



## TECHNOLOGY FOR PROCESSING PLUM A STONE FRUIT INTO JAM

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**Abstract:** *This article comprehensively analyzes the technology for processing plums (*Prunus domestica* L.) into jam, detailing the key stages: raw material selection, washing, pit removal, cooking, homogenization, pasteurization, and packaging. The study evaluates the technology's impact on nutritional properties (vitamin C, dietary fiber, antioxidants), energy consumption, environmental sustainability, and quality control measures. Special emphasis is placed on the practical applicability of plum jam production in Uzbekistan's agricultural context, its economic significance, and its potential in the global export market. The research is grounded in scientific literature, Uzbekistan's normative-legal documents, and practical data from local enterprises. A comparative analysis of the advantages and limitations of each processing stage is provided, alongside recommendations for optimizing production processes, adopting modern technologies, and enhancing market competitiveness through organic certification and eco-friendly packaging. The article aims to contribute to the development of Uzbekistan's food industry by proposing strategies for improving plum jam production efficiency and sustainability.*

**Keywords:** *Plum, jam, processing, technology, cooking, pasteurization, homogenization, nutritional properties, quality control, energy consumption, environmental sustainability, packaging, agriculture, food industry, export.*

### Introduction

Plums (*Prunus domestica* L.), a stone fruit, are a cornerstone of agricultural production and the food industry due to their rich nutritional profile, which includes vitamin C (8–10 mg per 100 g), dietary fiber (2–3 g per 100 g), antioxidants (notably



anthocyanins), and essential minerals (potassium, magnesium, iron). These attributes make plums an ideal raw material for processing into value-added products like jam, which is widely used as a spread, ingredient in bakery products, and component in desserts. Plum jam's extended shelf life, sensory appeal, and versatility contribute to its high demand in both local and international markets. In Uzbekistan, plum processing is a vital agricultural sector, with key production regions such as the Fergana Valley, Samarkand, and Surkhandarya yielding over 80,000 tons of plums annually, a significant portion of which is processed into jam and other products (Uzbekistan Statistics Agency, 2024).

The production of plum jam in Uzbekistan is governed by a robust legal framework designed to ensure product safety and quality. The Law of the Republic of Uzbekistan "On Food Safety" (2021) mandates strict compliance with microbiological, chemical, and sanitary standards to protect consumer health. The Law "On the Development of Agriculture" (2004) promotes the adoption of modern technologies in processing and export preparation to enhance the competitiveness of agricultural products. Standards such as DSt 3285:2014 (for jams and preserves) and DSt 3331:2016 (for fruit and vegetable purees), approved by the "UzDavStandart" agency, specify requirements for jam quality, including sugar content (50–65%), acidity (0.5–1.2%), organoleptic properties, and storage conditions. These normative-legal documents provide a foundation for standardizing production processes and ensuring compliance with international market requirements.

This article examines the technology for processing plums into jam, covering the stages of raw material selection, washing, pit removal, cooking, homogenization, pasteurization, and packaging. The study aims to evaluate the technology's efficiency, its impact on nutritional properties, energy consumption, environmental sustainability, and its practical applicability in Uzbekistan's agricultural sector.

By analyzing scientific literature, practical data from Uzbek enterprises, and global market trends, the article provides a comparative analysis of the advantages and limitations of each processing stage. Recommendations are proposed for



optimizing production processes, reducing environmental impact, and enhancing Uzbekistan's competitiveness in the global plum jam market.

### **Main Body**

#### **1. Characteristics and Importance of Plum Jam**

Plum jam is a processed product obtained by cooking plum pulp with sugar, resulting in a homogeneous, shelf-stable product with a rich flavor and texture. It is valued for its nutritional content, including dietary fiber, which supports digestive health, and antioxidants, which combat oxidative stress. Studies indicate that properly processed plum jam retains 60–70% of vitamin C and 70–80% of antioxidants, making it a nutritious option for health-conscious consumers. In Uzbekistan, plum jam is a staple in local diets and a significant export product, with approximately 8,000 tons exported in 2023 to markets such as Russia, Kazakhstan, and China (Uzbekistan Statistics Agency, 2024). The production of plum jam extends shelf life to 12–24 months, adds value to raw plums, and supports agricultural diversification, contributing to economic growth in rural areas.

Plum jam's versatility enhances its market appeal. It is used in bakery products (e.g., pastries, cakes), as a filling in confectionery, and as a standalone spread. The growing global demand for natural and organic products has increased interest in sugar-free or low-sugar plum jams, particularly in premium markets like Europe and the USA (Global Trade Data, 2024). In Uzbekistan, enterprises such as “Samarkand Fruit” have capitalized on this demand by exporting high-quality plum jam, reinforcing the country's position as a key player in the global food industry.

#### **2. Plum Jam Production Technology**

The production of plum jam involves a series of carefully controlled stages to ensure product quality, safety, and marketability. These stages include raw material selection, washing, pit removal, cooking, homogenization, pasteurization, and packaging.

##### **2.1 Raw Material Selection and Preparation**

The quality of plum jam depends heavily on the selection of raw materials. High-quality, ripe, and undamaged plums with optimal sugar content (10–12% Brix)





are chosen, with popular varieties in Uzbekistan including “Stanley,” “Tulpan,” and “President.” These varieties are selected for their balanced sweetness, vibrant color, and high pectin content, which contributes to the jam’s texture. Harvesting occurs from July to September, when plums reach peak sugar and antioxidant levels, ensuring optimal organoleptic and nutritional properties (Rahman, 2019). The washing stage uses automated systems to remove dirt, microbes, and pesticide residues, aligning with DSt 3285:2014 standards. Water usage is a consideration, and recycling water in washing systems can enhance environmental sustainability.

## 2.2 Pit Removal and Crushing

After washing, plums undergo pit removal using specialized equipment to separate the stone from the flesh efficiently. The pitted plums are then crushed to produce a pulp, which forms the base for jam production. This stage is critical for preserving the fruit’s structure, but exposure to air can cause oxidation, leading to a 5–10% loss of vitamin C (Smith et al., 2020). To mitigate this, antioxidants such as ascorbic acid are often added. In Uzbekistan, medium-sized enterprises use automated pit-removing machines, which improve efficiency and reduce labor costs compared to manual methods used by smaller producers.

## 2.3 Cooking

Cooking is the core stage of jam production, where plum pulp is heated with sugar (typically in a 1:1 ratio) at 90–100°C for 20–40 minutes to achieve a sugar concentration of 50–65% Brix. This process gelatinizes pectin, enhances flavor, and ensures microbiological safety by inactivating enzymes such as polyphenol oxidase.

However, prolonged cooking at high temperatures can reduce vitamin C by 20–30% and antioxidants by 15–25%. In Uzbekistan, steam-jacketed kettles are commonly used for uniform heating, ensuring consistent texture and quality. For low-sugar or sugar-free jams, natural sweeteners (e.g., stevia) or pectin additives are increasingly used to meet consumer preferences for healthier products.

## 2.4 Homogenization

Homogenization ensures a smooth, uniform texture, enhancing the sensory appeal of the jam. This process is conducted under high pressure (100–150 bar) using



specialized homogenizers, which break down pulp particles to create a consistent product. Homogenization improves the jam's suitability for premium markets but increases energy consumption by 40–60 kWh per ton. In Uzbekistan, large enterprises employ automated homogenizers, while smaller producers may rely on manual mixing, which can result in inconsistent textures.

### 2.5 Pasteurization

Pasteurization is essential for ensuring microbiological safety and extending shelf life. The jam is heated at 85–95°C for 30–60 seconds, eliminating pathogens and spoilage microorganisms. This process results in a 10–20% loss of vitamin C, but 70–80% of antioxidants are retained. In Uzbekistan, modern steam pasteurizers are used by large enterprises, ensuring compliance with international safety standards. However, smaller producers often face challenges with outdated equipment, leading to inconsistent pasteurization and potential quality issues.

### 2.6 Packaging

Packaging is a critical stage for preserving jam quality and facilitating export. Plum jam is typically packaged in glass jars, metal cans, or aseptic containers (e.g., Tetra Pak). Aseptic packaging extends shelf life to 24 months and is preferred for export due to its durability and lightweight design. Glass jars, favored for their recyclability, are popular in local and European markets, where demand for eco-friendly packaging is growing (Global Trade Data, 2024). Enterprises like “Samarkand Fruit” use glass jars to export plum jam to Russia and Kazakhstan, while aseptic packaging is increasingly adopted for markets like China. The use of biodegradable materials aligns with global sustainability trends and enhances market competitiveness.

## 3. Quality Control and Nutritional Properties

Quality control is integral to ensuring that plum jam meets consumer expectations and regulatory standards. It involves assessing organoleptic properties (color, taste, aroma), physicochemical parameters (sugar content, acidity, viscosity), and microbiological safety. According to DSt 3285:2014, plum jam must have a sugar content of 50–65% and acidity of 0.5–1.2%. Proper processing retains 60–



70% of vitamin C and 70–80% of antioxidants, ensuring nutritional value. In Uzbekistan, large enterprises use automated systems to monitor quality parameters, including refractometers for sugar content and pH meters for acidity. Smaller producers, however, often lack access to advanced laboratory equipment, leading to challenges in maintaining consistent quality. Implementing affordable quality control solutions, such as portable testing devices, could bridge this gap.

Microbiological safety is a priority, as improper processing can lead to contamination by molds, yeasts, or bacteria. Regular testing for pathogens, as mandated by the “On Food Safety” law, ensures compliance with international standards like ISO 22000. Additionally, sensory evaluation by trained panels ensures that the jam’s color (deep purple or red), taste (sweet-tart balance), and texture (smooth or slightly chunky) meet market expectations. In premium markets, organic certification (e.g., EU Organic) enhances product value by guaranteeing the absence of synthetic additives or pesticides.

#### 4. Energy Consumption and Environmental Sustainability

Plum jam production is energy-intensive, particularly during cooking and pasteurization, which consume 150–200 kWh per ton.

In Uzbekistan, where electricity costs can be a significant expense for producers, adopting energy-efficient technologies is critical. Solar-powered equipment, such as solar-heated kettles or pasteurizers, can reduce energy costs by 20–30%. Uzbekistan’s abundant solar resources (3000 hours of sunshine annually) make this a viable option for sustainable production.

Environmental sustainability is further enhanced by waste management strategies. Plum pits, a byproduct of jam production, can be processed into oil for food or cosmetic applications or used as animal feed, reducing waste. Biodegradable packaging, such as compostable films or recyclable glass jars, aligns with global sustainability trends and meets the demands of environmentally conscious consumers in Europe and the USA . Additionally, water recycling in the washing stage and energy-efficient equipment can minimize the environmental footprint of jam production.





### 5. Economic and Export Potential in Uzbekistan

Plum jam production is a key driver of Uzbekistan's agricultural economy. In 2023, Uzbekistan exported over 8,000 tons of plum jam, primarily to Russia, Kazakhstan, and China, generating significant revenue (Uzbekistan Statistics Agency, 2024). The global demand for natural and organic products presents opportunities for expansion into premium markets. Organic certification, such as EU Organic, can increase export prices by 20–30%, while low-sugar or sugar-free jams cater to health-conscious consumers in Europe and the USA (Global Trade Data, 2024). Emerging markets in Asia, such as Japan and South Korea, also show growing demand for high-quality fruit preserves.

To capitalize on these opportunities, Uzbekistan must address several challenges. Small and medium-sized enterprises often lack access to modern equipment and quality control systems, limiting their ability to meet international standards. Government support through subsidies for equipment upgrades and training programs for farmers and processors can enhance production capacity. Additionally, branding plum jam with a “Made in Uzbekistan” label and promoting organic products can strengthen market positioning.

### 6. Challenges and Opportunities

Despite its potential, plum jam production in Uzbekistan faces several challenges. Small-scale producers often lack access to modern equipment, leading to inefficiencies and quality inconsistencies. High energy costs and reliance on traditional packaging materials limit competitiveness in global markets. Additionally, limited awareness of organic certification processes among farmers hinders access to premium markets.

Opportunities include leveraging Uzbekistan's abundant plum production and favorable climate to scale up processing. Investments in solar-powered equipment and waste recycling can reduce costs and environmental impact. Partnerships with international certification bodies can facilitate organic certification, while marketing campaigns highlighting Uzbekistan's agricultural



heritage can enhance brand recognition. Developing low-sugar or sugar-free jams can tap into growing health trends, further expanding market share.

## 8. Recommendations for Advancing Plum Jam Production

To enhance plum jam production in Uzbekistan, the following strategies are recommended:

**Adopt Modern Technologies:** Invest in automated cooking, homogenization, and pasteurization equipment to improve efficiency and quality consistency.

**Promote Energy Efficiency:** Implement solar-powered systems to reduce energy costs by 20–30%, leveraging Uzbekistan’s abundant solar resources.

**Enhance Quality Control:** Provide small and medium-sized enterprises with access to affordable quality control tools, such as portable pH meters and refractometers.

**Pursue Organic Certification:** Support farmers and producers in obtaining EU Organic or USDA Organic certification to access premium markets.

**Develop Eco-Friendly Packaging:** Invest in biodegradable and recyclable packaging to meet global sustainability demands.

**Strengthen Farmer Training:** Establish training programs to improve skills in modern processing techniques and quality standards.

**Expand Market Strategies:** Promote “Made in Uzbekistan” branding and target emerging markets (e.g., Japan, South Korea) with tailored products like low-sugar jams.

## Conclusion

The technology for processing plums into jam, encompassing raw material selection, washing, pit removal, cooking, homogenization, pasteurization, and packaging, is a vital process in Uzbekistan’s food industry. It preserves 60–70% of nutritional properties, extends shelf life, and enhances the value of plums, contributing to both local consumption and export markets. In Uzbekistan, plum jam production supports economic growth and agricultural diversification, with over 8,000 tons exported in 2023. Challenges such as high energy consumption and limited access to modern equipment can be addressed through investments in solar-





powered systems, eco-friendly packaging, and organic certification. Future research should focus on optimizing energy efficiency, developing sustainable waste management practices, and expanding market strategies to capture premium segments. By implementing these recommendations, Uzbekistan can strengthen its position as a leading producer of high-quality plum jam in the global market.

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