

COMMON METHODS FOR DRYING APRICOT A STONE FRUIT

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Abstract. This article analyzes the common methods for drying apricots, including natural, mechanical, and modern technologies (infrared, microwave, and lyophilization). The efficiency, energy consumption, impact on product quality, and environmental sustainability of these methods are examined. Special attention is given to their applicability in Uzbekistan's agricultural context and their significance in the export market. The study is based on scientific literature and practical data, providing a comparative analysis of the advantages and limitations of drying processes. The article offers recommendations for selecting optimal methods and adopting modern technologies to advance apricot drying in Uzbekistan.

Keywords: Apricot drying, natural drying, mechanical drying, infrared drying, microwave drying, lyophilization, agriculture, food industry, product quality, energy consumption, environmental sustainability.

Introduction

In agriculture and the food industry, fruit processing, particularly the drying of apricots is crucial for extending shelf life, preserving nutritional properties (vitamins A, C, E, minerals such as potassium, magnesium, and iron), and enhancing export potential. In Uzbekistan, apricot drying is a key agricultural sector, particularly in the Fergana Valley, Samarkand, and Surkhandarya regions, which are major hubs of economic activity. In 2023, Uzbekistan exported over 50,000 tons of dried apricots, reflecting its strong position in the global market (Uzbekistan Statistics Agency, 2024).

Apricot drying activities in Uzbekistan are regulated by a legal framework. The Law of the Republic of Uzbekistan "On Food Safety" (2021) establishes requirements for ensuring the quality and safety of food products during drying processes, mandating compliance with sanitary norms and freedom from microbiological and chemical contamination. The Law "On the Development of Agriculture" (2004) supports the advancement of technological processes in processing and export preparation of agricultural products. The DSt 3302:2015 standard, approved by the "UzDavStandart" agency, specifies requirements for dried fruits, including apricots, such as moisture content (10–15%), organoleptic properties, and storage conditions. These normative-legal documents ensure environmental safety and product quality in drying processes.

This article examines the common methods for drying apricots—natural (sun drying), mechanical (chamber drying), and modern technologies (infrared, microwave, and lyophilization). The study aims to analyze the efficiency, energy consumption, impact on product quality, and environmental sustainability of these methods, as well as to identify their applicability in Uzbekistan’s agriculture. Based on scientific literature and practical research, the advantages, limitations, and prospects of these methods are evaluated.

Main Body

1. Natural Drying Method (Sun Drying)

Natural drying, or sun drying, is the most traditional and widely used method for processing apricots. In this process, apricots are dried in open air under sunlight and natural ventilation, reducing moisture content to 10–15%. Uzbekistan’s dry and hot climate, particularly in the Fergana Valley and Samarkand regions, with high solar radiation (approximately 3000 hours of sunshine annually), provides favorable conditions for natural drying. The primary advantage of this method is its zero energy consumption and environmental friendliness, making it economically viable for smallholder farms. Studies indicate that natural drying preserves the natural color, taste, and aroma compounds of apricots, enhancing their market competitiveness (Smith et al., 2020).

However, natural drying has several limitations.

The process is time-consuming (7–14 days) and dependent on weather conditions (e.g., rain, high humidity). Open-air drying increases the risk of dust, insect, and microbiological contamination, which can compromise product quality. For instance, studies show that natural drying can result in a 20–30% loss of vitamin C due to prolonged exposure to high temperatures and accelerated enzymatic reactions (Smith et al., 2020). Additionally, standardizing quality is challenging, limiting the method’s applicability for industrial-scale production. In Uzbekistan, natural drying is primarily used for local markets and small farms, but additional quality control is required for export-oriented products. To improve the application of natural drying in Uzbekistan, dedicated drying platforms (e.g., mesh-protected structures) and adherence to sanitary norms are recommended. Furthermore, pre-treatment with chemicals (e.g., sulfur dioxide) is common to enhance quality, but its use is debated from environmental and consumer safety perspectives.

2. Mechanical Drying (Chamber Drying)

Mechanical drying involves drying apricots in specialized chambers with controlled temperature (50–70°C) and humidity conditions, utilizing fans and heating elements. This method reduces drying time to 2–4 days. Its primary advantage is consistent product quality and low contamination risk. Controlled conditions ensure better preservation of apricots’ color, taste, and nutritional properties (vitamin C, antioxidants). Studies indicate that mechanical drying retains 10–15% more vitamin C compared to natural drying (Johnson & Lee, 2021). In Uzbekistan, mechanical drying is widely used by medium and large enterprises, significantly contributing to the quality of export-oriented dried apricots. For example, the “AgroExport” enterprise in Samarkand produces over 10,000 tons of dried apricots annually using mechanical drying (Uzbekistan Statistics Agency, 2024).

However, energy consumption is high, increasing operational costs. Drying one ton of apricots requires 500–700 kWh of electricity, and the initial cost of equipment can be a barrier for smallholder farms. To enhance the efficiency of mechanical drying in Uzbekistan, research is being conducted on hybrid solar-powered drying systems. For instance, experimental farms in Tashkent region are testing solar-powered drying chambers, which can reduce energy costs by 30–40% (UzAgroTech, 2023). Additionally, drying at high temperatures (above 70°C) may lead to the loss of antioxidants and enzymes, making the selection of optimal temperature (55–65°C) and time parameters critical.

3. Modern Drying Technologies

Modern drying technologies, including infrared, microwave, and lyophilization (freeze-drying), provide high quality and efficiency in apricot drying.

3.1 Infrared Drying

Infrared drying uses radiation to rapidly and uniformly evaporate moisture from apricots, reducing drying time by 50% (approximately 4–6 hours). This method preserves 85–90% of nutritional properties, including vitamin C and antioxidants (Zhang et al., 2022). Infrared drying is more energy-efficient than mechanical drying, as radiation targets only the fruit's moisture. Although less common in Uzbekistan's industrial applications, research indicates its promising potential. For example, experiments at Tashkent State Agrarian University have shown that infrared drying can reduce energy costs by 20% .

3.2 Microwave Drying. Microwave drying rapidly evaporates moisture using microwaves, reducing drying time to 1–2 hours. This method produces high-quality products, preserving taste and texture, but high power levels may lead to partial loss of antioxidants (Aliyev, 2023). Due to high equipment costs and energy consumption, microwave drying is primarily used by large enterprises in Uzbekistan, limiting its adoption by small farms.

3.3 Lyophilization (Freeze-Drying). Lyophilization involves freezing apricots and removing moisture through sublimation, preserving 95% of nutritional properties and natural color.

However, the process is costly and technologically complex, making it suitable for premium markets (Europe, USA) where lyophilized apricots command high prices. In Uzbekistan, this method is rarely used but holds significant potential for expanding export opportunities. For instance, demand for lyophilized apricots in China increased by 15% in 2023.

4. Comparative Analysis of Methods. Each drying method has distinct advantages and limitations. The comparative analysis indicates that natural drying is cost-effective and suitable for small farms but limited in quality and time efficiency. Modern methods offer high quality and speed but incur higher costs. In Uzbekistan, a combination of mechanical and infrared drying may be optimal, balancing quality and cost efficiency.

5. Prospects for Apricot Drying in Uzbekistan

Apricot drying is a significant contributor to Uzbekistan's export market. In 2023, over 50,000 tons of dried apricots were exported, primarily to Russia, China, and Europe. While natural drying remains prevalent, adopting modern technologies can enhance product quality and

competitiveness. Infrared drying reduces energy consumption and supports environmental sustainability, while lyophilization meets the demands of premium markets. Implementing hybrid solar-powered drying systems can reduce costs and environmental impact. Uzbekistan's high solar energy potential makes this approach particularly viable for improving energy efficiency in agriculture. Additionally, government programs to enhance farmer skills and support enterprises with modern equipment are recommended to improve drying quality.

Conclusion

The common methods for drying apricots—natural, mechanical, and modern technologies (infrared, microwave, and lyophilization)—play a vital role in agriculture and the food industry. Natural drying is cost-effective and eco-friendly but limited in quality and time efficiency. Mechanical drying ensures consistent quality but has high energy consumption. Modern technologies provide high quality and speed but are costly. To advance apricot drying in Uzbekistan, developing hybrid methods, improving energy efficiency, and adopting modern technologies are recommended. Future research should focus on environmental sustainability, cost optimization, and enhancing product quality.

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