EFFECT OF DRYING METHOD ON PROCESS DURATION, YIELD, AND QUALITY OF PUMPKIN FRUITS

Sobirova Raykhon Khudaybergan qizi
https://orcid.org/0009-0000-7398-8222
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Abstract

This article investigates the morphological characteristics of pumpkin varieties and the effect of pre-drying treatments on drying duration and product yield. The results showed that varieties with a higher pulp proportion are technologically more suitable for drying and processing. Among the pre-drying treatments, blanching significantly reduced drying time and increased the yield of the finished product. The obtained results are important for improving pumpkin drying technology.

Keywords: pumpkin, variety, morphological traits, drying, product yield, blanching, processing technology

Introduction

The morphological structure of pumpkin fruits (fruit mass, peel proportion, seed fraction, and pulp content) is one of the main factors determining their efficiency in industrial processing, drying yield, and technological suitability. In particular, varieties with a higher pulp proportion tend to produce a greater yield of finished products, whereas varieties with higher peel and seed fractions are more likely to experience processing losses.

In addition, pre-drying treatments (acid treatment, antioxidant treatment, blanching) alter moisture distribution within tissues and affect enzymatic activity, thereby significantly influencing drying duration and the quality of the final product.

The aim of this study was to comparatively evaluate the morphological characteristics of pumpkin varieties and to determine the influence of pre-drying treatments on drying duration and product yield.

Materials and Methods

Ten pumpkin varieties were studied: Ispanskaya-73 (control), Kashgarskaya-1644, Palov kadu-268, Vitaminnaya, Zapekanka, Non kadu, Tyoshchin pirog, Ulybka, Zolotaya, and Kroshka.

Morphological indicators

The following parameters were evaluated for each variety (Table 1):

- average fruit mass (kg)
- peel proportion (%)
- seed fraction (%)

• pulp proportion (%)

Pre-drying treatments

Pumpkin varieties were prepared using four variants, and drying time (min) and product yield (%) were comparatively assessed (Table 2):

1.Control – mechanical cleaning and slicing

2.Treatment with citric acid solution (0.3–0.5%)

3.Treatment with ascorbic acid solution

4.Short-term blanching (80–90°C, 1–3 min)

Results

The morphological structure of pumpkin fruits is one of the main factors determining processing efficiency, yield, and technological suitability. Fruit mass, peel thickness, seed proportion, and pulp content play an important role in industrial processing, drying, canning, and the production of semi-finished products.

According to the data in Table 1, the studied pumpkin varieties differ significantly in fruit mass and structure. These differences are associated with the genetic characteristics and morphological structure of the varieties and directly influence their technological efficiency.

Table 1

Morphological and technological characteristics of pumpkin varieties

No.	Variety	Average fruit mass (kg)	Peel proportion (%)	Seed fraction (%)	Pulp proportion (%)
1	Ispanskaya-73	3.8	7.5	6.2	86.3
2	Kashgarskaya-1644	4.5	8.1	7.0	84.9
3	Palov kadu-268	5.2	9.0	6.5	84.5
4	Vitaminnaya	3.2	6.8	5.9	87.3
5	Zapekanka	2.9	6.5	6.3	87.2
6	Non kadu	4.1	8.4	6.8	84.8
7	Tyoshchin pirog	3.6	7.2	6.0	86.8
8	Ulybka	2.7	6.1	5.6	88.3
9	Zolotaya	3.4	7.0	6.1	86.9
10	Kroshka	2.5	5.8	5.4	88,8

Fruit mass among the studied varieties ranged from 2.5 to 5.2 kg. The largest fruits were recorded in the Palov kadu-268 variety (5.2 kg), which places it among the most suitable varieties for industrial processing. The Kashgarskaya-1644 (4.5 kg) and Non kadu (4.1 kg) varieties also belong to the relatively large-fruited group.

The smallest fruits were observed in the Kroshka (2.5 kg), Ulybka (2.7 kg), and Zapekanka (2.9 kg) varieties. Such varieties are generally considered suitable for fresh consumption or for portion-sized product production.

The peel proportion is an important indicator determining processing yield. According to the data, peel content ranged from 5.8% to 9.0%. The highest peel proportion was observed in the Palov kadu-268 variety (9.0%). Although this increases mechanical strength, it slightly reduces processing yield.

The lowest peel proportion was recorded in the Kroshka (5.8%), Ulybka (6.1%), and Zapekanka (6.5%) varieties. These varieties are therefore distinguished by their potentially higher processing yield. The seed fraction is important for the biological value of the product and potential oil yield. Among the studied varieties, seed content ranged from 5.4% to 7.0%. The highest value was observed in Kashgarskaya-1644 (7.0%), indicating that this variety may also be suitable for seed production and oil processing. The lowest seed content was observed in Kroshka (5.4%) and Ulybka (5.6%), which allows these varieties to be classified as high-pulp processing varieties.

Pulp proportion is the main economic indicator in processing. According to the data, pulp content ranged from 84.5% to 88.8%. The highest pulp proportion was recorded in the Kroshka variety (88.8%). Similarly, Ulybka (88.3%), Vitaminnaya (87.3%), and Zapekanka (87.2%) also showed high pulp yields. These varieties are therefore considered most suitable for drying, puree production, and canning. Relatively lower pulp proportions were observed in Palov kadu-268 (84.5%), Non kadu (84.8%), and Kashgarskaya-1644 (84.9%), which is associated with their higher peel and seed fractions.

Overall analysis of the morphological indicators showed that varieties with a high pulp proportion and low peel fraction are technologically preferable for processing. In this regard, Kroshka, Ulybka, Vitaminnaya, and Zapekanka showed advantages. Large-fruited and mechanically strong varieties — Palov kadu-268, Kashgarskaya-1644, and Non kadu — are more suitable for transportation and long-term storage.

During pumpkin drying, the initial preparation stage is a crucial factor determining product quality and technological efficiency. Pre-drying treatment influences moisture distribution in tissues, enzymatic activity, oxidation processes, and tissue structural stability. Therefore, selecting the optimal pre-treatment method is important for increasing product yield and reducing drying duration.

In the experiments, pumpkin varieties were prepared in four variants: mechanical cleaning and slicing (control), treatment with citric acid solution, treatment with ascorbic acid solution, and short-term blanching. Drying time and final product yield were comparatively analyzed for all variants (see Table 2).

In the control variant, drying duration was the longest, ranging from 420 to 504 minutes. This is explained by the fact that moisture remained in a relatively free state within tissues and enzymatic processes were not fully inhibited. Under such conditions, moisture removal from internal layers proceeds slowly, prolonging the drying process.

In the citric acid treatment variant, drying time decreased by approximately 15–25 minutes. This can be attributed to the acidic environment reducing enzymatic activity and limiting oxidation processes on the product surface. In addition, acid treatment partially loosens cell walls, thereby slightly accelerating moisture release.

Table 2

Effect of preparation methods on drying duration and product yield of pumpkin varieties (2023–2025)

№	Variety	Control (mechanical cleaning and slicing)		Citric acid treatment (0.3–0.5%)		Ascorbic acid treatment		Short blanching (80–90°C, 1–3 min)	
		Time (min)	Yield (%)	Time (min)	Yield (%)	Time (min)	Yield (%)	Time (min)	Yield (%)
1	Ispanskaya-73	480	14,0	462	14,3	456	14,5	426	15,0
2	Kashgarskaya-1644	498	13,8	474	14,1	468	14,3	432	14,8
3	Palov kadu-268	504	13,7	486	14,0	480	14,1	444	14,6
4	Vitaminnaya	438	14,9	420	15,2	414	15,4	396	15,8
5	Zapekanka	444	14,7	426	15,0	420	15,1	402	15,6
6	Non kadu	492	13,9	468	14,2	462	14,3	426	14,8
7	Tyoshchin pirog	474	14,1	456	14,4	450	14,6	414	15,0
8	Ulybka	432	15,1	414	15,4	408	15,6	390	16,0
9	Zolotaya	462	14,3	444	14,6	438	14,8	408	15,2
10	Kroshka	420	15,3	402	15,6	396	15,8	378	16,2

When treated with ascorbic acid, a further reduction in drying time was observed. This method provides an antioxidant environment for the product and more effectively inhibits oxidation processes. As a result, in most varieties the drying time decreased by 20–30 minutes compared with the control. This effect can be explained by the ability of ascorbic acid to maintain biochemical stability within tissues.

The shortest drying time was recorded in the blanching treatment. During blanching, cell walls partially soften, air spaces decrease, and moisture release accelerates. For example, in the Palov kadu-268 variety drying time decreased from 504 to 444 minutes, while in the Kroshka variety it decreased from 420 to 378 minutes. Overall, this made it possible to accelerate the drying process by approximately 10–15%.

When evaluating drying efficiency, product yield is considered the main economic indicator. In the control variant, yield ranged from 13.7% to 15.3%, reflecting substantial moisture loss during drying. Treatment with citric acid increased yield by approximately 0.3–0.5%. This is associated with improved retention of dry matter in the product. The acidic environment limits enzymatic degradation and helps preserve tissue integrity.

Treatment with ascorbic acid resulted in even higher yields, increasing by 0.5–0.7% in most varieties compared with the control. This can be explained by the antioxidant effect, which helps preserve nutrients within the product.

The highest yield was observed in the blanching variant, where yield increased by up to 0.8–1.0% relative to the control. For example, in the Kroshka variety yield increased from 15.3% to 16.2%, and in the Ulybka variety from 15.1% to 16.0%. This can be explained by the stabilization of cell structure during blanching, which reduces dry matter losses during drying. The results showed that pumpkin varieties responded differently to pre-drying treatments. In varieties with softer tissues and higher moisture content, the effect of preparation methods was more pronounced. For example, in the Kroshka, Ulybka, and Vitaminnaya varieties drying time decreased significantly and yield increased.

In contrast, in varieties with denser tissues and thicker peel, differences were relatively smaller. This group includes Palov kadu-268, Kashgarskaya-1644, and Non kadu. In these varieties, moisture diffusion proceeds more slowly under natural conditions, so the influence of preparation methods was somewhat limited. It was established that pre-drying treatment plays a decisive role in shaping product quality. Acid treatment limited enzymatic browning and helped preserve product color. Blanching accelerated drying and reduced energy consumption. In addition, blanching improved the retention of nutrients in the product.

The chemical composition of pumpkin fruits is an important factor determining their nutritional value, processing efficiency, and stability during drying. Dry matter, sugars, carotenoids, vitamins, pectin substances, and mineral elements not only define nutritional and biological value but also characterize quality changes during drying. Therefore, comparative analysis of pumpkin varieties in fresh and dried states provides an important scientific basis for evaluating their technological suitability.

According to the research results, although the chemical composition of fresh pumpkin varieties was generally similar, significant differences were observed in some indicators. Dry matter content in fresh fruits ranged from 10.9% to 12.4%. The highest value was recorded in the Vitaminnaya variety (12.4%), indicating its biochemical richness, while the lowest value was observed in the Kroshka variety (10.9%). Dry matter content directly influences product energy value, processing efficiency, and drying yield. It was also determined that morphological characteristics of pumpkin varieties play an important role in their technological suitability for drying. Varieties with a high pulp proportion — Kroshka, Ulybka, Vitaminnaya, and Zapekanka — were found to be most suitable for drying and processing. Among pre-drying treatments, blanching showed the strongest effect, significantly reducing drying time and maximizing product yield. Acid treatments also produced positive results, particularly ascorbic acid treatment, which consistently improved drying efficiency.

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