still a problem to dissolve, grind the sugar to a fine powder and then mix it with the pectin.

Mix the fruit juice, sugar, citric acid and green ginger in a stainless steel saucepan and start boiling the mixture. Near the end of the boiling process add the pectin and sugar mix. (The pectin should not be heated for longer than necessary because it will be broken down and then the jam will not set).

Jam should not be boiled for more than 12-15 minutes as this can lead to the development of caramel flavours, over sweetness and discolouration, apart from being a waste of energy. By reducing the amount of water in the starting recipe the boiling time can be reduced. The 'end point' is reached when the total soluble solids is up to 70%, which is measured with a refractometer. In most countries the legal minimum sugar levels in jam, are 65% for jam in hermetically sealed containers, and 68.5% for jam in non air tight containers. Jam with a final sugar content of over 70% sugar will start to form crystals in the jam during storage. The 'end point' is usually reached around 106-108°C (depending on barometric pressure and height above sea level).

When the 'end point' has been reached the jam should be filled into clean sterilized jars which have been cleaned and then steamed to sterilise them, and are still hot so that the jars do not crack. The jars should be filled as quickly as possible so that the jam is not heated for longer than necessary, or recontaminated because it has cooled down before being sealed in the jar.

The lip of the jar should be clean and dry (wipe with clean tissue paper) before placing the lid on it. The filled jars can be placed in water to cool down the jam so that it does not keep cooking in the jar, the water level should be kept below the lid of the jar. The gel formation takes place as the temperature comes down to around 55°C, if the jam is moved when the gel is forming the gel structure will be broken and the jam will not set.

Apricot jam

Ingredients (to make 2.4kg jam):

1.5kg fresh apricots
1.5kg sugar
300ml water

Preparation of the fruit

Sort the fruit and discard any unripe, over-ripe or damaged fruit.
Wash in clean water and leave to drain
Cut the fruit in half and remove the stone. Cut the pieces in half again if preferred.
Weigh the prepared fruit and place in a large cooking pan with the water.

Heat treatment and addition of sugar

Cook over a medium heat until the fruit has softened and the volume has reduced by one third.
Stir with a wooden spoon to prevent burning at the bottom of the pan.
Add the sugar and stir until it has all dissolved
Turn up the heat and boil rapidly until the product reaches its end point (use a refractometer if available. If not use a jam thermometer, the drop test or the wrinkle test).

Filling and packaging

Cool the jam to about 85°C and pour into the hot sterilised jars. The jars should be hot when they are filled or they may crack.

Fill the jars to about 9/10ths of their volume. Place the clean lids onto the jars, fasten them loosely and invert the jars to sterilise the lid with the hot jam.

If you are using plastic jars, let the jam cool to about 80°C before pouring into the jars.

Carrot and lemon jam

Ingredients (to make 5.7-6.4kg jam):

2-4kg carrots
4-8 medium size lemons (including 35ml lemon juice)
3.5kg sugar
Water (about 1200ml per kg grated carrot)

Preparation of the fruit

Choose carrots that are all of a similar size and maturity.
Peel the skin and cut off the green stalk residue.
Cut lengthwise into 3-6mm strips and then cut the strips in half or into quarters; or grate using a cheese grater.
Weigh the grated carrot and place in a pan.
Wash the lemons and cut into thin slices. Remove the pips.
Cut the lemon rind into thin strips without removing the white part. Add the strips of rind, the pulp and the lemon juice to the carrots. Add enough water to cover the carrots.

Preparation of the jars and lids

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.
Let the water 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.

Heat treatment and addition of sugar

Cook the carrots with the lemon and water over a low heat for 60-90 minutes to soften the carrots. Stir with a wooden spoon to prevent burning at the bottom of the pan.
When the carrot pieces disintegrate and become transparent and the lemon rind strips are soft, add one third (1.2kg) of the total sugar and dissolve rapidly. Continue cooking on a medium fire for 10 minutes.
Add the remaining sugar (2.3kg) and dissolve rapidly. Boil on a high fire until the mixture sets (use a refractometer if available, a jam thermometer or the drop test). Stir with a wooden spoon to prevent burning.

Filling and packaging

Cool the jam to about 85°C and pour into the hot sterilised jars. The jars should be hot when they are filled or they may crack.
Fill the jars to about 9/10ths of their volume. Place the clean lids onto the jars, fasten them loosely and invert the jars to sterilise the lid with the hot jam.
If you are using plastic jars, let the jam cool to about 80°C before pouring into the jars.

Cherry jam

Ingredients (to make 2.3kg jam):

1.8kg stoned cherries
Juice of 3 lemons (about 135ml or 9tbsp)
1.4kg sugar

Preparation of the fruit

Wash the cherries and drain well.
Remove the stones from the centre.
Either leave the cherries whole (minus the stone) or cut into half or quarters
Crack a few of the cherry stones and remove the kernels (optional step).
Weigh the cherries and place in a pan together with the lemon juice and kernels.

Preparation of the jars and lids

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.
Let the water 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.

Heat treatment and addition of sugar

Cook over a low heat for about 45 minutes until the cherries are soft. Stir with a wooden spoon to prevent burning at the bottom of the pan.
Remove from the heat. Add the sugar and stir until it is dissolved.
Bring to the boil. Boil rapidly for about 30 minutes until the jam is set (use a refractometer if available, a jam thermometer or the drop test). Stir with a wooden spoon to prevent burning.

Filling and packaging

Cool the jam to about 85°C and pour into the hot sterilised jars. The jars should be hot when they are filled or they may crack.
Fill the jars to about 9/10ths of their volume. Place the clean lids onto the jars, fasten them loosely and invert the jars to sterilise the lid with the hot jam.
If you are using plastic jars, let the jam cool to about 80°C before pouring into the jars.

Apple jam

Ingredients (to make 1kg jam):

1.4kg apples (peeled and cored)

1.4kg sugar

50ml lemon juice

1tsp cinnamon powder (optional) or cardamom powder according to personal taste

200-400ml water

Preparation of the fruit

Sort the fruit. Remove under-ripe, over-ripe and rotten apples.

Wash the apples, peel them and remove the core.

Slice the apples finely and place in a large saucepan with enough water to prevent the fruit from burning on the base of the pan (do not add too much water as you will need to cook for longer to remove the excess).

Preparation of the jars and lids

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.

Let the water 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.

Heat treatment and addition of sugar

Cook the apples over a low heat for about 15-20 minutes until the apples are soft. Add the lemon juice, sugar and cinnamon or cardamom if you are using it. Keep over a low heat until the sugar had dissolved. Turn up the heat to high so that the mixture boils. Stir continuously to prevent the jam burning.

Boil rapidly for about 30 minutes until the jam is set (use a refractometer if available, a jam thermometer, or the drop test or wrinkle test). Stir with a wooden spoon to prevent burning. If any foam rises to the surface of the jam during boiling, scoop it off with the spoon to remove it.

Filling and packaging

Cool the jam to about 85°C and pour into the hot sterilised jars. The jars should be hot when they are filled or they may crack.

Fill the jars to about 9/10ths of their volume. Place the clean lids onto the jars, fasten them loosely and invert the jars to sterilise the lid with the hot jam.

If you are using plastic jars, let the jam cool to about 80°C before pouring into the jars.

Apple jelly

Ingredients: (to make 0.8-1.0kg jelly)

1.8kg apples

1200ml water

Stick of cinnamon, a few cloves or cardamon (optional)

500g sugar per 500ml juice obtained

Selection and preparation of the fruit

Sort the fruit. Remove any rotten or bruised apples. Wash well.

Cut the apples into quarters but do not remove the skin or core (most of the pectin is contained in the apple skin). Make sure you cut out any bad pieces of apple.

Preparation of the jars and lids

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.

Let the water 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.

Heat treatment

Put the fruit in a large pan with the water. Tie the cinnamon or cloves in a piece of muslin and add that to the pan.

Cook over a low heat until the fruit is soft and pulpy. Remove the bag of spices.

Juice extraction

Place the pulp in a jelly bag (a piece of clean muslin cloth that is suspended over a bowl). Leave to strain overnight. Make sure that the dripping juice is in a clean place where it cannot be contaminated by flies and dust. Do not squeeze the bag to extract the juice as this makes the juice cloudy.

Measure the juice into a large pan.

Heat treatment and addition of sugar

Heat the juice gently in a pan. Add the sugar (500g per 500ml juice) and stir until the sugar has dissolved.

Turn up the heat and boil the mixture rapidly until the jam is set (use a refractometer if available, a jam thermometer, the drop test or the wrinkle test). Stir with a wooden spoon to prevent burning. Remove any foam from the surface of the jam with a wooden spoon.

Filling and packaging

Cool the jam to about 85°C and pour into the hot sterilised jars. The jars should be hot when they are filled or they may crack.

Fill the jars to about 9/10ths of their volume. Place the clean lids onto the jars, fasten them loosely and invert the jars to sterilise the lid with the hot jam.

If you are using plastic jars, let the jam cool to about 80°C before pouring into the jars.

Equipment suppliers

Note: This is a selective list of suppliers and does not imply endorsement by Practical Action

Cutting and slicing equipment

A range of manual and powered cutting and slicing machinery is available.

Eastend Engineering Company

173/1 Gopal Lal Thakur Road
Calcutta 700 035
India
Tel: +91 33 2553 6397

Gardners Corporation

158 Golf Links
New Delhi 110003
India
Tel: +91 11 2334 4287/2336
3640 Fax: +91 11 2371 7179

Narang's Corporation

P-25 Connaught Place
New Delhi 110001
India
Tel: +91 11 2336 3547
Fax: +91 11 2374 6705

Juice filters, strainers and sieves

A range of filtering and straining equipment can be used. The simplest is the filter bag (or jelly bag) made of terylene or muslin cloth. More sophisticated are the filter presses and strainers which may be mechanised.

Gauthier

Parc Scientifique Agropolis
34397 Montpellier
Cedex 5
France
Tel: +33 4 67 61 11 56
Fax: +33 4 67 54 73 90

Alvan Blanch

Chelworth
Malmesbury
Wiltshire
SN16 9SG
United Kingdom
Tel: +44 (0) 666 577333
Fax: +44 (0) 666 577339
E-mail: info@alvanblanch.co.uk
Website: <http://www.alvanblanch.co.uk>

Lakeland Mail order kitchenware

38 Alexandra Buildings
Windermere
LA23 1BQ
United Kingdom
Tel: +44 (0)15394 88100
Website: www.lakeland.co.uk

Gardners Corporation

India (see above)

Weighing machines

It is important to have accurate weighing machines. Quite often more than one machine is required - a large one to weigh the fruit and a small one for weighing out the dry ingredients such as pectin and spices.

Fisher Scientific

Bishop Meadow Road
Loughborough
LE11 5RG
UK
Tel: +44 1509 231166
Fax: +44 1509 231893
Email: fisher@fisher.co.uk
Web: www.fisher.co.uk

Alvan Blanch

UK (see above)

Lakeland

UK (see above)

Gardners Corporation

India (see above)

Essae-Teraoka Ltd377/22 6th Cross Wilson Garden

Bangalore 560027

India

Tel: +91 80 2216185/2241165

Narangs Corporation

India (see above)

Juice extractors and pulpers

A variety of juice extractors and pulpers is available from a wide range of suppliers. They are available in different capacities and either manual or powered (either electric or diesel).

Kenwood Limited

New Lane

Havant

Hampshire

PO9 2NH

United Kingdom

Tel: +44 (0) 23 9247 6000

Fax: +44 (0) 23 9239 2400

Website: <http://www.kenwood.co.uk>**Alvan Blanch**

UK (see above)

Lehman Hardware and Appliances Inc.

P.O. Box 41

Kidron

Ohio 44636

USA

Tel orders: +1 877 438 5346

Tel enquiries: +1 888 438 5346

E-mail: info@lehmans.comWebsite: <http://www.lehmans.com>**Robot Coupe**

12 Avenue Cal Leclerc

BP 134

71303 Montceau-les-Mines

France

Tel: +33 3 85 58 80 80

DISEG (Diseno Industrial y Servicios Generales)

Av Jose Carlos Mariategui 1256

Villa Maria del Triunfo

Lima

Peru

Tel: +51 14 283 1417

Servifabri SA

JR Alberto Aberd

No. 400 Urb Miguel Grau (ex Pinote)

San Martin de Porres

Lima

Peru

Tel: +51 14 481 1967

Bajaj Machine Private Limited

7/20, 7/27, Jai Lakshmi Industrial Estate,

Side-IV

Sahibabad Industrial Area

Ghaziabad-201301

U.P

India

Tel: +91 120 22775119/22775137

Fax: +91 120 22775137

Website: www.indiamart.com/bajajmachine**Buhler (India) Pvt Ltd**

13-D, K A I D B Industrial Area, Attibele

Bangalore

Karnataka 562107

India

Tel: +91 80- 27820000

Fax: +91 80-7820001

Website: www.buhlergroup.com**Delhi Industries**

4 Paharganj Lane,

New Delhi 110055

India

Tel: +91 11 2529720, 27525200,

27536888

Fax: +91 11 25791291

Do-All-Engineering Industries

87/12, Industrial Suburb, Yeshawanthpur
Bangalore
Karnataka 560022
India
Tel: +91 80 23345754, 23372298
Fax: +91 80 23346138

Eastend Engineering Company

India (see above)

Florachem

Flat No. 1119, Hemkunt Chambers, 89,
Nehru Place
New Delhi 110019
India
Tel: +91 11 25589502

Gardners Corporation

India (see above)

Food Packs Indiana

Thrikkariyoor, Kothamangalam, Ernakulam
Kerala 686692
India
Tel: +91 485-2522134, 2523610

Geeta Food Engineering

Plot No C-7/1 TTC Area
Pawana MIDC Thane Belapur Road
Behind Davita Chemicals Ltd
Navi Mumbai 400 705
India
Tel: +91 22 2782 6626/2766 2098
Fax: +91 22 2782 6337

Narangs Corporation

India (see above)

For boiling

Boiling pans should be made of aluminium, enamelled metal or stainless steel. For larger quantities it is necessary to buy equipment which does not cause burning or sticking of the product to the bottom of the pan. Stainless steel steam jacketed kettles, which are double walled pans are suitable for boiling large quantities of jam and are available in a range of sizes (from 5 to 500 litres).

Gardners Corporation

India (See above)

Alvan Blanch

United Kingdom (See above)

Praj Industries Ltd

Praj House Bavdhan
Pune, Maharashtra 411021
India
Tel: +91 20-22951511, 22952214
Fax: +91 20-22951511 / 22952214
Website: www.praj.net

Techno Equipments

Saraswati Sadan
1st Floor, 31 Parekh Street
Mumbai 400004
India
Tel: +91 22 2385 1258

Kundasala Engineers

Digana Road
Kundasala
Kandy
Sri Lanka
Tel: +94 8 420482

Udaya Industries

Uda Aludeniya, Welligalla
Gampola
Sri Lanka
Tel: +94 8 388586
Fax: +94 8 388909

Mark Industries (Pvt) Ltd

348/1 Dilu Road
Mokbazar
Dhaka 1000
Bangladesh
Tel: +880 2 9331778/835629/835578
Fax: +880 2 842048
Email: markind@citechco.net

HRS Process Systems Pvt Ltd

Asia Division, Praj House,
Bavdhan, Pune
Maharashtra 411021 India
Tel: +91 20- 22951511
Fax: +91 20- 22951718
Website: www.hrsasia.co.in

Raylons Metal Works

Kondivita Lane
J. B. Nagar Post Office
Post Box No. 17426
Andheri (E) Andheri - Kurla Road,
Mumbai - 400 059
India
Tel: +91 22 26323288 / 6325932

Sri Rajalakshmi Commercial Kitchen Equipment

No.57, (old No. 30/1) Silver Jubilee Park
Road
Bangalore - 560 002
India
Tel: +91 (0)812 2222 1054/223 9738
Fax: +91 (0)812 2222 2047

United Engineering (Eastern) Corporation

Shantiniketan Site No.2 & 3
(10th Floor) 8 Camac Street
Kolkata, West Bengal 700017
India
Tel: +91 33-22823914, 22820157
Fax: +91 33-22823742

Israel Newton Limited

Summerley Works
All Alone Road
Bradford
West Yorkshire BD10 8TT
United Kingdom
Tel: +44 (0)1274 612059
Fax: +44 (0)1274 612059

APV Baker Limited

Manor Drive
Paston Parkway
Peterborough
Cambridgeshire
PE4 7AP
United Kingdom
Tel: +44 (0)1733 283000

T Giusti and Son Limited

Rixon Road, Finedon Road Industrial
Estate
Wellingborough,
Northamptonshire NN8 4BA
United Kingdom
Tel: + 44 (0)1933 229933
Fax: + 44 (0)1933 272363
Website: www.giusti.co.uk

Bottle filling and packaging equipment**H Erben Limited**

Lady Lane
Hadleigh
Suffolk
IP7 6AS
United Kingdom
Tel: +44 (0)1473 823011
Fax: +44 (0)1473 828252
Website: <http://www.erben.co.uk>

Acufil Machines

S. F. No. 120/2, Kalapatty Post Office
Coimbatore - 641 035
Tamil Nadu, India
Tel: +91 422 2666108/2669909
Fax: +91 422 2666255
Email: acufilmachines@yahoo.co.in,
acufilmachines@hotmail.com
Website: www.indiamart.com

Sussex and Berkshire Machinery Company PLC

Blacknest
Alton, Hants GU34 4PX
United Kingdom
Tel: + 44 (0)1420 22669
Fax: + 44 (0)1420 22687
E-mail: technical@sabplc.uk
Website: <http://www.sabplc.co.uk/>

Autopack Machines Pvt Ltd

101-C Poonam Cambers
A Wing, 1st Floor
Dr Annie Besant Road, Worli
Mumbai 400018
India
Tel: +91 22 2493 4406/2497
4800/2492 4806
Fax: +91 22 2496 4926
E-mail: autopack@bom3.vsmil.net.in
Website: www.autopackmachines.com

technical brief

Bombay Engineering Industry

R NO 6 (Extn) Sevantibai Bhavan
Chimatpada
Marol Naka Andheri (East)
Mumbai 400059
India
Tel: +91 22 2836 9368/2821 5795
Fax: +91 22 2413 5828

Eastend Engineering Company

India (See above)

Gardners Corporation

India (see above)

Gurdeep Packaging Machines

Harichand Mill compound
LBS Marg, Vikhroli
Mumbai 400 079
India
Tel: +91 22 2578 3521/577 5846/579
5982
Fax: +91 22 2577 2846

MMM Buxabhoj & Co

140 Sarang Street
1st Floor, Near Crawford Market
Mumbai, India
Tel: +91 22 2344 2902
Fax: +91 22 2345 2532
yusufs@vsnl.com; mmmb@vsnl.com;
yusuf@mmmb.in

Narangs Corporation

India (see above)

Orbit Equipments Pvt Ltd

175 - B, Plassy Lane
Bowenpally
Secunderabad - 500011, Andhra Pradesh
India
Tel: +91 40 32504222
Fax: +91 40 27742638
Website: <http://www.orbitequipments.com>

Pharmaco Machines

Unit No. 4, S.No.25 A
Opp Savali Dhaba, Nr.Indo-Max
Nanded Phata, Off Sinhagad Rd.
Pune - 411041, India
Tel: +91 20 65706009
Fax: +91 20 24393377

Rank and Company

A-p6/3, Wazirpur Industrial Estate
Delhi - 110 052
India
Tel: +91 11 27376101
Fax: +91 11 7234126
Rank@poboxes.com

Mark Industries (Pvt) Ltd

Bangladesh (See above)

Alfa Technology Transfer Centre

301 Cach Mang Thang 8
Tan Binh District
Ho Chi Minh City
Vietnam
Tel: +84 8 9700868
Fax: +84 8 8640252

**Technology and Equipment Development
Centre (LIDUTA)**

360 Bis Ben Van Don St
District 4
Ho Chi Minh City
Vietnam
Tel: +84 8 9400906
Fax: +84 8 9400906

Banyong Engineering

94 Moo 4 Sukhaphibaon No 2 Rd
Industrial Estate Bangchan
Bankapi
Thailand
Tel: +66 2 5179215-9

John Kojo Arthur

University of Science and Technology
Kumasi
Ghana
Alvan Blanch
UK (see above)

technical brief

Refractometers

The refractometer is used to measure the sugar content.

Bellingham + Stanley Ltd.

Longfield Road, North Farm Industrial Estate
Tunbridge Wells, Kent TN2 3EY
United Kingdom
Tel: +44 1892 500400
Fax: +44 1892 543115
E-mail: sales@bs-ltd.com
Website: <http://www.bs-ltd.com>

Gardners Corporation

India (see above)

International Ripening Company

1185 Pnieridge Road
Norfolk
Virginia 23502-2095
USA
Tel: +1 757 855 3094
Fax: +1 757 855 4155
Email: info@QAsupplies.com
Web: www.qasupplies.com

References and further reading

Practical Action Technical Briefs:

[Passion fruit jam](#)
[Lime marmalade](#)
[Pineapple jam](#)
[Strawberry jam](#)
[Watermelon jelly](#)
[Food labelling](#)
[Fruit waste utilisation](#)
[Juices and Drinks](#)
[Snack Foods](#)

[*Technical manual on small-scale processing of fruits and vegetables*](#), Food and Agriculture Organization of the United Nations (FAO)

[*Setting up and Running a Small Fruit or Vegetable Processing Enterprise: Opportunities in Food Processing*](#) CTA

[*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

[*Fruit and Vegetable Processing*](#) UNIFEM Practical Action Publishing, 1993

This document was produced by Dr. S Azam Ali for Practical Action March 2007. 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.

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Practical Action is a development charity with a difference. We know the simplest ideas can have the most profound, life-changing effect on poor people across the world. For over 40 years, we have been working closely with some of the world's poorest people - using simple technology to fight poverty and transform their lives for the better. We currently work in 15 countries in Africa, South Asia and Latin America.