

# Development of sukat preparation technology from introduced unabi (*Ziziphus jujuba* Mill.) fruits

Musirmon Ochilov<sup>1\*</sup> and Xikmat Shaumarov<sup>1</sup>

<sup>1</sup>Tashkent State Agrarian University, 100140 Tashkent, Uzbekistan

**Abstract.** Unabi (*Ziziphus jujuba* Mill.) is considered a fruit with high food and medicinal properties in Uzbekistan, and this article presents the results of improving the technology of making sukat from unabi fruits introduced from China. In the development of technological parameters of fruit drying, when three stages of 40-50-60 °C drying regimes were used for 12 hours with 4-hour intervals, "Junzao" and "Zanhuangdazao" were among the dried varieties with 91.0 and 90.0 points. excellent quality sugarcane, "Jixinzao", "Xiangzao", "Tangzao", "Linyilizao", "Ta-Yan-Tszao" varieties were evaluated, respectively 87.3; 86.1; 79.5; 78.3; 75.1 points were obtained, and the average commodity type candied fruit products were obtained, as well as "Dabailing", "Mayabaizao" and "Dongzao" varieties, respectively 56.0; 54.9; 55.4 were evaluated with the lowest indicator score, so it was recorded as an unsuitable variety for making sukat.

## 1 Introduction

In countries such as China, India, Pakistan, Afghanistan, CIS, Israel and Egypt, which are the leaders in the cultivation of unabi in the world, the nutritional and healing properties of unabi are high, they are sweet and sour, they are eaten fresh, they have wide processing possibilities, and they are resistant to drought, to create new varieties, to introduce and plant promising varieties. extensive scientific research is being conducted in the direction of improving technologies for cultivation and production of various products. Therefore, its introduced area has been expanding in recent years. In more than 48 countries that grow unabi around the world, its total area is more than 3 million hectares, and the total volume of production is more than 10 million tons. In China alone, its area is more than 2 million hectares, and about 8 million tons of products are grown annually [11-15].

Sukats are fruits obtained by boiling less in sugar paste. Fruits are boiled until the amount of dry matter in the product reaches 75-80%. Boiled fruits should be transparent. Fruits are separated from pulp, sprinkled with sugar and dried at low temperature to 84-88% dry matter content. Ready-made candies are divided into 5 different varieties [2].

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\* Corresponding author: [m\\_ochilov83@mail.ru](mailto:m_ochilov83@mail.ru)

To increase the rate of saturation of the fruit with pomace, it is necessary to irreversibly lose cell protoplasm, because the rate of absorption of pomace into whole cells is hundreds of times slower than in damaged cells [3].

Various drying methods are used to dry fruits and vegetables whole or in pieces: convective, conductive, radiation, high frequency, vacuum, etc. [4]. Unabi fruits boiled in sugar syrup were dried by convective method.

In our country, where the demand for medicinal and high-nutritional products is increasing, the introduction of increasing the range of consumer products by growing new varieties and processing their fruits is one of the urgent tasks of the national economy [6-10].

## 2 Materials and Methods

Experiments on the process of sorption of unabi fruits in sugar syrup, syrup concentration, drying regimes and evaluation of organoleptic properties of the finished product were conducted in the laboratory of the Department of "Preservation and Processing of Agricultural Products" of Tashkent State Agrarian University. In the experiment, 10 varieties of unabi introduced from China ("Dongzao", "Linyilizao", "Dabailing", "Mayabaizao", "Junzao", "Zanhuangdazao", "Jixinzao", "Xiangzao", "Tangzao" and "Ta-Yan-Tszao" [5], mechanical treatment of the fruit surface and convective drying equipment were used.

The amount of dry matter in the unabi fruit was determined using the "Refractometric" method, and the physical, chemical and organoleptic quality indicators of unabi fruits and sukat were carried out using the E.P. Shirokov methods.

The development of technological parameters of drying was carried out using three-stage drying modes with 4-hour intervals for 12 hours: 1st drying mode - at a temperature of 30-40-50 °C; 2nd drying mode - at a temperature of 40-50-60 °C; 3rd drying mode - at a temperature of 50-60-70 °C; 4th drying mode - at a temperature of 70-60-50 °C.

## 3 Results and Discussion

Sukats are a complex drying object, where parameters such as initial and final moisture content, chemical composition, structural-mechanical changes and mass exchange characteristics should be taken into account. During the drying process of sukat preparation, not only the natural properties of the product should be preserved, but also significantly improved. Therefore, the choice of the optimal mode of the dryer should be directly related to the product characteristics and the requirements for the production technology of one or another type of finished product, that is, the scientific basis of the theory and technology of drying should be based.

The drying process should be carried out in conditions that reduce the possibility of sugar caramelization, protein denaturation, and do not spoil the appearance and quality of the finished product. For this, a soft mode drying method is required, which determines the task of our research.

The goal of our work is to establish the optimal drying regime, taking into account the speed of drying, the reduction in the size of candied fruits during the drying process, and the change in the chemical quality indicators of the finished product.

The analysis of drying of the product shows that in the first drying mode (30-40-50 °C) the drying temperature at a low temperature is normal, corresponding to the permeability of the fruit. During the continuous drying period, called the first drying period, free moisture is removed. This has a positive effect on the quality of the harvested product, especially on

keeping the color and size of the fruit. However, it will not be possible to provide enough heat energy to dry large-sized fruits of "Linyilizao", "Dabailing" and "Mayabaizao" varieties within the specified period of time, as a result, the process will not be completed. In this mode, the product takes a long time to deworm, which in itself has a negative effect on the increase in electricity consumption and the shortening of the deworming season.

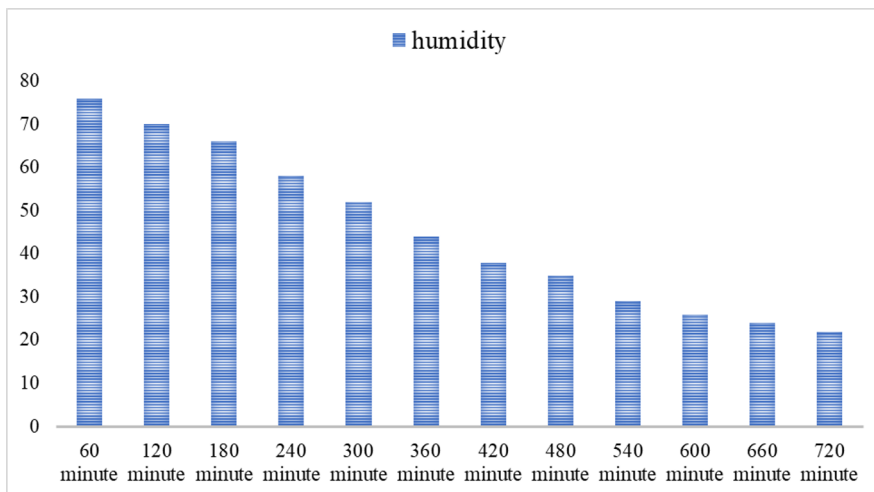
Among the varieties studied, the highest yield of finished products was in "Junzao", "Zanhuangdazao", "Jixinzao", "Xiangzao" and "Tangzao" varieties, 81.7%, 77.8%, 75.8%, 74.5%, respectively. , was 72.1%, but it was evaluated with a significantly lower score according to the organoleptic parameters of dried candied fruits in another regime.

The organoleptic indicators of the "Ta-Yan-Tszao" variety compared to the products dried in the 2-3 and 4 modes in the first drying mode are 6.8; 4.5; 3.8 points, "Xiangzao" variety 7.8; 2.1; 0.5 points, "Zanhuangdazao" variety 8.1; 5.1; 1.0 points, "Tangzao" variety 7.2; 3.8; 4.8 points, "Junzao" variety 8.2; 5.5; 1.3 points, 5.0 in "Dabailing" variety; 3.3; 3.3 points, 7.0 in "Linyilizao" variety; 4.7; 3.9 points and "Jixinzao" variety 7.9; 5.3; Rated 2.8 low. 0.4, respectively, compared to "Mayabaizao" and "Dongzao" varieties, which were dried according to the temperature of mode 4 only; It is only rated higher by 1.1 points. The main reason for this is that the product contains too much moisture and has an unripe fruit smell.

In the second mode, the initial heating of the surface of the candied unabi fruit layers is very strong, and after 1-2 minutes, the surface of the fruit takes the temperature of the internal environment of the drying equipment. This is due to the absorption of a significant part of the radiation flux in the surface layer of raw materials. In this case, part of the supplied energy goes to phase changes of moisture, and then the rate of heating of the surface layers is significantly reduced.

When sukat was dried in the artificial drying equipment, due to the special efficiency of infrared rays, the inner layers of the sukat were also rapidly heated. Despite the rapid heating of the inner layers of the raw material, in the first minutes the difference between the temperature of the surface and the central layers has a significant value of 10-15 °C. The presence of such a temperature gradient leads to thermal diffusion of moisture to the central layers and increases the intensity of heating.

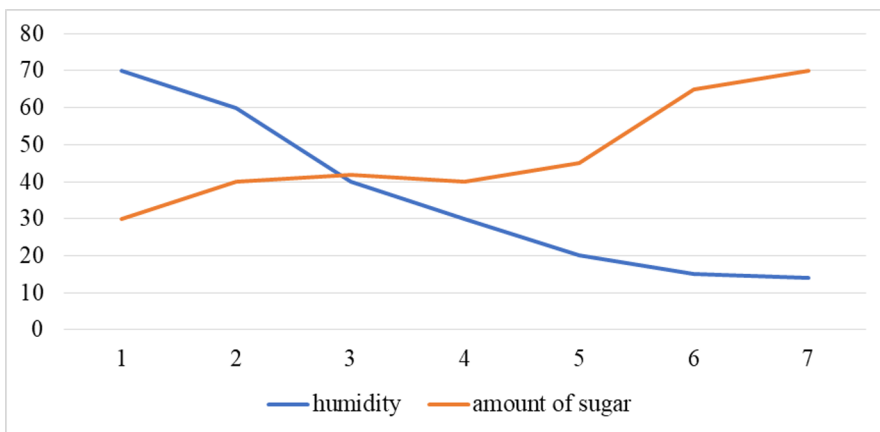
Inversely proportional to time, the moisture content of unabi fruits decreased with time, while in the first 60 minutes, the moisture content of the fruit was on average 72-75%, after the last 720 minutes, this moisture content was 20-22% (Figure 1).



**Figure 1.** Inversely proportional change of moisture content during drying process

Considering the intensity of heating of the surface layers of the sukats and the high amount of dry matter in the prepared material, maintaining a drying temperature of 40 °C for 4 hours ensured a uniform and gradual heating of the inner layers. This helped to maintain the shape and size of the sukats.

After the heating period, the moisture content of the material decreases over time according to Linnaeus' law. The drying curve on the graph will have the correct reading. During this period, the temperature of the surface and the center of the fruit is the same, that is, the difference between the temperature of the air and the temperature of the surface of the material is at a constant value (Figure 2). After that, a period of constant drying speed begins in the technological process, which is characterized by a constant temperature of the material. The use of the second drying mode allows to obtain fruit products that have not lost their shape, especially "Junzao" and "Linyilizao" unabi varieties, with an attractive appearance and maximum retention of biologically active substances.



**Figure 2.** Sukat drying curve (drying time, hours)

"Junzao" and "Zanhuangdazao" varieties are 91.0 among the varieties dried in the second mode (at a temperature of 40-50-60 °C); It was evaluated with 90.0 points and had a clear advantage, "Jixinzao", "Xiangzao", "Tangzao", "Linyilizao", "Ta-Yan-Tszao" varieties, respectively 87.3; 86.1; 79.5; 78.3; It was evaluated with 75.1 points and it was determined that it is possible to prepare sugarcane products of the average commercial variety, as well as "Dabailing", "Mayabaizao" and "Dongzao" varieties, respectively 56.0; With 54.9 and 55.4 points, they were recorded as varieties that scored less than the minimum score.

In general, varieties dried according to the second mode had a higher index in the range of 0.5-1.5 on average compared to all unabi varieties dried in the 3-4 mode.

Drying in the third mode helps to reduce the time of the technological process by 1.0-1.5 hours, but the candied fruit has a lower index in organoleptic evaluation due to the more unattractive appearance of the raw material of candied fruits. This can cause a sharp drop in the marketability of products.

Compared to the control variety "Ta-Yan- Tszao" (72.8 points), "Junzao" variety took the highest place with 15.5 points, followed by "Zanhuangdazao" with 14.2 points. "Jixinzao" varieties with 11.9 points, "Xiangzao" and "Linyilizao" varieties were evaluated with small differences with 7.6 and 3.2 points. Also, varieties with low performance compared to the control were noted, these are "Mayabaizao", "Dongzao", "Dabailing" varieties, respectively 19.5; 19.1; It was 18.5 points. Based on the results of the analysis, it is technologically not recommended to dry the varieties "Mayabaizao", "Dongzao" and "Dabailing" in this drying mode.

It allows us to conclude that it is not advisable to immediately use this mode during drying according to the fourth mode, because in the first hour of drying, a rapid increase in the temperature of the surface layers of candied fruits was observed along with the oxidation of polyphenolic substances, which led to the loss of biologically active substances and significantly reduced the appearance of the finished product.

**Table 1.** Establishing optimal drying regimes in the preparation of sukat (2021-2023)

Variety name	Temperature regime °C	Finished product output, %	Organoleptic assessment	Moisture content, %
Ta-Yan-Tszao	30-40-50	67,1	68,3	24,1
	40-50-60	66,5	75,1	22,0
	50-60-70	65,9	72,8	20,6
	70-60-50	65,3	72,1	18,5
Xiangzao	30-40-50	74,5	78,3	24,0
	40-50-60	73,8	86,1	21,9
	50-60-70	73,1	80,4	20,4
	70-60-50	72,5	78,8	18,3
Zanhuangdazao	30-40-50	77,8	81,9	24,6
	40-50-60	77,1	90,0	22,0
	50-60-70	76,4	87,0	21,3
	70-60-50	75,7	82,9	18,9
Tangzao	30-40-50	72,1	72,3	23,9
	40-50-60	71,5	79,5	21,3
	50-60-70	70,2	76,1	20,0
	70-60-50	70,8	77,1	18,1
Mayabaizao	30-40-50	52,3	50,0	23,7
	40-50-60	51,9	54,9	21,0
	50-60-70	51,4	53,3	19,8
	70-60-50	50,9	49,6	18,0
Junzao	30-40-50	81,7	82,8	24,0
	40-50-60	81,0	91,0	22,0
	50-60-70	80,3	88,3	21,6
	70-60-50	79,5	84,1	19,1
Dabailing	30-40-50	57,4	51,0	23,0
	40-50-60	56,9	56,0	21,0
	50-60-70	56,4	54,3	21,3
	70-60-50	55,9	49,7	18,0
Dongzao	30-40-50	55,1	50,4	22,9
	40-50-60	54,6	55,4	21,0
	50-60-70	54,1	53,7	19,2
	70-60-50	53,6	49,3	18,0
Linyilizao	30-40-50	67,4	71,3	24,0
	40-50-60	66,8	78,3	22,0
	50-60-70	66,2	76,0	21,0
	70-60-50	65,6	75,2	19,0
Jixinzao	30-40-50	75,8	79,4	24,0
	40-50-60	75,1	87,3	21,8
	50-60-70	74,5	84,7	20,7
	70-60-50	73,8	82,2	19,0

In this regime, as well as the indicators recorded in other regimes, "Junzao", "Zanhuangdazao" and "Jixinzao" varieties are 84.1, respectively; 82.9. It was evaluated with 82.2 points, the average performance varieties "Xiangzao", "Tangzao", "Linyilizao"

and "Ta-Yan-Tszao" are 78.8, respectively; 77.1; 75.2 was set as 72.1 points. "Dabailing", "Mayabaizao" and "Dongzao" varieties that scored below the minimum evaluation index are 49.6; 49.7; As they scored 49.3 points, these varieties were also recorded as non-drying varieties (Table 1). The moisture content of the finished product varied between varieties, the main reason for this being the difference in dry matter and water content of the variety.

According to it, varieties with 22% moisture content in terms of optimal storage and usability were observed in variants dried at a temperature of 40-50-60 °C. "Ta-Yan-Tszao", "Junzao", "Linyilizao" and "Zanhuangdazao" varieties got this indicator.

Thus, according to the results of the conducted research, the study of temperature parameters, taking into account the changes in the kinetics of drying, the mechanical structure and biochemical properties of raw materials, made it possible to optimize the technological process of sukat drying. The following drying regimes are recommended for production - during the first 4 hours at a temperature of 40 °C, uniform and gradual heating of the inner layers is ensured, during which air circulation is improved, after 4 hours at 50 °C it is normalized according to the permeability of the fruit and at a temperature of 60 °C the product is dry passes into the drying phase.

In order to improve the organoleptic quality indicators of Unabi sukat, preparation and drying processes of raw materials for drying should be carried out differentially, taking into account the characteristics of the variety.

Development of a technological scheme for making sukat from unabi fruits. The following points should be taken into account in the production of high-quality sukat from fruits and berries; It consists of keeping the amount of biologically active substances in the raw materials to the maximum, improving the taste and appearance of the product, reducing the amount of sugar in the prepared sugar, shortening the duration of technological processes.

Based on the above experiments on determining the optimal concentration of sugar syrup, preparing fruits for sorption, increasing the intensity of the sorption process, and choosing the modes of drying, we developed a scheme for making sukat. According to it, receiving fruits, sorting, mechanical treatment of the fruit surface, boiling in 3 stages (for 15, 10, 5 minutes) and after each boiling, putting the fruits to soak in sugar paste for 4 hours, separating the fruits from the paste, 40-50 in 3 different modes It includes the processes of drying at 60 °C for 12 hours with 4-hour intervals, sorting products according to shape and color, packaging the finished product and keeping the products at optimal temperatures until sale.

## 4 Conclusion

In the production of high-quality sukat products, unabi fruits are dried for 12 hours at 3 different temperature regimes of 40-50-60 °C with an interval of 4 hours. In order to improve the organoleptic quality indicators of the product, the preparation and drying processes of raw materials for drying should be carried out differentially, taking into account the varietal characteristics and biochemical composition of fruits.

The amount of dry matter in the composition of sukat made from unabi fruits was 78-80%, and the moisture content was 18-24% on average. Due to the high concentration of sugar in sukat, 60-65%, cells of microorganisms hydrate and die. Therefore, it is recommended to store unabi sukats at a temperature of 0-20 °C and a relative humidity of 75% for 6-12 months.

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