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Specific Features of Convective Drying of Plum, a Stone Fruit

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Abstract

This article provides information on the varieties of plum, a stone fruit, and their convective drying process. Plums (locally known as "gayloli") are processed in three different ways: 1) lye treatment (referred to as boiled gayloli in vernacular), 2) dried gayloli (initially spread on the ground), and 3) leaf form (also known as gayloli bark in vernacular). Additionally, plums are widely used in their ripe form for various purposes. The article focuses on the convective drying method, its technological aspects, advantages, and impact on the physicochemical properties of the fruit. The study highlights the suitability of this method for industrial-scale processing in Uzbekistan and its role in producing high-quality, long-shelf-life products for domestic and export markets.

Keywords: Plum, convective drying, thermal effect, jam, traditional drying, stone fruit.

Introduction

Plums are believed to have originated in Syria. The most familiar purple-colored plums consumed today are derived from crossing wild blackthorn and cherry plum. In Uzbekistan, horticulture has been a significant field of activity since ancient times, and today, this sector has seen considerable advancements, achieving notable successes. Examples include the development of new varieties of apples, pears, peaches, grapes, and apricots, leading to the establishment of over 1,000 orchards. In recent years, the demand for plums (locally referred to as "gayloli") has significantly increased. This is due to their resilience compared to other horticultural crops, early fruiting, resistance to diseases, drought tolerance, and ability to grow in suboptimal soil conditions without losing yield potential. Consequently, establishing plum orchards is currently a highly viable endeavor.

Plums belong to the division of angiosperms, class of dicotyledons, and the Rosaceae family. In Uzbekistan, five types of plums are commonly found. Their life form is a tree with a taproot system. The stem is multi-branched, often thorny, reaching a height of 3–6–8 meters. Leaves are simple, arranged in groups of 3–5 on the stem. Flowers have a structure typical of the Rosaceae family, blooming from late April to early May. The fruit is a drupe, ripening from late August to early September. Plums begin bearing fruit in their fourth year, primarily propagated through root suckers. Plums are highly suitable for horticulture due to their rapid ripening, ability to grow in dry conditions, and low water requirements (irrigated 4–6 times in the first year). Compared to other horticultural crops, plums have high viability. Their planting scheme is typically 4x4 meters, distinguishing them from other crops due to these characteristics.

Plum fruits are of significant importance in the food industry and human diet. In addition to the "gayloli" varieties, plums have numerous other cultivars. The caloric content of plums is moderate, with approximately 46 kcal per 100 grams of fresh garden plums. The fruit is round, oval, or elongated, weighing 60–100 grams, and comes in yellow, green, red, or bluish-black colors, often covered with a waxy coating. Plums contain 14–21% sugar, 0.5–1.2% acids, nitrogenous compounds, and vitamins. They are consumed fresh, dried, canned, or processed into juices, jams, marmalades, and other products.

Plums are primarily propagated through grafting and root suckers, with cherry plum being the best rootstock. After planting, trees begin yielding fruit in 4–6 years. In Uzbekistan, plums bloom in March–April, and their fruits ripen from mid-June to late September. A single tree can produce 20–

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50 kg of fruit, with some yielding up to 100 kg, and they remain productive for 20–25 years while being cold-resistant. Their care is similar to that of other stone fruit trees. In Uzbekistan, varieties such as Vengerka, Berton, Ispolin, Samarqand black plum, Washington, and others are cultivated.

Plum (Prunus domestica) is a stone fruit with high biological value, containing numerous beneficial substances, including vitamins (A, C, K, B-group), fiber, natural sugars, antioxidants, and organic acids. In Uzbekistan, various plum varieties are grown, and one of the primary preservation methods is drying. Both traditional and modern drying technologies exist, with convective drying (using airflow) being widely applied on an industrial scale. This article analyzes the technological aspects, advantages, and physicochemical effects of the convective drying method for plums.

Stone fruits, including plums, are rich in vitamins, antioxidants, sugars, and organic acids beneficial to human health, making drying a popular method for preserving them during the winter season. Convective drying is one of the most commonly used industrial methods, preserving the fruit’s taste, shape, and nutritional properties.

2. Convective Drying Technology

Convective drying is a technological process that removes moisture from the surface of a product through hot air, transforming it into vapor. This process is carried out using a continuous airflow within a drying chamber. Controlling air temperature, pressure, and velocity ensures product quality. At the start of the drying process, the air temperature is typically 85–90°C, which is gradually reduced to 50–60°C by the end. The advantages of convective drying include:

- Preservation of the product’s natural appearance;
- Uniform heat distribution;
- Reduction of bacterial activity;
- Retention of nutritional value to a significant extent.

The drying process is divided into three stages:

- Initial stage (85–90°C): Surface moisture evaporates.
- Middle stage (70–75°C): Water from internal cells is released.
- Final stage (50–55°C): The fruit’s external and internal moisture levels are balanced.

When performed correctly, convective drying results in a final product moisture content of 20–25%, making it suitable for long-term storage. Convective drying uses hot airflow passed through specialized chambers to evaporate moisture from the fruit’s surface. Factors such as drying speed, air temperature, humidity levels, and fruit density play a critical role in this process.

3. Plum Drying Process

Before drying, plums are washed and blanched in hot water for 2–3 minutes. This step softens the skin and accelerates the drying process. The plums are then placed in a convective dryer, where drying takes 12–24 hours, reducing moisture content to 20–25%. The dried plums should be lightweight, free from spoilage, and uniform in color.

4. Physicochemical Changes

During drying, several physicochemical changes occur in plums. Moisture content decreases, sugar concentration relatively increases, and acidity levels drop. The color shifts to a darker purple shade. The surface becomes glossy, and the taste remains pleasant. Notably, the vitamin content, particularly B-group vitamins, is relatively well-preserved. The drying process reduces moisture, limiting microbial growth. The increased sugar concentration enhances flavor, while organic acids (e.g., malic, citric, oxalic acids) decrease but maintain taste balance. Thermal processing may reduce B-group vitamins, but vitamins A and C remain largely unaffected (Khujaev, 2022).

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5. Technological Efficiency and Economic Analysis

Convective-dried plums can be stored long-term, are convenient for transportation, and are suitable for consumption. The product's weight decreases, but its nutritional value is largely retained. This method is environmentally friendly and economically efficient for industrial applications, producing export-quality products. Compared to traditional sun-drying, convective drying yields higher-quality products, reduces drying time, minimizes losses, and saves labor. Automated drying chambers further enhance production efficiency. Although energy consumption is higher, the improved product quality and extended shelf life offset these costs.

Dried plums command higher prices in domestic and international markets.

6. Conclusion and Recommendations

Convective drying of plums, a stone fruit, enables the production of high-quality, nutritious, and long-shelf-life products. This technology operates efficiently through heat and air exchange, playing a significant role in large-scale packaging, export preparation, and meeting consumer needs. In the future, it is recommended to further develop this technology by adopting energy-efficient dryers, digital monitoring, and automation.

Convective drying provides effective and high-quality results for plum processing, enabling long-term storage, preservation of beneficial properties, and production of consumer-ready products. Future advancements should focus on modernizing this technology, using automated dryers, and implementing energy-saving methods.

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