PROCESSING OF FRUIT JAM

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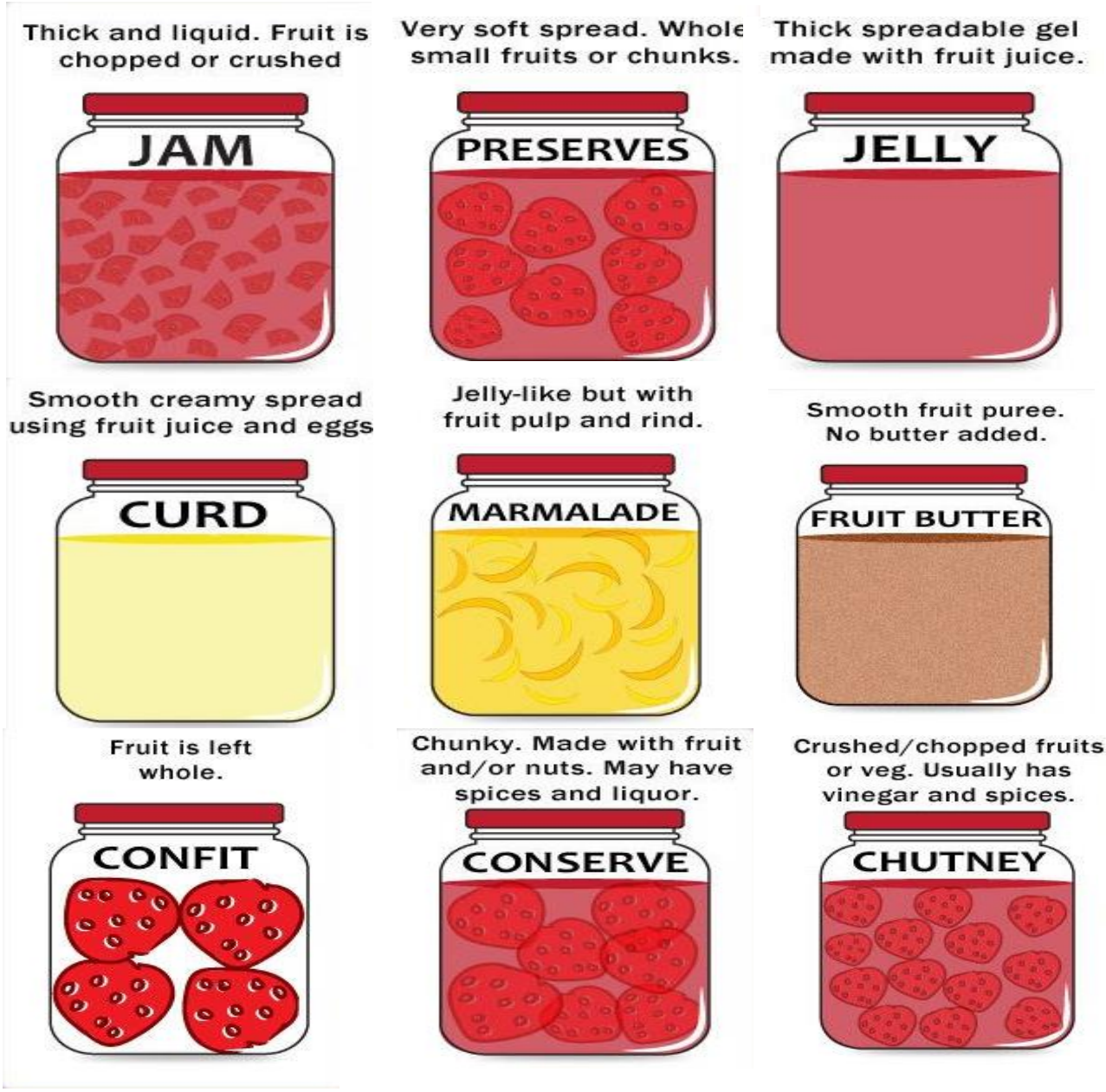
CONTENT

FRUIT PRESERVE

The term *preserves* is usually interchangeable with *jams* even though *preserves* contain chunks or pieces of the fruit whereas *jams* in some regions do not. Other names include: *chutney*, *confit*, *conserve*, *fruit butter*, *fruit curd*, *fruit spread*, *jelly*, and *marmalade*. Some cookbooks define preserves as cooked and gelled whole fruit (or vegetable), which includes a significant portion of the fruit. In the English speaking world, the two terms are more strictly differentiated and, when this is not the case, the more usual generic term is 'jam'. The singular *preserve* or *conserve* is used as a collective noun for high fruit content jam, often for marketing purposes. Additionally, the name of the type of fruit preserves will also vary depending on the regional variant of English being used.

Fruit preserves are preparations of fruits whose main preserving agent is sugar and sometimes acid, often stored in glass jars and used as a condiment or spread. There are many varieties of fruit preserves globally, distinguished by method of preparation, type of fruit used, and place in a meal. Sweet fruit preserves such as jams, jellies and marmalades are often eaten at breakfast on bread or as an ingredient of a pastry or dessert, whereas more savory and acidic preserves made from vegetable fruits such as tomato, squash or zucchini, are eaten alongside savoury foods such as cheese, cold meats, and curries.

TYPE OF FRUIT PRESERVES



JAM - GENERAL INFORMATION

Jam is a product made by boiling fruit pulp with sufficient sugar to a reasonably thick consistency, firm enough to hold the fruit tissues in position. Fruits like mango, apple, guava, pineapple, grapes, oranges and banana are suitable for jam making. Jams may be made from a single fruit, or from a combination of two or more fruits. High concentration of sugar facilitates preservation. Fresh fruits give the best jams. Pectin is the main ingredient in the fruit which gives a set to the jam; it is preferable to use some immature fruits.

Jam is made using pulp from a single fruit or from a mixture of fruits. The combination of high acidity (pH around 3.0) and high sugar content (68-72%) prevents mould growth after opening the jar. There are two important points to remember when making jams: There must be the correct proportions of juice, sugar, acid and pectin in order to form a good gel. In general, slightly under-ripe fruits contain more acid and pectin than do overripe fruits, but there are differences in the amounts of acid and pectin in different types of fruit. Water must be boiled off quickly to concentrate the mixture before it darkens. If whole fruit is used, there are two heating stages: at the start, the fruit is heated slowly to soften it and to extract pectin; then the mixture is boiled rapidly until the sugar content reaches 68- 72%. This change in heat output requires a large and easily controllable burner. At a small scale, a stainless steel pan and a gas burner can be used, but the mixture should be constantly stirred to prevent it burning onto the base of the pan, particularly towards the end of boiling when it thickens. At higher production rates, a double-jacketed pan is better because it gives more even and faster heating and does not risk burning the product.

PROCESSING DETAILS FOR JAM PRODUCTION

Preparation of the fruit

a) Fruit should be washed in clean water, peeled and the stones removed. Fruit should be as fresh as possible and slightly under-ripe.

b) Over-ripe and/or bruised fruit will not make good jam as it has low levels of pectin and/or acid.
c) The jam will not set. Accurate scales are needed to make sure that the correct amounts of ingredients are used each time.
d) Two sets of scales are needed - one with a large capacity for sugar and fruit and a smaller set for pectin and citric acid.

Pulp Extraction : The pH of the 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.

Others 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 standardized gel each time and there will be less risk of a batch failing to set.

Pectin is available commercially as either a powder or a liquid concentrate. It is stable if stored in cool, dry place and it will only lose about 2% of its gelling power per year. Powdered pectin is added to fruit pulp at 3-6 g per kg of final product, but it should first be mixed with about five times its weight of sugar to prevent lumps forming when it is added to the pulp or juice. Liquid concentrate can be added directly to the juice.

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.

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).

There are two main types of pectin

a) high methoxyl (HM)
b) low methoxyl (LM).

High methoxyl pectins form gels in high solid jams (above 55% solids) and in a pH range 2.0-3.5. There are a large number of different types of HM pectin, such as 'rapid set' and 'slow set' and it is necessary to specify carefully the type required when ordering pectin from a supplier.

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. Low methoxyl (LM) pectin is used mainly for spreads or for gelling agents in milk products.

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, 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.

Pectin and acid content in various types fruits

Fruits that have sufficient acid and pectin	**Fruits that do not have enough acid or pectin**	**Fruits that do not have enough acid and pectin**
Unripe fruits: especially apple,	Ripe fruits: especially apple,	Ripe fruits: especially melon,

quince, lemon, grapefruit, passion fruit, guava	orange, mango,	banana, strawberry, pineapple
Sugar : fruit juice ratio = 1:1	Sugar : fruit juice ratio = 0.6 to 0.75:1	Sugar : fruit juice ratio = 0.5:1

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 crystallization. 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 strong syrup and then filtered through muslin cloth or a fine mesh.

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

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

Calculation of yield

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

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 acids 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.

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.

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 9/10^{ths} of their volume, to help a vacuum to form in the space above the product as it cools and the jars are kept upright during cooling until the gel has formed. The problems of obtaining glass jars have led some producers to use plastic tubs, but these are not easy to hot-fill because they melt and the lid seals are often not good enough to prevent product leaking out and attracting insects.

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

END POINT TEST FOR JAM

The finishing or end point of jam concentrations can be determined by any of the following methods. drop test, refractometer test, Boiling point method, by weighing method.

1. **Drop test:** In this method, a little quantity of jam is taken from the boiling pan in a teaspoon and allowed to air cool before putting a drop of it in a glass filled with water. If the drop of jam touches the bottom of glass without disintegrating in the water, jam is considered to be ready. The only drawback of this method is that jam sometimes gets overcooked while it is being cooled for testing.

Refractometer method : The cooking of jam is stopped when the refractive index reading of refractometer indicates 68.50°brix. The jam should be immediately cooled before placing a drop of it on the refractometer glass as the reading is calibrated at 20°C. The main advantage of the method is its ease of handling.

2. **Boiling point method :** Most jams should be concentrated to a boiling point of 106°C at sea level. Correction will however, be necessary for higher locations as the boiling point decreases with increase in altitude. Generally, end point for making jam should be 13°C higher than the boiling point of water at the location. A jelly thermometer may be used with advantage for determining the boiling point of jam. The method is simplest and best to determine the finishing point of jam.
3. **By weighing method :** The weight of the jam prepared from the fruits rich in pectin is one and half times the weight of the sugar taken. The disadvantage of the jam is that weighing is required frequently at the end of boiling which is practically time consuming and uneconomic as heat energy is wasted during weighing.

QUALITY TEST FOR JAM

Determination of pectin

There are three simple tests that with experience can be used to check the natural pectin content of juice or pulp to determine whether additional pectin should be added for jam making, or whether a pectic enzyme should be used to make clear wine:

1. Mix an equal amount of juice and methanol (wood alcohol) Observe the amount and type of material that is precipitated. Juices that are rich in pectin form large amounts of bulky gelatinous material, those that have moderate pectin levels form small clots and those that have little pectin form small flaky pieces of sediment.
2. Mix equal parts of juice and sugar and half the amount of Epsom salts (i.e. a ratio of

3. 1:1:0.5) and leave for 20 mins. If a semi-solid gel forms, there is sufficient pectin for jam making.
4. Add 3 teaspoonfuls of methylated spirit to one teaspoonful of wine in a small jar. Stir it and leave for 30 mins. Any white strings or blobs indicate that the wine contains pectin and should be cleared with a pectic enzyme.

Determination of acidity

To measure the amount of acid in a product, a 10g sample is mixed with 90 ml of distilled water and 0.3 ml of phenolphthalein indicator solution in a glass flask. The instructions for making the indicator solution are given on the phenolphthalein package.

Sodium hydroxide N/10

Phenolphthalin indicator

Weigh 5 g of the sample. Make into a fine paste by the addition of distilled water in pestle and mortar. Filter and transfer the contents to 100 ml volumetric flask. Take 5 ml of the aliquote and titrate against N/10 NaOH using phenolphthalin as indicator. The appearance of pale pink colour indicates the end point.

$$\text{Titrable acidity} = \frac{\text{Titre value X N of NaOH X equivalent weight of acid}}{\text{Volume of sample}} \times 100\%$$

Milliequivalent of acids	
Lactic acid	0.0090
Aceticacid	0.0060
Malic acid	0.0067
Citric acid	0.0064

Acidity is expressed based on the main predominant acid present in sample.

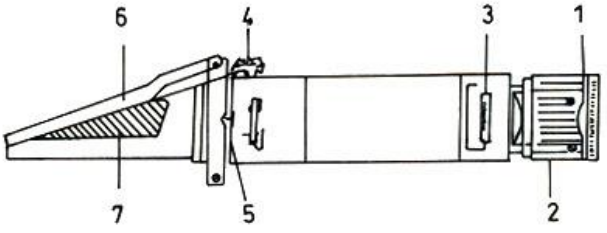
pH: In some processes it is necessary to check the pH of a product or the amount of acid that is present. pH is a measure of acidity (pH 1-6), through neutrality (pH 7) to alkalinity (pH 8-14). It can be measured by dipping a piece of pH paper into a sample of liquid food and comparing the colour change with a chart supplied with the paper. For greater accuracy a hand-held pH meter can be used. pH does not measure the amount of acid in a food. This is important in pickling and sauce making to calculate the Preservation Index.

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

a) Ensure the solution is at a temperature of 20°C.
b) 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.
c) Hold the refractometer near a source of light and look though the field of vision.
d) 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.
e) Open the prism and remove the sample with a piece of paper or clean wet cotton.



1. Eyepiece
2. Scale focusing
3. Scale
4. Scale calibrating
5. Objective lens
6. Cover
7. Prism

Hand refractometer

Hand refractometer (Instruction for use)

1. Hold the refractometer horizontally and point it towards a light source
2. Lift the cover and dry off the calibrating water from the prism. Place one or two drops of the sample to be tested on the prism and close the cover.
3. With cover and prism facing a light source, look into the eye piece and note where the boundary line appears. The correct measurement in percentage of sugar is read at the point where the boundary line crosses the scale.
4. After use carefully clean and dry cover and prism.

Moisture content

The moisture content of dried fruits and vegetables can be found using a laboratory drying oven. Finely chopped samples are carefully dried in a laboratory oven at 100^{o}C +/- 1^{o}C for 4 hours and reweighed. They are put back into the oven and checked again at hourly intervals until they do not lose any more weight.

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.

FORMULATION AND GENERAL PREPARATION OF JAM

Formulation:

Weight of fruit pulp	=	200 kg
Weight of sugar	=	200 kg
Citric acid	=	1.8 kg
Pectin	=	1.5 kg (app)
Total weight of jam	=	265 to 270 kg

Flow Sheet for Preparation of Jam

Fruits

(matured and firm)

↓

Washing

↓

Extraction of pulp

↓

Boiling

↓

Addition of sugar

(50 : 45 to 50)

↓

Addition of pectin

(mixed with sugar in 1 : 10 ratio, based on pectin grade)

↓

Boiling till the end point reached when TSS is 68°Bx

and also flaking when examined with a laddle

↓

Filling

↓

Cooling

↓

Labelling

Method:

1. Ingredients required: weight of fruit pulp 200 kg, weight of sugar 200 kg, citric acid 1.8 kg, pectin 1.5 kg (app.) (pectin calculated based on the TSS present in fruit pulp, sugar and grade of pectin).
2. Selection of fruit : Select matured and firm fruits with good colour and flavour. Fruit is washed thoroughly to remove any adhering dust and dirt.
3. Pulping : The edible portion of the fruit is separated and pulped (or) juice extracted.

4. Addition of sugar and acid : Sugar is added to the fruit pulp in the ratio of 50 : 45. For every kilogram of fruit three-fourth or equal quantity of sugar is added. Citric acid is added at the rate of 0.6 per cent / kg of jam.
5. Boiling : Combine pulp, sugar and citric acid and boil to partially concentrate the product by evaporation of excess moisture. The end product is judged by checking the TSS of 65-68° Brix (or) to the final temperature reaching 106°C and by practice it is noted by the flaking at the laddle end.
6. Pectin : Pectin is added to obtain good consistency. Pectin is always mixed with 10 times its weight of sugar to facilitate easy dispersion of pectin in the pulp.
7. Filling : Prepared jam is filled in sterilised bottles and sealed.

Note: Commercial grade pectin -one gram of pectin will form jam with 100 parts of sugar (100 grade pectin).

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.

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	

Recipe 2

Fruit:Sugar = 45:55; **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	

FSSAI

STANDARDS & GUIDELINES

2.3.31: Jam

- Jam means the product prepared from sound, ripe, fresh, dehydrated, frozen or previously packed fruits including fruit juices, fruit pulp, fruit juice concentrate or dry fruit by boiling its pieces or pulp or puree with nutritive sweeteners namely sugar, dextrose, invert sugar or liquid glucose to a suitable consistency.
- It may also contain fruit pieces and any other ingredients suitable to the products.
- It may be prepared from any of the suitable fruits, singly or in combination.
- It shall have the flavour of the original fruit(s) and shall be free from burnt or objectionable flavours and crystallization.
- It shall meet the following requirement:—

Total soluble solids (m/m) Not less than 65.0 percent

- The product shall be manufactured from not less than 45 percent, by weight, of original prepared, fruit, exclusive of any added sugar or optional ingredients of finished product except where fruit is strawberry or raspberry where it shall contain not less than 25 percent fruit.

The product may contain food additives permitted in FSSR 2011 regulations Appendix A

Artificial Sweeteners & Polyols	Aspartame (methylester) Sucralose Isomalt Sorbitol	1000 ppm 450 ppm GMP 30% max.
Polydextrose	Polydextrose	GMP
Antioxidants	Ascorbic Acid	GMP

Thickening agents	Calcium alginates	GMP
Firming agents (singly or in combination)	Calcium chloride	200 ppm max. for use only on the fruit pieces
Preservatives (Singly or in combination) & its Salt	Sulphur dioxide Benzoic acid Sorbic acid and its sodium potassium or calcium salts	40 ppm 200 ppm 500 ppm
Flavours	Natural flavours and natural flavouring substances/ Nature identical flavouring substances/ Artificial flavouring substances	GMP
Colours (Natural)	Chlorophyll	GMP
Colours (Synthetic)	Ponceau 4R, Carmolsine, Erythrosine, Tartrazine, Sunset yellow FCF, Indigo carmine, Brilliant blue FCF, Fast green FCF	200 ppm max.
Acidifying agents singly or in combination	Citric acid, Fumaric acid, Malic acid, L-Tartaric acid	GMP
Antifoaming agents	Dimethyl Polysiloxane Mono-and diglycerides of fatty Acids of edible oils	10 ppm max. GMP

FSSR 2011 regulations Appendix B Microbiological requirements

Mould Count	**Positive in not more than 40.00 percent of the field examined**

HYGIENE AND SANITATION

Hygienic Condition for Processing Unit

A food-manufacturing unit shall be an establishment in which raw food material is sorted, cleaned, processed and the final product stored for subsequent consumption by the public. Proper care in environmental and personal hygiene should be taken in such establishments in view of its importance in public health.

1. **Scope :** The hygienic conditions required for establishing and maintaining a food processing unit.

2. **Site :** A food processing unit shall preferably be situated in an open, clean and healthy surroundings far away from road-side where lot of dust arises due to vehicular-traffic ; garbage dumps; cattle sheds ; open sewage drains or other places likely to breed flies. It shall be free from sources of obnoxious fumes, smokes, odours or excessive dust.

3. **Building :** The structure shall be of permanent nature and shall be suitable in size, construction and design to facilitate maintenance and hygienic operations for processing purposes. It should provide sufficient space for housing of equipment and storage of materials (raw as well as finished products). The material of construction shall be of brick, plaster, cement, concrete, tile or any other equivalent materials, which ensure cleanliness. Construction of the building shall be such that it shall be rodent-proof, flyproof and birdproof. No portion of building shall be used for domestic purposes or other types of food preparations unless separated by suitable partitions or locations or other effective means so as to avoid contamination of the product with undesirable microorganisms, odour , chemicals, filth or other foreign material.
4. **Ventilation and lighting :** The food manufacturing unit shall be adequately lighted and ventilated keeping in view the number of workers, their hours of work and nature of operation.

5. **Floor :** The floor shall be smooth, washable, properly sloped to gullies connected to sewers or drains. The floor should be constructed of impervious material, which may be cleaned easily. A slop of 1 cm to 1.5 cm per linear meter is considered necessary for drainage. It shall be impervious to water and not affected by weak acids, alkalis or steam. Cemented floor shall be made for workroom, storeroom and godown.

6. **Walls and ceilings :** Internal walls and ceilings should have smooth, non-absorbent light-coloured surface, free from cervices and sharp angles, to facilitate their efficient cleaning. The junction of the floor with the walls and the junction between the two walls should be rounded to prevent accumulation of dust.

7. **Repairs :** The building shall be maintained in a proper state of repair and cleanliness at all times. Whenever required, it may be lime washed, painted, disinfected and deodorized.

8. **Processing room:** The room shall be made flyproof and rodent-proof. The floor shall be impervious to water and shall have a sufficient slope to ensure adequate drainage. Drains in processing rooms shall be cemented and covered with detachable covers. Drains shall be kept clean and shall be provided with traps at suitable places before they are connected with the municipal drain to avoid blocking or choking, or in the absence of any such arrangement, they shall be drained in soakage pits situated at a suitable distance from the factory and also the source of water supply. Adequate facilities for washing the room shall be provided. Adequate number of washbasins and sinks shall be provided.

9. **Preparation and filling :** Table top shall be of such material as to be impervious to water. Other portions of the tables shall be free from corners, cracks and cervices. Proper ventilation shall be maintained to prevent condensation and drippage. Exhaust fans shall be provided where necessary.

10. **Raw material store room :** The rooms shall be made and maintained rodent-proof. They shall also be made free from dampness as far as possible. If articles to be stored are such as to attract flies, fly proofing shall be provided.

11. **Packaging and storage room :** The packing and storage rooms shall be flyproof.

12. **Doors and windows :** The processing rooms shall be provided with effective means to prevent the entry of flies and insects. Such effective means may be screens, fans, etc. The processing rooms should be provided with self-closing double doors. The doors and windows should be covered with flyproof wire gauze, and they should open outwards.

13. **Drainage** : Effective drainage should be provided to drain off a large quantity of water used for washing the raw material, machinery, equipment, furniture, floor, etc. 15 to 30 cm half circular drains with glazed pipe at the bottom should be provided. The slope of the floor should be towards the drains and the farthest end of the floor from the drain should not be more than 5 m. The drain openings should be provided with screen traps to prevent solid matter from clogging the drains. The ends of the drains leading to the outside of the factory should be made rodent-proof by providing screens. The screens shall be examined periodically and replaced or cleaned, if necessary. The drains should have water seals of minimum 5 cm dia. Mesh type cover for the drain should be better to prevent habitation of cockroaches and rodents in closed areas of the drain.

14. **Raw material handling :** Raw materials so selected should be stored in premises that will protect them against contamination and infestation and minimize deterioration. Raw materials before being introduced into the processing line should be inspected, sorted so as to remove undesirable materials. Raw materials should be stored in clean premises which should provide appropriate protection from contamination or deterioration. The finished product should be transported under such conditions as will preclude the contamination with or development of

pathogenic or toxigenic micro-organisms or infestation and protected against the deterioration of the product.

Factory and Processing Hygiene

General factory hygiene : Waste and rubbish shall be collected in covered receptacles and shall not be allowed to scatter on the floor of the unit. It should be disposed of in a manner which is not detrimental to the hygiene of the surroundings of the disposal. Adequate measures shall be taken to prevent mould growth on equipment and internal structures of processing and storage rooms. Floors and drains shall be kept clean. On no account shall the process room be used or converted to a store room for raw materials or used as eating room. Only the items required for processing on a particular day shall be kept in the process room.

The premises where raw materials are stored should be separate from the premises and shall be free from dampness where final packaging is concluded. The places used for storage, manufacture of handling of edible foods should be separate from those used for inedible materials. Proper places shall be provided for storage of brooms, brushes, buckets and other cleaning items. The factory effluents shall be disposed of from the factory in a manner which is not detrimental to the hygiene of the factory and its surroundings. The effluents shall not be let off on road or in the open outside the factory premises. Window glass and light fittings shall be maintained clean and dust-free at all times. Premises should be well lit and ventilated.

Special attention should be given to equipment producing excessive heat, steam, obnoxious fumes or vapours. Good ventilation should be provided and mould growth in overhead structures should be prevented. Light bulbs and fixtures suspended above should be of safety type or otherwise protected in such a way as to prevent contamination in the case of breakage.

Plant and Equipment Hygiene

Material for equipment: All surfaces coming into contact with the food shall be smooth, free from pits, crevices and loose scale and shall be non-absorbent. Furthermore, surfaces shall be non-toxic and unaffected by food products and cleaning compounds. The finish of corrosion-resistant (stainless steel, nickel alloy, etc.) surfaces shall be smooth. The use of galvanized sheets as food contact surfaces shall be minimum. Plastics shall be abrasion-resistant, heat-resistant to the degree needed for the product and for the cleaning process, and shatter-proof. All gasketing and packing materials shall be non-porous, non-absorbent, and fitted in a manner such as to prevent its protruding into the product.

Installation of equipment : All equipment shall be installed on a foundation of durable, easily cleanable material. Equipment shall be placed at least 45 cm from walls and ceiling, or sealed water-tight thereto. It is desirable that at least 50 per cent space in the factory should be free for movement of personal. All portions of the equipment shall be installed sufficiently spaced above the floor on a minimum number of supporting to provide access for inspection and cleaning, or be installed completely sealed (water-tight) to the floor. Whenever equipment passes through walls or floors, it shall be sealed thereto or sufficient clearance shall be allowed to permit inspection, cleaning and maintenance. Where pipes pass through ceilings in the floor above of processing areas, pipe sleeves shall be inserted in the floor above so that their upper periphery is at least 5 cm above the floor.

Connections : All electrical connections, such as switch boxes, control boxes, and cables, shall be installed at least 45 cm away from the equipment and walls to facilitate cleaning, or be completely sealed to the equipment or wall. All equipment coming into contact with raw materials or the product shall be kept clean. All parts of equipment coming in contact with food shall be sterilized by steam or any other suitable sterilizing agent after each processing run. The entire processing system shall be cleaned at the close of operation and flushed out with potable water prior to use.

Container cleanliness : It shall be ensured that containers are clean. The containers shall not be stacked in a manner, which allows the contamination of the product.

Water supply : There shall be an adequate supply of safe and potable water. Running water under pressure shall be easily accessible to all rooms and areas in which food is handled and equipments are washed. Hot and cold water in ample supply shall be provided for plant clean-up needs, where necessary. The storage tanks for water should, unless completely sealed, be kept covered with tight fitting lids, examined regularly and cleaned out at least once every six month. The date of the last cleaning and next cleaning shall be prominently displayed on the storage tanks. The water shall be periodically examined as desired by the licensing authority, chemically and bacteriologically. A record of such examination shall be maintained.

Operation practices and production requirements:

1. **Sanitation control programme** : It is desirable that each processing unit in its own interest should appoint an individual who is responsible for maintaining the cleanliness of the plant.

2. **Laboratory control procedures :** In addition to any control by the official agencies having jurisdiction, it is desirable that each processing unit should have access to laboratory control of the hygienic quality of the products processed. Such controls should reject foods that are unfit for human consumption.

Personal Hygiene

Every person employed for food handling in the factory shall be medically examined by an authorised registered medical practitioner and the examination shall include X-ray of the chest for tuberculosis. The examination shall also include: examination of stool for protozoal and helminthic infestation for those parasites which are transmitted by ingestion, and for the presence of *Salmonella*, *Shigella* species and *Vibrio cholerae*; urine; and blood examination for veneral diseases. Subsequently, the employee shall be

medically examined once in a year or more frequently; if necessary, to ensure that he is medically fit and free from communicable diseases. A record of such examination shall be maintained. It shall be impressed on all employees that they should notify the medical officer or management, cases of fever, vomitting, diarrhoea, typhoid, dysentery, boils, cuts and sores and ulcers (however small), discharging ears and notifiable diseases occurring in their own homes and families.

No worker who is suspected to be suffering from any of the disorders listed in above shall be permitted to work inside the unit. The supervisor shall check the personal hygiene of the workers before the start of work and whenever they enter any processing room after any absence. Employees shall keep their finger nails short and clean and wash their hands with soap or detergent and water before commencing work and after each absence, specially after using sanitary conveniences. Towels used for drying hands should be clean. No worker shall allow his hands or any part of his body or clothing to come in contact with the food. He should adopt strict hygienic practices so as to avoid adding any microbial contamination to the material. All employees shall be inoculated and vaccinated against the enteric groups of diseases once a year and against smallpox once in two years. In case of an epidemic all workers shall be inoculated. A record shall be maintained. No worker shall be allowed to work without proper clothing and foot wear.

Employees shall be provided with clean uniforms (preferably white) or aprons or both and clean washable caps, where necessary. Separate room or place for changing the clothes shall be provided. The clothes shall not be hung in any processing room. The uniforms shall not be worn outside the plant but put on just before starting the work and changed when leaving. Eating, spitting, nose cleaning or the use of tobacco in any form or chewing betel leaves shall be prohibited within the manufacturing, packing and storage area of the unit. Notice to this effect shall be prominently displayed and enforced.

Sufficient and suitable sanitary conveniences shall be provided, maintained and kept

clean in every factory. The conveniences shall be properly lighted. Separate conveniences shall be provided for each sex. No conveniences shall open directly into any workroom in the factory. The conveniences shall always be maintained clean and in good repairs. Sufficient number of wash basins with adequate provision of nail brushes, soap and towels, latrines and urinals in the prescribed manner should be provided, conveniently situated and accessible to workers at all times while they are at the factory. The wash basins shall be installed in or alongside the sanitary conveniences.

Good Manufacturing Practice (GMP)

They are a series of general principles that must be observed during manufacturing. When a company is setting up its quality program and manufacturing process, there may be many ways it can fulfill GMP requirements. It is a production and testing practice that helps to ensure a quality product.

Employees and trainees	Equipment	Buildings and facilities	Production and process control
❑ Well trained in what they do ❑ Hair covering / net ❑ Beard covering ❑ Disposable gloves ❑ Clean uniforms or coats ❑ No injuries / illness ❑ Clean cut nails ❑ No Jewellery / phones / watches ❑ Wash hands ❑ Clean personal habits ❑ Documented classes and trainings	❑ Follow appropriate cleaning schedule for each equipment ❑ Should be designed for food plants and not contain polychlorinated biphenyls (PCBs) ❑ No build up of food or other material ❑ No build up of cleaning solvents / detergents ❑ Should be easy to disassemble for clean up and inspection ❑ No dead space in the machinery to prevent growth of microbes ❑ Sanitization of equipment surface	❑ Area around - Clear of litter, weeds, grass, bush ❑ No standing water around ❑ Clean maintenance of floors, walls, ceilings, windows, screens and no flaking paints ❑ Insect prevention by mesh screens ❑ Tightly sealed windows and doors ❑ Absence of cracks and holes ❑ No evidence of domestic animals ❑ Clean rest rooms ❑ Refilling of hand washing facilities – soaps, paper ❑ No leaks in the premise – roof, walls, windows ❑ Overhead lights covered with shield	❑ Products stored in first in, first out basis ❑ Internal products dated ❑ No overstocking – causes spoilage ❑ Inspection of incoming vehicles ❑ Regular checking of faded, dusty, discolored containers ❑ Spoiled foods to be placed separately in Quarantine area ❑ Disposal of quarantined items quickly ❑ Inspection of incoming materials for damage or contamination ❑ Proper sealing of unused materials ❑ Storage of materials in safe manner ❑ Setting up of effective procedure recall