JAM

Food and Agriculture Organization of the United Nations

JAM

1.- General information

Classification

- JAM -

A solid gel made from the pulp of a single fruit or mixed fruits. The fruit content must be at least 40%. In mixed fruit jams the first-named fruit must be at least 50% of the total fruit. The total sugar content must be no less than 68%. In tropical climates, 70% sugar is preferable.

- JELLY-

A crystal clear jam, made from filtered fruit juice rather than fruit pulp.

- MARMALADE-

Usually produced from citrus fruits and has fine shreds of peel suspended in the gel. The fruit content should not be less than 20% and the sugar content is similar to jam.

2.- Processing details for jam and marmalade production

Suitability for small-scale production

Jams, jellies and marmalades are increasing in importance in many countries, particularly in wealthy urban areas..

When made properly, jams and marmalades are safe products due to the high acid and sugar content.

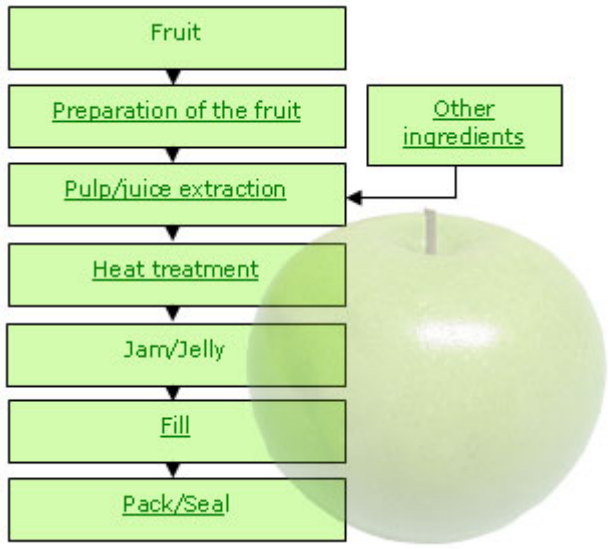
It is essential that a survey is carried out to determine the potential market for the product before starting on production. A successful business depends on a good market for the prodcut. Too often, small-scale processors decide to make jam because there is an abundant supply of raw material, with no evaluation of the demand for the product.

Constraints to production

Preserves require a large quantity of sugar. In many cases, refined white sugar has to be bought from urban centres and may be expensive.

The availability of fruits is seasonal. Fruits must be semi-processed and stored for use later in the season, or a sequence of fruits should be used to allow year-round production.

A high working capital is needed to purchase fruits in mid-season when the prices are low.



2.1.-Preparation of the fruit

Fruit should be washed in clean water, peeled and the stones removed. 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.

The jam will not set. 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 sugar and fruit and a smaller set for pectin and citric acid.

2.2.-Pulp/Juice Extraction

To produce a clear juice for jelly, the juice should be filtered using a muslin cloth bag. The pH of the juice or pulp should be 3.0 to 3.3. It is measured using a pH meter and adjusted by adding citric acid or sodium bicarbonate (if the acidity is too high, for example with limes). Pectin is added to the pulp at this stage. Follow the instructions on the package.

2.3.- Added Ingredients

Pectin

Pectins are naturally present in fruits. Some fruits contain higer levels than others. The richest sources are citrus peels, passion fruit and apple. Strawberries and melon contain low levels. In general, the pectin level decreases as the fruit matures. Low-pectin fruits are often mixed with high pectin fruits to achieve the correct level. Pectin is needed to make the fruit set into a gel.

Although it is possible to get a good preserve using the pectin in the fruit, it is better to buy pectin powder or solution and add a known amount to the fruit juice or pulp. This will produce a standardised gel each time and there will be less risk of a batch failing to set.

Pectin can be bought, either as a light brown powder or a dark liquid concentrate. It is usually supplied as '150 grade' (or 150 SAG) which indicates the ratio of the weight of sugar to pectin that will give a standard strength of gel when the preserve is boiled to 65% soluble solids. 5 SAG is normally enough to produce a good gel.

There are two main types of pectin

- high methoxyl (HM)

- low methoxyl (LM).

High methoxyl pectins form gels in high solid jams (above 55% solids) and in a pH range 2.0-3.5.

Low methoxyl pectins do not need sugar or acid to form a gel, instead they use calcium salts. LM pectins form a gel with a wide range of solids (10-80%) within a broad pH range of 2.5-6.5.

Pectins may be either slow or fast setting. For most preserves a slow setting type is needed so it can set in the jar. If pieces of fruit are suspended in the gel, or if large volumes of jam are being made, a fast 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.

2.4.-Heat Treatment

There are two stages of heating. First, the fruit should be heated gently to soften the flesh and extract the pectin. This is followed by rapid boiling to evaporate the water until the final sugar content is reached. The end-point of boiling is measured using a refractometer (this measures the sugar concentration). A jam thermometer can also be used to assess the end point, but this is less accurate than using a refractometer.

2.5.-Filling

The jars should be clean and sterilised. The ideal temperature for pouring is 82-85°C. Hotter than this and condensation will form under the lid. This will drop down and dilute the jam, allowing mould to grow. Colder than this and the jam will be difficult to pour. Containers should be filled to about 9/10ths of their volume.

2.6.-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.

General

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

3.- Preparation of 5 SAG pectin working solution

30g of 150 SAG pectin

150g sugar

720ml water

- Mix the pectin and sugar thoroughly.

- Heat the water to 70-75°C and slowly add the sugar/pectin, mix with constant stirring.

  If a small elecTRic stirrer is available there will be less chance of lumps forming.

- Heat to boiling and boil for 1 minute, again with constant stirring.

- Hold at 50-60°C (a double saucepan is useful here).

sugar	Sugar has two main roles: to set the preserve and to prevent microbial spoilage. The final concenTRation has to be high enough (>68%) to prevent fermentation by moulds or yeasts, but low enough (<72%) to prevent crystallisation.			
	Refined, granular, white sugar should be used, but even this will often contain small amounts of material (eg black specks) which reduce the value of a preserve. The sugar should be dissolved in water to make a sTRong syrup and then filtered through muslin cloth or a fine mesh.			
	The sTRength of the sugar syrup can be easily calculated as follows:	% sugar =	weight sugar ——————— weight sugar + weight water	*100

4.- Calculation of yield

Acid

The fruit must have a high level of acidity (pH 3.0-3.3) to enable the pectin to form a gel. This is not a problem with most fruits but melon, papaya and banana are all low-acid fruits that need citrus juice or citric acid to be added.

Citric acid, malic acid or tartaric acid are added to adjust the pH of the fruit pulp to 3.0-3.3. Citric acid is usually used as this one is most widely available.

$$\text{Total yield} = \frac{\text{Total soluble solids (TSS) of raw materials}}{\text{Percentage of total soluble solids in final product}} * 100$$

5.- Determination of total and subtotal

Determination of total soluble solids

The soluble solids content of a solution is determined by the index of refraction. This is measured using a refractometer, and is referred to as the degrees Brix. It is widely used during fruit and vegetable processing to determine the concentration of sugar in the products.

Sugar concentration is expressed in degrees Brix. At 20°C, the Brix is equivalent to the percentage of sucrose (sugar) in the solution (60° Brix is equivalent to a sugar content of 60%). The measurement must be made at 20°C to get an accurate value.

Measurement of degrees brix

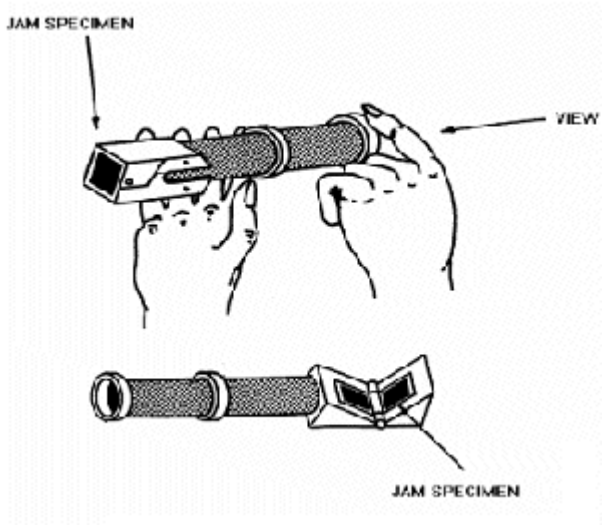
1. Ensure the solution is at a temperature of 20°C.

2. Place one or two drops of sample onto the prism and close the prism carefully. The sample should be evenly spread over the surface of the prism.

3. Hold the refractometer near a source of light and look though the field of vision.

4. The line between the dark and light fields will be seen in the field of vision. Read the corresponding number on the scale. This is the percentage of sugar in the sample.

5. Open the prism and remove the sample with a piece of paper or clean wet cotton.



6.- Making

A.-Lime marmalade

Reference: ITDG Technical Brief, Lime marmalade

1 litre lime juice

20g sodium bicarbonate

3kg sugar

1200g 5SAG pectin (made from 40g pectin, 200g sugar and 960ml water)

few drops green food colour

200g sugared lime peel shreds

1. Marmalade is made according to the basic jam/marmalade method. However, there are a few quality assurance points that must be observed:

2. Limes have a very high level of acidity (pH 2.7- 2.9) which means that they need to be treated differently to most other fruits.

3. Fruit preserves need a pH of between 3.0 and 3.3 to enable the pectin to make a strong gel. Therefore the pH of lime juice has to be increased by adding sodium bicarbonate (baking powder).

4. The amount of sodium bicarbonate added varies according to the variety and acidity of the lime. The acidity is measured using a pH meter if one is available. If one is not available, then a series of tests must be carried out to find the correct amount of sodium bicarbonate to add to make a good gel. About 20g sodium bicarbonate per litre of juice is a good starting point.

5. One of the problems of making marmalade is to ensure that the peel pieces are evenly distributed throughout the gel, not floating at the top. This is achieved by soaking the peel in sugar so that it has the same density as the gel.

6. After squeezing out the juice, the lime peel must be shredded into very thin slices about 1-2.5cm long. The shreds are saturated in sugar.

7. The shredded peel is mixed with sugar (1kg peel and 1kg sugar) and left in a sealed container for one week, stirring occasionally. After this time, the shreds will be floating in a dense syrup. Sodium metabisulphate (1g per kg peel) can be added to prevent the growth of mould and yeast.

8. Extraction of the lime juice is time consuming and tedious. Use of a small juicer is recommended. The juice is very acidic and therefore should not be collected in metallic containers. Only use food-grade plastic, stainless steel or wooden utensils. The juice must be filtered or strained to remove any pulp.

9. Fruit juice can be preserved for later use by adding 3g sodium metabisulphate per litre of juice and storing in a sealed container.

10. The lime juice, bicarbonate and half the sugar are placed in the pan, brought to the boil and boiled for 3 - 5 minutes with steady stirring (it is impossible to state boiling times exactly, as this depends on the heat source etc).

11. The remaining half of the sugar, peel, pectin and green colour are added and boiling continued until the required sugar level (68%) is reached (as measured either by refractometer or jam boiling thermometer).

B.-Passion fruit jam

Reference: ITDG Technical Brief Passion fruit jam

Sugar 49%

Fruit juice 20%

Skin pulp 20%

Water 11%

Sodium bicarbonate 0.02%

1. Passion fruit juice has a pH 2.6-3.0 and a high starch content. The bigger fruits (more than 30g) are more suitable for food processing as they have more juice and less rind. The fruits are most suitable for processing when all greenness has disappeared and the outer skin has a smooth or slightly crinkled surface.

2. The fresh whole fruit can only be stored for a few days at ambient temperature before it deteriorates. At 6.5°C they can be stored for 3-4 weeks. The pulp can be stored for long periods in bulk with 1000-1500ppm sulphur dioxide or benzoic acid or a mixture of both, but there is a reduction in the quality of the flavour. During heat preservation the main problem to overcome is the loss of the extremely heat sensitive flavour, which is susceptible to quick oxidation.

3. Sodium bicarbonate is added to adjust the pH of the juice. The optimum pH to give a good gel is pH 3.0.

4. Wash whole fruits in clean water and discard any bad fruits.

5. Cut fruits in half with a stainless steel knife and scoop out the pulp with a stainless steel spoon.

6. Extract the juice from the pulp by liquidising it at a very low speed (this stops the chipping of the seeds, which gives black specks in the jam that are very hard to remove and look like dirt) for about one minute. Tip the contents into a muslin cloth and squeeze out the juice leaving the seeds behind. This method will give a yield of raw juice from whole fruit of between 30-35%.

7. To make skin pulp take the same quantity of skins, as skin pulp required. Boil the skins for about 30 minutes, until the flesh of the skin is soft and translucent. Remove the skins from the water and scoop out the flesh from the outer cuticle. Liquidise this softened flesh with water, (2 parts softened flesh, to 1 part water -use the water in which the skins were boiled as this contains pectin washed out during the boiling) to a smooth cream. Squeeze the mixture through a muslin cloth to remove hard pieces of pith. Skin pulp is added to the jam as it contains natural pectin and saves adding artificial pectin which is expensive.

8. Mix the juice with sodium bicarbonate before boiling. If the bicarbonate is added during boiling the jam will bubble up over the top of the pan.

9. Boil all the ingredients in a stainless steel pan until it reaches the 'end-point'. Jam should not be boiled for more than 12-15 minutes as it can develop a caramelised taste, become too sweet or discoloured. By reducing the amount of water that is added, the boiling time can be reduced.

10. The end point is reached when the total soluble solids content is 70%. This is measured using a refractometer. Jam with over 70% sugar may crystallise during storage.

11. The end point is usually reached when the temperature is 106-108 deg C. When the jam is nearly at this temperature, a small amount is removed and tested with a refractometer. The sample must be cooled before it is measured. It is important that the utensils used are dry to get an accurate reading.

12. It is important to stir the jam at all times during heating to prevent burning at the bottom of the pan.

13. When the endpoint has been reached, the jam is filled into clean, sterile glass jars. The jars should be sterilised with boiling water or steam and should be hot when they are filled to prevent them from cracking.

14. The jars should be filled as quickly as possible so that the jam does not continue cooking for longer than needed. The tops of the jars should be wiped clean with a clean cloth and the lids placed on.

C.-Pineapple-papaya jam

Reference. FAO (1995) (Ref 37).

Pineapple pulp 11.4kg

Papaya pulp 11.4kg

Cane sugar 22.8kg

Apple pectin (150 grade) 171g

Citric acid 182g

Fresh ground ginger 214g

1. Remove and discard the ends of the pineapples. Remove the skin and take out the central core. Prepare a pulp by passing the fruit pieces through a pulping machine fitted with a 100mm screen sieve.

2. Peel the papaya, halve the fruits and remove the seeds. Pulp in the pulping machine using a 100mm screen sieve.

3. If ginger root is used as a flavouting, peel and macerate it using a Kenwood blender until it has a very fine paste-like consistency.

4. Place the weighed fruit pulp into a stainless steel steam jacketed kettle and heat to about 43°C, stirring constantly.

5. Turn off the heat. Add the pectin (that has previously been mixed with about ten times its weight with some of the pre-weighed sugar) and stir continuously to prevent the pectin from clotting.

6. When the pectin has dissolved, add the remainder of the sugar and dissolve completely in the mixture. Turn on the heat and stir the mixture until the jam starts to boil vigorously. Continue stirring until the jam is almost at its finishing point (105°C).

7. Add the citric acid and ginger if it is being used.

8. After the jam has reached 105°C, it is tested for the end point. This is determined by removing samples of the jam at intervals and measuring the total soluble solids (TSS) in a refractometer. The sample must be cooled before it is measured. When the required TSS has been reached, the jam is taken off the heat and any surface foam is removed.

9. The hot jam is quickly poured into hot sterile jars. The jars are sterilised by boiling in water for 30 minutes. They should be hot when they are filled to avoid them cracking when the hot jam is poured in.

10. The jars are fitted with sterile lids and sealed. The jars are then inverted for about 3 minutes to ensure that the lids are sterilised.

11. The filled jars are cooled in clean running water until they are slightly higher than room temperature. They are air-dried and labelled.

D.-Mango jam

Reference. FAO (1995) (Ref 37).

Mangoes - ripe and under-ripe

Sugar - 60% of the weight of prepared mango

Lemon juice - 2 spoons per kg mango

1. Wash and peel the mangoes using a stainless steel knife. Cut into small chunks and weigh. Weigh out the sugar (equal to 60% the weight of mango).

2. Add 70% of the weighed out sugar to the mango pieces, plus 2 spoons of lemon juice per kg of mango. Heat the mixture, stirring all the time, until the total solids is 55° Brix as measured by a refractometer.

3. Add the remaining 30% of sugar plus 2 spoons lemon juice per kg mango. Heat again. Stir well during heating until the total soluble solids is 67-68°Brix.

4. Hot fill the jam into clean sterile jars. The jam should be stirred in the jars to eliminate any air that may have got in. Seal the jars with sterile screw caps.

5. Cool to room temperature. Label the jars and store in a cool dry place.

E.-Tropical fruit jam - pineapple, guava, papaya or maracuya

Reference. FAO (1995) (Ref 37).

6kg peeled fruit

3kg sugar

50ml lemon juice

This is an extra quality jam that is prepared with less sugar than normal. Because it has less sugar, the jam must be stored in a refrigerator after opening, or consumed within a few days.

1. Sort the fruit, discard any unripe, over-ripe or damaged fruit.

2. Wash in clean water and leave to drain.

3. Peel with a stainless steel knife and cut into halves or quarters depending on the size of the fruit. Place the pieces in a large stainless steel cooking pan.

4. Cook on a low heat, stirring continually with a wooden spoon to prevent the jam from sticking to the bottom of the pan. Simmer for 15 minutes.

5. Turn up the heat and cook for a further 15 minutes, stirring continually.

6. Add 1kg sugar and dissolve rapidly. Cook for 30 minutes. Add 50ml lemon juice.

7. Add the remaining 2kg of sugar, dissolve rapidly and boil for 15-20 minutes until the product reaches setting point.

8. Remove from the heat, cool to about 85°C and pour into clean, sterilised jars.

9. Cover with clean sterile lids, cool to room temperature and label.

F.-Apricot jam (extra)

Reference. FAO (1995) (Ref 37).

6kg fresh apricots

3kg sugar

50ml lemon juice

This is an extra quality jam that is prepared with less sugar than normal. Because it has less sugar, the jam must be stored in a refrigerator after opening, or consumed within a few days.

1. Sort the fruit, discard any unripe, over-ripe or damaged fruit.

2. Wash in clean water and leave to drain.

3. With a stainless steel knife, split each fruit in half. Remove the stone and any dark patches. Weigh the fruit. The fruit halves can be cut into two if preferred.

4. Place the fruit pieces in a stainless steel pot. Cook over a medium heat, stirring continually with a wooden spoon. Simmer for 15 minutes.

5. Turn up the heat and cook for a further 15 minutes, stirring continually. If there is not enough time to finish the process, the jam can be left at this stage until the following day. Allow the product to cool and cover with a lid. The following day, heat over a medium flame for 15 minutes.

6. Add 1kg sugar and dissolve rapidly. Cook for 30 minutes. Add 50ml lemon juice.

7. Add the remaining 2kg of sugar, dissolve rapidly and boil for 15-20 minutes until the product reaches setting point.

8. Remove from the heat, cool to about 85°C and pour into clean, sterilised jars.

9. Cover with clean sterile lids, cool to room temperature and label.

G.-Jam from small berries (strawberries, raspberries, blackberries)

Reference. FAO (1995) (Ref 37).

2kg ripe strawberries

2kg refined sugar

50ml lemon juice

pectin - optional

This jam is made from small berries such as strawberries, blackcurrants, raspberries etc. Different berries can be mixed to make a mixed fruit jam.

1. Sort the fruit, discard any unripe, over-ripe or damaged fruit.

2. Wash in clean water and leave to drain. Remove the stalks.

3. Cut the large fruits into halves or quarters. The small berries can be left whole. Place in a large stainless steel pan.

4. Add the lemon juice and small pieces of the rind. Add 200g sugar. Stir with a wooden spoon, cover the pot and leave to stand for 1-2 hours so that the strawberries release their juices.

5. Gently heat the pan so that the juices run from the fruit. Stir continually with a wooden spoon to prevent the juices burning and sticking to the bottom of the pan.

6. Simmer for 15 minutes to concentrate the juice. Add the rest of the sugar and stir until it dissolves. Cook on a high flame, stirring constantly, until the end point is reached. Remove the foam from the top with a slotted spoon.

7. Remove from the heat, cool slightly to 90-95°C and fill into the clean, sterile jars.

8. Cover with clean sterile lids, cool to room temperature and label.

H.-Juicy sweet oranges

Reference. FAO (1995) (Ref 37).

Sugar - 1 part for every part of juice

Pectin - 0.5% of the total weight of the mixture

1. Select ripe fruits with clean, unblemished skin.

2. Wash in clean water and leave to drain.

3. Halve the fruits and squeeze out the juice using a manual or electric juicer.

4. Preserve the peel in clean containers. Remove the white part from the inside of the peel.

5. Filter the juice twice, once through a thin and once though a thick cloth.

6. Weigh the juice to calculate the amount of sugar. Heat the juice slowly until boiling, in a covered pot. Add several large pieces of prepared peel. Soak the peel in the juice for 15 minutes. Remove the peel.

7. Weigh the sugar so that it equals the weight of the juice. Remove 1% of the weighed sugar and keep this to mix with the pectin.

8. Add the sugar to the boiling juice, dissolving it rapidly so that it does not leave crystals round the edge of the pot.

9. Weigh the pectin so that it equals 0.5% of the total weight of the juice-sugar mixture. Blend with the 1% of sugar that was kept aside.

10. Cut the peel in thin strips (3-4mm wide, 3cm long). Add the peel strips to the boiling mixture and cook for 5 minutes with the pot covered.

11. Add the pectin to the juice and dissolve properly. Boil over a high heat until the Brix measures 64-65° with a refractometer or the temperature reaches 104°C.

12. Pour the mixture into clean, sterile jars, filling it to the brim.

13. Close the jars with clean sterile lids and turn them upside down to cool. Clean the jars, cool to room temperature and label.

7.- Basic jam recipes

The following basic recipes are only guidelines since they depend on the composition of fruit (which varies between different types) and the different consumer tastes for sweetness, acidity and consistency. They assume that the fruits used are poor in pectin – hence commercial pectin has to be added.

Reference: Fruit and vegetable processing by Mircea Enachescu Dauthy.

Recipe 1 Fruit:Sugar = 50:50;	
Desired Brix in the finished product = 68%	
	Soluble Solids
10 kg fruit at 10% TSS	1.000 kg
10kg sugar	10.000 kg
60g pectin (grade 200)	0.060 kg
55g citric acid	0.055 kg
Total Soluble Solids	**11.115 kg**
Yield = 11.115*100/68 = 16.4 kg	

Desired Brix in the finished product = 68%	
	Soluble Solids
10 kg fruit at 10% TSS	1.000 kg
2.5 litre water	
12.2kg sugar	12.200 kg
65g pectin (grade 200)	0.065 kg
60g citric acid	0.060 kg
Total Soluble Solids	**13.325 kg**
Yield = 13.325*100/68 = 19.6 kg	

Recipe 3 Fruit:Sugar = 40:60;	
Desired Brix in the finished product = 68%	
	Soluble Solids
10 kg fruit at 10% TSS	1.000 kg
3.3 litre water	
15kg sugar	15.000 kg
85g pectin (grade 200)	0.085 kg
80g citric acid	0.080 kg
Total Soluble Solids	**16.165 kg**
Yield = 16.165*100/68 = 23.8 kg	

8.- Problems and possible solutions

During production of jams, various factors have to be taken into account:

1. Size of the container. The quanitity of pectin indicated in the recipes is valid for containers of 1kg or less. For larger volumes the pectin content must be increased as follows:

Capacity	Increase pectin by
1-2.5kg	5%
2.5-5.0kg	10%
5.0-10.0kg	20%
10.0-20.0kg	30%

2. Finishing point. The quantity of pectin given is for a final Brix (total soluble solids) of 68%. For different final TSS, the pectin content should be increased as follows:

Final Brix	Increase pectin by
66	5%
65	10%
64	15%
62	20%
60	30%

3. Acidic taste. If the product is too acidic, replace the citric acid by tartaric acid.(63% of the amount of citric acid.)

4. Formation of clots. If the batch clots, it is probably due to the pH being too low or the TSS being too high: correct accordingly.

5. Formation of liquid at the surface. If liquid forms on the surface, it is proably due to too low pH or too low pectin content.

6. Crystallisation. If liquid forms on the surface, the pH is too low - reduce the acid content. If liquid does not form on the surface, the TSS or pH is too high.

7. Formation of mould. The TSS is probably below 68° Brix. The filling may have been carried out at a low temperature. If the containers are large, wait until they are cold before closing.

8. Wrong batch. Dilute the jam with water to 30% TSS, cook briefly. Add this dliuted jam to a new batch, but only at a maximum of 10% of the total mass.