Study of Drying Technology for Fig (Ficus carica L.) Fruits

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Abstract: This research is devoted to a comprehensive study of the technological parameters and economic efficiency of drying fig (Ficus carica L.) fruits under the climatic conditions of Uzbekistan. The study primarily focuses on the local "Sariq Anjir" (Tashkent/Namangan fig), "Qora Anjir," and the internationally recognized "Kadota" varieties. Three drying methods—natural sun drying, artificial convection drying, and combined methods—were subjected to a comparative analysis. Drying kinetics, energy consumption, nutrient preservation, and final product quality were utilized as key performance indicators.

Experimental results indicate that while natural sun drying is the most cost-effective in terms of energy consumption, it lacks stability regarding microbiological safety and product quality. Conversely, the combined drying method was identified as the most technologically superior; it ensures the preservation of optimal texture and color and provides high export-oriented characteristics while significantly reducing energy consumption compared to the artificial method. From an economic perspective, the "Sariq Anjir" variety recorded the highest profit indicators, achieving a net profit of 7.6 million UZS per ton and a profitability level of 61.3%. The study concludes that implementing combined drying technologies in the agricultural sector of Uzbekistan will drastically reduce harvest losses, stimulate the fruit and vegetable processing industry, and enhance the competitiveness of local dried figs in the global export market.

Keywords: *Ficus carica L., fig drying, food technology, dehydration kinetics, economic efficiency, Sariq Anjir, Kadota, combined drying method, net profit, profitability level, export-oriented production, post-harvest losses, nutritional value, sustainable processing.*

Introduction

Ficus carica L. (fig) belongs to the Moraceae (mulberry) family. The genus Ficus comprises between 600 and 1,900 species, making it one of the most species-rich plant genera. However, only a few of these produce edible fruit. Most species are native to tropical and subtropical regions, the Middle East, and the Mediterranean basin. The fig is one of the oldest fruits domesticated by humanity. Alongside the pomegranate and olive, it is the third classic fruit crop associated with the emergence of horticulture in the Mediterranean basin over 6,000 years ago. Today, figs—marketed processed, dried, or fresh—are cultivated in many warm and temperate climates. Their growth is limited more by low winter temperatures than by summer heat. Climate significantly influences the size, shape, and the color of the skin and pulp of the fig. Rain, hail, and wind can diminish fruit quality and overall yield.

Currently, figs (both fresh and dried) are an essential component of the Mediterranean diet. Fig fruits, especially dried ones, are highly rich in fiber, micronutrients, polyphenols, proteins, Vitamin K, carbohydrates, magnesium, potassium, calcium, and natural sugars. According to literature, fresh and dried figs are effective in treating cardiovascular diseases, cancer, and constipation. In traditional Mediterranean medicine, these fruits are noted for their antipyretic (fever-reducing), laxative, aphrodisiac, anti-inflammatory, and anti-paralytic properties. Other parts of the tree—leaves, latex (milky sap), bark, and roots—are also utilized for medicinal purposes. Ficus carica leaves, branches, bark, and latex have been researched for their biological activity against microbes, cancer, inflammation, fever, diabetes, obesity, liver

damage, and diarrhea.

Due to its nutrient density and versatility, the fig could play an even more significant role in the global market. In 2020, over 1,315,588 metric tons of figs were produced across 289,818 hectares. Approximately 90% of this production originates from the Mediterranean basin and the Middle East. Turkey is the world's largest fig producer, accounting for about 26% of global production. Turkey, Egypt, Iran, Greece, Algeria, and Morocco constitute the "top six," representing nearly 70% of annual global output.

Compared to major fruit crops like apples, bananas, and citrus, global fig production volume is small. However, it has reached one-third to one-half of the production volume of apricots and cherries, meaning it can no longer be considered a minor crop. The majority of current commercial production is dedicated to dried figs. The greatest growth potential, however, lies in high-quality fresh figs. Currently, due to short transport windows and limited shelf life, fresh figs remain a high-value fruit with limited demand. To expand the market for fresh figs, it is essential to extend their post-harvest shelf life.

Relevance and Necessity of the Thesis Topic

The fig (Ficus carica L.) is one of the world's ancient fruit crops, cultivated by humans for millennia. Globally, the area under fig cultivation is approximately 280–300 thousand hectares, with gross yields reaching 1.2–1.3 million tons in recent years. Most figs are consumed in dried form because fresh fruit is highly perishable and difficult to store for long periods.

A large portion of the world's fig production (especially in leading countries like Turkey, Iran, Egypt, and Morocco) is directed toward drying. Dried figs are a high-value-added product with significant export potential. They serve as an important part of healthy nutrition as a source of natural sweetness and nutrients (sugars, fibers,

minerals, and antioxidants).

Leading global producers include Turkey (320–356 thousand tons), Egypt, Morocco, Algeria, Iran, and Afghanistan. Turkey leads not only in production but also in the export of dried figs. Current priorities in global fig cultivation include increasing productivity, creating disease- and pest-resistant varieties, improving drying technologies, maintaining product quality, and reducing the risk of mycotoxins (aflatoxin).

The climatic conditions of the Republic of Uzbekistan (hot and dry summers) are highly favorable for growing and naturally drying figs. In recent years, efforts to test and cultivate high-yielding, disease-resistant local and foreign fig varieties have intensified in our country. However, the issues of harvesting, storage, and particularly the scientific improvement of drying technologies have not yet been sufficiently studied.

Strategic documents of the President of the Republic of Uzbekistan aimed at developing agriculture, increasing the income of farmers, and producing value-added exportable products define the development of the fruit and vegetable and drying industries as a vital task. Therefore, developing effective drying technologies for fig fruits to reduce losses, improve product quality, and increase export volumes is of great relevance.

This graduation thesis is conducted on the topic: "Study of Drying Technology for Fig (Ficus carica L.) Fruits."

Objective of the Research: To study various drying methods (natural sun drying, artificial convection drying, and combined methods) for fig fruits grown in Uzbekistan conditions, determine the most effective technological parameters, and improve the quality indicators of the dried product.

Research Tasks:

Analyze the economic importance, morphological, and biological characteristics of figs.

Familiarize with control measures against fig pests and diseases.

Study harvesting and primary technological processing methods.

Compare the effects of different drying methods.

Evaluate the impact of the drying process on quality indicators (moisture, color, texture, nutrient retention, microbiological safety).

Determine the economic efficiency of the drying technology and develop practical recommendations.

Object of Research: Fruits of promising fig varieties grown in the continental climate of the Republic of Uzbekistan. The study focuses on three varieties: the local Sariq Anjir (Namangan fig), Qora Anjir, and the foreign variety Kadota. These varieties are widespread in the Fergana Valley, Samarkand, and Tashkent regions, and are highly valued for their size, sweetness, and suitability for drying.

Subject of Research: Mechanisms and results of various technological drying methods (natural sun, artificial convection, and combined). This includes in-depth studies of drying speed, energy consumption, physicochemical and organoleptic indicators, nutrient retention levels, and microbiological safety.

Scientific Novelty: Through a comprehensive comparative study of various drying methods for Sariq Anjir, Qora Anjir, and Kadota varieties under Uzbekistan's climate, the most effective and economically viable drying technology is proposed. For the first time, a comparative analysis of sun, artificial, and combined drying methods in local conditions was conducted, establishing the relationship between quality indicators (color, texture, nutrient retention, and aflatoxin risk) and energy consumption. Consequently, optimal technological parameters for producing export-quality dried figs were developed.

Practical Significance: The research results are of practical value for fig-growing farms, drying enterprises, and clusters in Uzbekistan. The optimal drying technology proposed in this work allows for the reduction of post-harvest losses, enhancement of product quality, and increased production of exportable dried figs. Implementing these results will serve to increase farmers' income, create new jobs, and enhance the competitiveness of our country's dried fruit products in the global market.

2.1. Economic efficiency of drying fig (Ficus carica L.) fruits.

Today, the deep processing of agricultural products and the production of export-oriented goods are key priorities in the agricultural sector. In particular, processing highly perishable fruits to extend their shelf life and increase their economic value is of great importance. One such fruit is the fig (Ficus carica L.).

Due to its high content of natural sugars, organic acids, vitamins, minerals, and biologically active compounds, the fig possesses high nutritional value. However, fresh figs are extremely delicate and perishable, with a very limited shelf life. Consequently, a significant portion of the harvest is lost during storage and transportation. Drying technology plays a vital role in overcoming this challenge.

The drying process removes excess moisture from the product, which slows down microbial growth and extends shelf life. Dried figs are in high demand in the market and are among the primary exportable goods. Especially in countries like Turkey, Iran, and the Mediterranean region, dried figs are valued as an economically significant commodity.

The climatic conditions of the Republic of Uzbekistan, particularly the hot and dry summers, provide favorable opportunities for the natural drying of figs. This not only reduces production costs but also allows for the production of high-quality dried goods. By increasing the volume of fig cultivation and processing in our republic, it is possible to strengthen export potential, increase the income of farming enterprises,

and develop the food industry.

During the study, the economic efficiency of the Sariq Anjir (Tashkent fig), Qora Anjir, and Kadota varieties, which are widely grown in Uzbekistan, was examined. Calculations were based on 1 ton (1000 kg) of fresh harvest.

Due to the high moisture content in fig fruits, a reduction in mass occurs during the drying process. On average, 1 kg of dried product was obtained from 4 kg of fresh figs. Accordingly, 250 kg of dried product was prepared from 1000 kg of fresh fruit..

Table 1

Economic indicators by fig varieties (2024-2025)

№	Indicators	Sariq Anjir	Qora Anjir	Kadota
1	Fresh harvest quantity	1000 kg	1000 kg	1000 kg
2	Price of 1 kg of fresh fruit	10,000 UZS	15,000 UZS	20,000 UZS
3	Raw material value	10,000,000	15,000,000	20,000,000
4	Drying and technological costs	2,400,000	2,500,000	2,600,000
5	Total costs	12,400,000	17,500,000	22,600,000
6	Quantity of dried product	250 kg	250 kg	250 kg
7	Price of dried product	80,000 UZS	90,000 UZS	95,000 UZS
8	Gross income	20,000,000	22,500,000	23,750,000
9	Net profit	7,600,000	5,000,000	1,150,000
10	Profitability level	61.30%	28.50%	5.10%

As shown in the table data, the highest economic efficiency was observed in the **Sariq Anjir** variety. Due to the relatively low cost of raw materials and lower drying expenses, the net profit for this variety amounted to 7.6 million UZS. The profitability level reached 61.3%, which is significantly higher compared to the other varieties.

In the **Qora Anjir** variety, despite a higher selling price, the net profit was 5 million UZS due to the increase in raw material costs. The profitability level for this variety was

28.5%. At the same time, it was noted that the Qora Anjir variety has good marketability due to its superior appearance and consumer value.

Although the **Kadota** variety possesses high product quality and export potential, the high cost of fresh fruit negatively impacted its economic efficiency. As a result, the net profit was 1.15 million UZS, and the profitability level was 5.1%. This indicates a need to reduce costs or increase the selling price when cultivating the Kadota variety.

The profitability level was determined based on the following formula:

$$R=\frac{SF}{UX}\times 100$$

Where:

- **R** — profitability level (%);
- **NP** — net profit;
- **TC** — total costs.

For the **Sariq Anjir** variety, the calculation was performed as follows:

$$R=\frac{7600000}{12400000}*100=61.3\%\ 1.$$

Various technological methods are used in drying fig fruits. During the study, the economic and technological indicators of natural sun drying, artificial convection drying, and combined drying methods were compared.

Table 2.

Economic comparison of different drying methods

№	Indicators	Sun drying	Artificial convection drying	Combined method
1	Drying duration	6–8 days	18–24 hours	2–3 days
2	Energy consumption	Very low	High	Medium
3	Product quality	Medium	High	Very high
4	Color retention	Natural	Good	Very good

5	Texture	Medium	Soft	Elastic
6	Microbiological safety	Medium	High	High
7	Product loss	10–12%	4–5%	3–4%
8	Total cost	Low	High	Medium
9	Net profit	6–8 mln UZS	3–5 mln UZS	8–10 mln UZS
10	Profitability level	50–55%	25–30%	60–65%
11	Exportability level	Medium	High	Very high

As shown in the table results, the natural sun drying method is economically inexpensive. This method requires almost no energy consumption, which results in low total costs. However, the drying period is long, and the product quality depends on environmental factors.

Although artificial convection drying produces high product quality, total costs increase due to high electricity consumption. Consequently, the profitability level is lower compared to other methods.

The combined drying method was evaluated as the most optimal variant in terms of economic efficiency and product quality. In this method, initial sun drying followed by artificial drying results in reduced energy consumption and high product quality. The appearance, color, and texture of the product are well-preserved, meeting export requirements.

The results of the conducted research indicate that implementing fig drying technology is economically efficient for farming enterprises and processing plants. In particular, the high profitability level observed in the Sariq Anjir variety demonstrates its high suitability for drying.

By implementing these technologies in production:

Crop losses are reduced;

Production of export-oriented products is increased;

Income for farming enterprises is raised;

The processing industry is developed;

Opportunities for creating new jobs are expanded.

Furthermore, the growing international demand for dried fig products will contribute to the further development of this sector in the future. The combined drying technology is recommended as the most promising technology in terms of both product quality and economic efficiency.

Conclusions

1. It was determined that the fig (Ficus carica L.) is one of the most suitable fruit crops for drying and high-yield production in the hot and dry climatic conditions of Uzbekistan. Specifically, the abundance of sunny days during the summer months ensures an efficient natural drying process.
2. Research results indicated that drying fig fruits extends their shelf life several times over, increases transport durability, and creates opportunities for producing high-demand export products.
3. Among the studied varieties, the Sariq Anjir (Yellow Fig) variety demonstrated the highest economic efficiency. This variety achieved a net profit of 7.6 million UZS and a profitability rate of 61.3%, confirming it as one of the most optimal varieties for drying.
4. Among various drying methods, combined drying technology was evaluated as the most promising in terms of product quality, energy efficiency, and economic viability. This method preserved the color, texture, and organoleptic indicators of the product effectively, resulting in a high-quality product that meets international export standards.
5. It was scientifically and practically substantiated that processing fig fruits using modern drying technologies is crucial for increasing the income of farms, reducing

post-harvest losses, creating new jobs, and expanding the export potential of the country's dried fruit industry.

Recommendations

1. It is recommended to expand the cultivation of Sariq Anjir, Kadota, and Qora Anjir varieties, which are well-suited for drying under Uzbekistan's conditions, and to produce them on an industrial scale.
2. To maintain product quality during the drying process, it is essential to strictly adhere to fruit sorting, sulfur fumigation (bleaching), hygienic requirements, and microbiological safety standards.
3. In order to direct dried fig products toward the export market, modern packaging, certification, and logistics systems must be further developed.
4. It is recommended to continue scientific research on fig processing and drying, create new high-yielding and disease-resistant varieties, and develop innovative technologies aimed at reducing production costs..

References

1. Fayziyev, J.N. (2020). Scientific Substantiation of Technology for Increasing the Yield and Quality of Seedless Grape Varieties under the Conditions of Uzbekistan. Author's abstract of the dissertation. Tashkent. pp. 5–18.
2. Egamberdiyev, P.E. (2023). The Influence of Bud Loading on Grape Yield and Quality in the Cultivation of Table Grape Varieties Using the Overhead Trellis (Voish) Method. Dissertation. Tashkent. pp. 52–85.
3. Сапаева, З. Ш., & Абдуллаева, Б. А. (2021). Влияние низкотемпературной обработки некоторых сортов винограда на их аминокислотный состав. *Молодой ученый*, (22), 117-120.
4. Файзиев, Ж. Н., Эгамбердиев, П. Э., & Жўлбеков, И. С. Ў. (2022). УЗУМНИНГ ХЎРАКИ КАТТА ҚЎРҒОН НАВИНИ ВОИШ УСУЛИДА

ЕТИШТИРГАНДА КУРТАК ЮКЛАМАЛАРИНИ ҲОСИЛДОРЛИК КЎРСАТКИЧЛАРИГА БОҒЛИҚЛИГИ. *Academic research in educational sciences*, *3*(Speical Issue 1), 254-257.

5. Ergashovich, E. P., Mardonovich, K. F., Ogli, J. I. S. O. A. D. U., Shavkatovich, A. A., Djumanazarova, S. D., & Raimovna, R. D. (2022). Effect of buds particle on productivity and quality when growing Katta Kurgan table variety grapes by voish method.

6. Jo'lbekov, I., Ungarov, A., Umrzoqova, I., & Adhamov, A. (2023). UZUMNING SANOATBOP NAVLARINI YETISHRISH USULLARIGA DOIR MAVZULARNI INNOVATSION TEXNOLOGIYALARDAN FOYDALANGAN HOLDA TASHKIL ETISH. *Евразийский журнал технологий и инноваций*, *1*(6), 89-93.

7. Rakhmatov, O., Zhulbekov, I. S., & Kabulov, I. M. (2023). Experimental study of a drying installation for drying melon with IR-radiation. In *E3S Web of Conferences* (Vol. 443, p. 02005). EDP Sciences.

8. Жўлбеков, И. С. Ў. (2024). УЗУМНИНГ ШАРОБОП НАВЛАРИНИНГ ХУСУСИЯТЛАРИ ВА УЛАРДАН ТУРЛИ НАВЛИ ШАРОБ ТАЙЁРЛАШ ТЕХНАЛОГИЯЛАРИ. *Central Asian Journal of Multidisciplinary Research and Management Studies*, *1*(7), 158-165.

9. Khujakulov, F., Egamberdiev, P., Julbekov, I., Abduraimov, D., & Ungarov, A. (2023). The dependence of grape feeding on the productivity indicator and harvest quality of rizamat and large dry varieties.

10. Sultanov, K., Egamberdiev, P., & Khujakulov, F. (2024). THE DEPENDENCE OF THE AMOUNT OF ORGANIC MATTER ON THE DEVELOPMENT OF THE ROOTS OF GRAPE VARIETIES. *American Journal Of Agriculture And Horticulture Innovations*, *4*(03), 15-20.

11. Kamoliddin, S., Pulatjon, E., & Ibrohim, J. (2024). DEPENDENCE ON THE MECHANICAL COMPOSITION OF THE APPLICATION OF GROWTH SUBSTANCES TO THE GROWING VARIETIES OF GRAPES. *Universum: технические науки*, *8*(3 (120)), 37-40.

12. Weizhou, Z., O‘G, J. L. I. S., Qizi, S. S. I., Qizi, J. R. F. O., & Qizi, O. G. X. (2025). UZUM KO ‘CHATLARINI EKISH SXEMASI VA NAVLARNI JOYLASHTIRISH. *Central Asian Journal of Academic Research*, *3*(4), 94-97.

13. Sattarov, K., Eshmurodov, D., Mamatkulova, M., Julbekov, I., & Kharsika, I. (2025). The impact of active packaging and nanocoatings on the safety and shelf life of dairy products. *Scientific Journal'Animal Science & Food Technologies'*, *16*(2).

14. Эгамбердиев, П. Э., Хужакулов, Ф. М., Жулбеков, И. С. Ў., & Абдураимов, Д. У. Ў. (2025). ЗАВИСИМОСТЬ ПРИМЕНЕНИЯ РЕГУЛЯТОРОВ РОСТА НА МЕХАНИЧЕСКИЙ СОСТАВ ЯГОД СТОЛОВЫХ СОРТОВ ВИНОГРАДА. *Universum: технические науки*, *6*(12 (141)), 31-35.

15. O‘G, J. L. I. S., & Qizi, U. I. S. (2025). UZUMNI HOSILDORLIGI VA SIFATIGA ORGANIK VA MINERAL O ‘G ‘ITLARNING TA’SIRI. *Central Asian Journal of Academic Research*, *3*(4-3), 61-66.

16. Weizhou, Z., O‘G, J. L. I. S., Qizi, S. S. I., Qizi, J. R. F. O., & Qizi, O. G. X. (2025). UZUM KO ‘CHATLARINI EKISH SXEMASI VA NAVLARNI JOYLASHTIRISH. *Central Asian Journal of Academic Research*, *3*(4), 94-97.

17. Жулбеков, И. С. У. (2025). ВЛИЯНИЕ ЦИТОГУМИНОВОГО ВЕЩЕСТВА НА РАЗМЕР ЯГОД И МОРФОЛОГИЧЕСКИЕ ОСОБЕННОСТИ КИШМИШНЫХ СОРТОВ ВИНОГРАДА. *Universum: технические науки*, *4*(1 (130)), 9-11.