Food for Profit: Commercial Production of Jams, Jellies, and Fruit Butters

Find information about regulations, ingredients, methods, and common problems when making fruit preserves.

Fruit preserves are shelf-stable food products typically made by combining one or more types of fruit with sugar, acid, and pectin, and then concentrating the mixture by boiling or other means until a specific soluble solids content is reached. Also included in this food category are non-standard reduced-sugar jellies and jams and those that contains significant amounts of low-acid ingredients.

Definitions

- Jelly – Made from filtered fruit juice with no pieces of fruit or seeds present.
- Jam – Contains one or more types of crushed fruits.
- Fruit butter - A smooth, semisolid fruit mixture with no fruit pieces often containing spices.
- Marmalade – Made from citrus fruits including the peel.

Regulations For Commercial Production of Jams, Jellies, and Fruit Butters

Food manufacturers are subject to federal and state regulations. The U.S. Food and Drug Administration (FDA) has established food safety and standard of identity regulations which are enforced, where applicable, by the Pennsylvania Department of Agriculture (PDA). All food processors must follow basic food safety and sanitation standards in Current Good Manufacturing Practices (GMPs, 21 CFR Part 117 Subpart B). The FDA has established standards of identity for jams, jellies, and fruit butters that dictate how these terms can be used on product labels (21 CFR Part 150).

Jellies must be formulated to contain by weight no more than 55 parts of sugar for every 45 parts of fruit. However, requirements for jams depend on whether the fruit ingredient belongs to one of two fruit types. Group I fruits include red and black raspberries, boysenberries, strawberries, and grapes and must contain no more than 55 parts of sugar for every 47 parts of fruit. Group II fruits are mainly peaches, apricots, pears, plums, and citrus and must contain no more than 55 parts of sugar for every 45 parts of fruit. Both jellies and jams must be concentrated by heat or other means to achieve a soluble-solids content of no less than 65 percent (65% Brix).

Fruit butters must contain at least 5 parts by weight of fruit for every 2 parts of sugar and have a finished soluble solids content of at least 43%. Conserves, marmalades, and spreads do not have standards of identity, and do not require soluble-solids testing.

Non-standard jams and jellies made from fruits other than those in Group I or II, or that contain less than 65% soluble solids, must be informatively labeled so as not to claim to be a standard jam or jelly (for example, "Strawberry Fruit Spread"). The FDA Food Labeling regulation (21 CFR Part 101) dictates the content and format of labels and has specific requirements for labeling food allergens and limits on nutritional or health claims. The term "Reduced Sugar" can be applied before the term “Jam” or “Jelly” on the label. Only artificial sweeteners approved for use as a food additive or that have been declared “Generally Recognized as Safe” by FDA may be used.
Jams are exempt from the FDA Acidified Foods Regulation (21 CFR Part 114) unless they contain significant amounts of low-acid ingredients such as peppers, rhubarb, tomatoes, raisins, figs, nuts, bacon, or spices and herbs. For these products, the word “jelly” can be used if the 45:55 fruit to sugar ratio is followed, and the term is preceded or followed by the name of the non-standard ingredient (for example, “Hot Pepper Jelly”).

If you are unsure of federal laws and regulations that apply to your products, contact your local FDA Small Business Representative referenced below. It is also advisable to have your formulation and labels approved by PDA before beginning commercial production.

**Ingredients**

The main components of fruit preserves are fruit, sugar, pectin, and acid. Careful control over the amount of each ingredient is critical for producing a high-quality product that meets applicable regulatory requirements.

**Fruit**

The type of fruit used gives preserves their distinct flavor and color. The complex mixture of volatile aromas and bright colors typical of fresh fruit is transformed into darker and richer flavors during heating while the more stable sugars become concentrated.

Fruit used to make preserves should be sorted so they are free of mold or other signs of decay, heavy bruising, or insect damage. The fruit should be washed with water and stems, leaves, seeds, and skins removed.

**Sugar**

Glucose and fructose are the most abundant sugars in fruit. When the two are joined, they exist as a single sucrose molecule. Common table sugar is nearly pure sucrose and is the traditional source for making fruit preserves. Other sugar sources include honey, maple syrup, agave. Corn and maltose syrups can be used in jellies and jams to replace some or all of the sucrose, although no more than a 40% contribution of dextrose (glucose) to the total sugar concentration is permitted. Sugar substitutes used in jams and jellies include Stevia, sucralose, xylitol, and erythritol.

In addition to its obvious contribution to product sweetness, sugar acts in concert with pectin molecules to form a firm gel. The high concentration of sugar in jams and jellies also contributes a preservative effect by reducing the amount of water molecules available to support microbial activity. Reduced sugar jams and jellies and those sweetened with sugar substitutes are therefore sometimes supplemented with FDA approved preservatives such as sodium benzoate or potassium sorbate to extend shelf life.

The sweetness of preserves is proportional to the concentration of sugar dissolved in the product. Because sugar contributes most of the dissolved solids in preserves, the percent soluble solids, determined using a handheld or digital refractometer, gives a good estimate of sugar concentration. Processors use the term “Brix value” to signify the percent sugar in fruit juice and preserves.

Monitoring Brix values as the mixture is boiled is essential for meeting the regulatory minimum 65% soluble solids and to obtain the best possible product quality. Sugar concentrations that are too low can lead to a weak gel or no gel at all. When they are too high, the product can be overly firm and have a gummy texture. Over concentrating sugars during boiling can also cause crystals to form once the product is cooled to room temperature.

Consistent and accurate results are obtained by measuring ingredients by weight rather than by volume. To meet the regulatory limits on added sugar, the processor must plan ahead based on how much fruit is available or what maximum batch weight is compatible with capacity of equipment used to boil the mixture.

Either of the following formulas can be used:

1. For any given amount of fruit on hand, the factor 55/47 (Group I fruit) or 55/45 (Group II fruit) is used to calculate the maximum allowable weight of sugar. **Example:** for 20 lbs. of strawberries (Group I fruit), the amount of added sugar can be no more than 20 lbs. X 55/47 = 23.40 lbs. The combined batch weight is therefore 43.40 lbs.

2. For any desired total batch weight, the weight of the fruit is calculated by multiplying the batch weight by 0.47 for Group I fruit or by 0.45 for Group II fruit. The maximum amount of sugar for both fruit groups is calculated by multiplying the total batch weight by 0.55. **Example:** if the desired total batch weight for a peach jam (Group II fruit), is 50 lbs., The weight of peaches to use is: 50 lbs. X 0.45 = 22.5 lbs. The weight of sugar to use is: 50 lbs. X 0.55 = 27.5 lbs.

3. The weight of peaches to use is: 50 lbs. X 0.45 = 22.5 lbs.

4. The weight of sugar to use is: 50 lbs. X 0.55 = 27.5 lbs.

If fruit or juice ingredients have previously been sweetened, that amount of sugar must be accounted for in the formulation.
**Monitoring the concentration process.** Once boiling starts, water rapidly evaporates, and both Brix values and boiling point temperatures increase steadily. Periodic monitoring of the boiling process is therefore necessary to avoid overconcentrating the mixture. Direct measurement of Brix values and the rise in boiling point are the two most accurate methods.

- **Soluble solids values.** Periodic determination of Brix values by a refractometer is the preferred method for monitoring increases in soluble solids as the mixture boils. To avoid damaging the instrument and for most accurate results, hot samples should be placed into a small, capped container and allowed to cool before taking a reading. Once the 65% value is reached, the heat should be turned off and the jars immediately filled. Follow the instructions provided by the refractometer manufacturer for how to use and calibrate the instrument.

- **Boiling point.** The boiling point of sugar solutions increases as the soluble solids become more concentrated. The boiling point of a 65% sucrose solution at sea level is 221 °F. The target boiling point for jellies and jams is therefore approximately the same value. Continuous observations of the temperature of the boiling mixture with a candy or other high temperature thermometer is a good way to know when it is time to turn off the heat and start filling the jars. It is important to periodically check the accuracy of the thermometer in boiling distilled water which has a constant sea level boiling point of 212 °F.

**Pectin**

Pectins are naturally occurring substances found in cell walls that provide structure to plants. When used to make jellies and jams, they link with each other to form a gel that thickens the product. About 1% of most fruit is pectin, and it is concentrated mostly in the peel or rind. Apples, crab apples, citrus, gooseberries, and grapes often contain enough natural pectin to form a gel. Other fruits, such as strawberries, raspberries, cherries, and blueberries typically contain smaller amounts of pectin and must be combined with other fruits that contain higher amounts of pectin.

High pectin fruits can produce good results without adding pectin, particularly in jams that are highly concentrated beyond the standard 65% soluble solids endpoint. Slightly under-ripe fruit contains the highest amount of pectin although they may lack in flavor and be less sweet. As the fruit continues to ripen the pectin content decreases. Home jam makers often rely on a mixture of under-ripe and just-ripe fruit for optimum flavor and thickness. However, most jelly manufacturers add pectin products to achieve consistent results.

Commercial pectin is typically manufactured from citrus peels or apple pomace. Pectin grades are based on the number of parts by weight of sugar that one part of pectin will result in an acceptable gel firmness under optimal pH conditions and within a Brix range of 65%–70%.

Standard, or high-methoxyl, pectins are used for jams and jellies containing high amounts of sugar. Modified, or low-methoxyl, types are used for low calorie preserves and require extra calcium to form gel-producing pectin cross-links. Other firming agents that have been used in jams and jellies include gelatin, locust bean (carob) gum, and xanthan gum. Processors should purchase pectin, and other thickening agents, from reputable suppliers who can provide specific instructions on how to use their products.

Pectin products are sold in powder or liquid forms. Powdered pectins can be challenging to disperse evenly although products are available with additives that promote rapid and even dispersion. The pectin should be added to the cooking fruit and allowed to simmer for at least 1-2 minutes to dissolve. When insoluble clumps are an issue, pectin can be added to a small amount of warm (140 - 212 °F) water or sugar syrup and then mixed in a kitchen blender before adding to the kettle. Another strategy is to dry-mix powdered pectin with 4 to 5 times the amount of sugar before adding to the kettle.

**Acid**

Acids add tartness and decreases the perception of sweetness. The most common acids in fruit are citric, malic, fumaric, tartaric, and lactic acid. Fruit acidity varies between species and the level of maturity.

The optimal pH range for jams and jellies is 2.8 to 3.3. Too much acid can cause the pectin to degrade during boiling and too little can result in a weak gel. When low methoxyl pectin is used, the pH must be low enough to allow calcium ions to form chemical links. Acid also retards sucrose crystallization by chemically splitting (inverting) some of the sucrose molecules into more soluble glucose and fructose.

For consistent quality results, a pH meter is recommended to determine how much acid, if any, should be added to reach the optimal pH range. Processors of non-standard jellies and jams that contain low acid ingredients (for example, pepper jellies, mango jams, and conserves containing raisins and nuts) are strongly advised to use a pH meter to assure that the final product pH is well below the 4.6 limit for acidified foods.
General Procedures

1. Ingredient preparation
   - Sort, wash, and peel fruit
   - For jams, chop, slice, and mash as needed.
   - For jellies, extract juice and strain to remove solids.
   - For fruit butters, cook until it is soft enough to be pushed through a food mill or sieve.
   - Accurately weigh out ingredients.

2. Concentration by boiling
   - Combine fruit and sugar in a kettle or pot and rapidly bring to a vigorous boil.
   - Add pectin according to manufacturer’s instructions and stir to dissolve.
   - Check the pH and adjust if needed.
   - Continue to boil with stirring until a soluble solids value of at least 65% is reached.
   - Turn off the heat and immediately start filling jars.

3. Thermally process using a Hot-Fill-Hold (HFH) or Water Bath (WB) method
   - Pre-sterilize jars if fill temperatures are below 180 °F.
   - Pre-heat jars to 60°F below fill temperature to prevent glass breakage.
   - Fill the hot mixture (at least 185°F) into jars to allow a ¼ inch headspace.

Hot-Fill-Hold (HFH) processing.
   - Maintain kettle temperature to ensure consistent minimum fill temperature.
   - Immediately seal and invert the jars and hold for at least 2 minutes to sterilize the lids, then flip the containers.
   - Allow the jars to cool on a table with sufficient space between them for air to flow between each of them or use cool water spray or immersion methods.

Water Bath (WB) processing.
   - Use heat lids with heat-resistant plastisol gasket specially designed for hot water bath processing.
   - Methods from University Extension services can be used if the type of food, size of the container, and the processing method stated in the recipe are strictly followed.

Problems Encountered When Making Fruit Preserves

Evidence of microbial spoilage
Microorganisms are abundant in fruit, some of which can cause products to spoil. Mold spores are particularly of concern because they are relatively tolerant to heat and can germinate and grow at the high sugar and acid levels found in preserves. Strategies for minimizing spoilage problems in jams and jellies therefore include minimizing spore levels in the fruit and processing environment and producing a tight vacuum seal that prevents oxygen-loving molds from growing. Products that show gross signs of spoilage, including mold growth or foul odors, should be discarded.

Possible remedies:
   - Use good quality fruit and sort out any that show signs of decay or excessive bruising.
   - Remove culled fruit from processing and storage areas on a daily basis.
   - Evaluate your processing environment for potential sources of post processing contaminant such as open windows, flying insects, and unsanitary equipment.
• Regularly clean floors, drains, and walls to prevent buildup of microorganisms, and clean and sanitize tables, utensils, and equipment each day before processing begins.
• Prevent heat-resistant spores from accumulating by turning off water baths when not in use and by regularly draining and adding fresh water.
• Do not use jars with chips or cracks and discard any lids with defects in the sealing surface.
• Check that the sealant material is appropriate for heat processing method used.
• Use consistent fill temperatures of at least 185 °F to sterilize the inside of the container, the headspace, and the bottom of the lid.
• Immediately apply lids to the filled jars to protect the product from air currents that may carry microorganisms.

Poor flavor and color quality
Excessive loss of volatile flavor compounds and degradation of pigments can occur if poor quality fruit is used or ingredients are boiled too long. Quality losses during storage can be accelerated if contaminants are introduced during processing. Even very small amounts of iron, copper, or tin can accelerate flavor and color degradation. Oxygen and light also contribute to oxidative darkening of pigments and flavor loss during product storage.

Possible remedies:
• Use only high-quality fruit that is free from signs of decay.
• Heat the fruit and sugar mixture to the boiling point as rapidly as possible, boil vigorously until the target Brix value is reached, and fill and seal jars without delay.
• Stir continuously to avoid scorching.
• Consider smaller batch sizes for more efficient and uniform heating.
• Use only acid-resistant stainless-steel boiling kettles and utensils.
• Use fill temperatures at 180 °F or higher to ensure an oxygen-free headspace.
• Store the product in a cool room away from bright light to the extent possible.

Product is too soft or runny
Jellies and jams that do not set or thicken properly are most commonly caused by an incorrect balance of fruit, sugar, acid, and pectin. Using the wrong type of pectin or not using it according to the manufacturer’s guidelines is another cause. Some fruits take longer than others to set up completely, especially those made from packaged juice products. Pectin molecules are heat-sensitive and exposure to too much heat can cause them to break down and not set properly.

Possible remedies:
• Train operators to carefully follow the procedures written in the product formulation, and to measure them precisely by weight, not by volume.
• Do not boil longer than necessary to reach the target Brix value or use smaller batch sizes to increase heating efficiency.
• If pectin does not adequately disperse, dry-mix powder with 4 to 5 parts sugar or pre-blend in hot water or sugar syrup before adding to the kettle. Consider using commercially available liquid pectin products.
• Add the pectin closer to the end of the boiling process to minimize thermal degradation.
• Consult your pectin supplier for expert advice on what type of pectin to use and what levels work best for your product.

Leaking jars
A tight seal keeps the product in the jar and prevents air and microorganisms from getting in. The condition of the closure and the vacuum level achieved during processing are factors that affect seal integrity.

Possible remedies:
• Verify that fill levels are consistently within ¼ to ½ inch from the top of the jar.
• Inspect jars for chips, use only new lids, and inspect them for defects in the plastisol gasket.
• Make sure that fill temperatures are consistent from start to end of filling.
• Use a vacuum gauge to periodically check for batch-to-batch consistency.
• Make sure the lid is appropriate for the type of jar, and that it is not over or under tightened.

Formation of crystals

When the boiled mixture is cooled down, dissolved sugar molecules can become supersaturated and start to crystallize. Crystallization is most often a concern in clear jellies where they detract from the visual quality of the product. Adding too much sugar or concentrating the mixture well above the target 65% soluble solids limit can lead to crystallization problems. Even a few crystals remaining on the sides of the boiling kettle can provide a starting point for further crystallization. Agitating the sealed jars while they are cooling and fluctuating storage temperatures are also thought to accelerate crystal formation. Crystals in grape jellies can be caused by the precipitation of naturally occurring tartaric acid once the product is cooled.

Possible remedies:

• Train operators to accurately weigh out ingredients according to the written recipe.
• Cook the mixture at a rapid boil to thoroughly dissolve the sugar.
• Consider replacing some of the sucrose with corn syrups which can disrupt the crystallization process.
• Make sure the pH is at the optimal value for both pectin activity and inversion of some of the sucrose into glucose and fructose molecules.
• Rinse down the sides of the kettle and wipe with a clean cloth before filling to eliminate any residual sugar crystals.
• Skim off any surface foam before filling jars.
• Prevent tartrate crystallization in grape jellies by refrigerating the extracted juice overnight to allow tartrate crystals to settle out and then strain them out before making jelly.

Foam or air bubbles

Foam is a common occurrence during the boiling process and it can be a visual defect in jellies and jams if it is transferred to the product as the jars are filled. Bubbles can detract from the appearance of jellies, especially those that are lighter in color. Evidence of air bubbles could also be a sign of post-processing yeast contamination.

Possible remedies:

• Do not allow jelly or jam to start gelling before jars are filled.
• Remove surface foam before filling and ladle or pour quickly into jars.
• Consider using a slower set pectin to allow enough time for bubbles to clear before jars are filled.
• Control the mixing process to limit the incorporation of air into the product.

Floating fruit

Density differences between the pieces of fruit and the surrounding sugar solution can cause fruit to float to the top of jams before they are cooled. Some reasons may be that the fruit was not fully ripe, it was not thoroughly crushed, or it was not cooked long enough.

Possible remedies:

• Reduce the size of pieces by mashing the fruit for a longer amount of time.
• After boiling is completed, remove from the heat, let it sit for enough time for fruit to float, and then gently stir to submerge the fruit before filling the jars.
• After jars are filled, remove air bubbles with a plastic or wooden tool.
• Invert the filled and sealed jars periodically while they cool to redistribute the pieces throughout the jar.
• Use a rapid set pectin that will thicken the jam in the jar before the fruit can rise to the top.

References


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